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Chakawodza, Josphine Munyaradzi

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Effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 Learners

by

Josphine Munyaradzi Chakawodza

Student Number: 1416315

Protocol Number: H/20/11/11

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Supervisor: Dr. Mpunki Nakedi

Co-supervisor: Professor Rita N. Kizito

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ABSTRACT

Globally, the use of blended teaching has increased tremendously, particularly at university level. However, there is a dearth of research on the use of blended teaching at high school level and in a developing nation, as well as on the efficacy of blended teaching at high schools, particularly those that are least advantaged. These under-resourced schools where traditional face-to-face teaching is prevalent, cater for the largest learner cohort in South Africa. This study focused on Organic Chemistry, a Physical Sciences topic which most South African learners generally find difficult resulting in poor academic achievement. All this requires that innovative teaching methods be employed. When designed effectively, blended teaching comes with several benefits, such as catering for learner diversity, self-directedness, and flexibility, thereby increasing learning gains (Armellini & Rodriguez, 2021, Halverson & Graham, 2019). The main aim of this study was to determine the effectiveness of blended teaching in developing learning engagement and academic achievement in Organic Chemistry in Grade 12 learners at one of the least advantaged High schools of South Africa. A mixed method approach in the form of sequential explanatory design was utilised. Two existing groups (resembling quasi experimental design in which the subgroup sample assignment depicted elements of random sampling), one experimental (n=100), and another control (n=100), comprising Grade 12 Physical Sciences learners from one school participated in this study. Quantitative data collected through surveys and Organic Chemistry test were analysed using descriptive and inferential statistics as well as moderated regression analysis while qualitative data (interview data from six boys, six girls, and two teachers) were analysed using thematic, content, and comparative analyses. This showed that blended teaching was significantly more effective in developing learning engagement and improving academic achievement in Organic Chemistry. It was concluded that the 'blend' used in this study was effective for the broader South African high school context. Additionally, two out of three learning engagement sub-constructs had significant moderating effects on the relationship between blended (or traditional face-to-face) teaching and academic achievement while the third one did not.

Keywords: blended teaching, traditional face-to-face teaching, learning engagement, academic achievement, Organic Chemistry, South African high school context.

Declaration

I declare that this thesis is my own, original work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination in any other University.



Name: Josphine Munyaradzi Chakawodza

Dedication

I dedicate this thesis to my husband and daughter who supported me throughout the years and to God who made it possible.

Acknowledgements

I would like to take this opportunity to thank the following people for their support and contribution to the success of this thesis:

- My husband, Christopher, for his support.
- Dr Mpunki Nakedi and Professor Rita N. Kizito for their support and guidance.
- Our daughter Charmaine for her support.
- Mpumalanga Department of Education for allowing the project.
- Research school staff and the learners for their participation.

List of abbreviations

NSC: National Senior Certificate

CAPS: Curriculum and Assessment Policy Statement

FET: Further Education and Training

GET: General Education and Training

HET: Higher Education and Training

DoE: Department of Education

KOOCT: Knowledge of Organic Chemistry Test

OCLESQ: Organic Chemistry Learning Engagement Survey Questionnaire

CE: Cognitive Engagement

EE: Emotional Engagement

ATP: Annual Teaching Plan

HOD: Head of Department

LMS: Learning Management System

ABL: Active blended learning

RMSEA: Root Mean Square Error Approximation

F2F: Face-to-face

CFI: Comparative Fit Index

TLI: Tucker-Lewis Index

SRMR: Standardized Root Mean Squared Residual

CFA: Confirmatory Factor Analysis

EFA: Exploratory Factor Analysis

PCA: Principal Component Analysis

PAF: Principal Axis Factoring

KMO: Kaiser-Meyer-Olkin

Df: Degrees of freedom

MRA: Moderated Regression Analysis.

ZPD: Zone of Proximal Development

COI: Community of Inquiry

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CHAPTER ONE: INTRODUCTION

1.1 Background to the study

The increased adoption of the blended teaching strategy has been attributed to accelerated developments in technology and access to internet services in both developed and developing nations (Seery & O'Connor, 2015; Bonk & Graham, 2012; Fischer et al., 2018). Internationally, there has been growing advocacy for the use of the blended teaching (Bonk & Graham, 2012; Seery & O'Connor, 2015; Sahni, 2019; O'Flaherty & Phillips, 2015). However, implementation of blended teaching programmes in the broader sector of South African high school context has been hampered by limited access to internet services, a lack of teacher development, funding challenges, and poor wi-fi connectivity (Fisher et al., 2017). Blended learning has been defined in a variety of ways by different researchers (see for example, Yaghmour, 2016; Bonk and Graham, 2012; Williams et al., 2008; Dziuban et al., 2018). In this study, the definition presented by Garrison and Vaughan (2008) was adopted, mainly due to its comprehensiveness.

According to Garrison and Vaughan (2008), blended learning is the 'thoughtful' combination of the online and the traditional face-to-face teaching methods (discussed hereafter) in a way that caters for contextual factors while being guided by the educational goal to be fulfilled. This definition is supported by other researchers (see for example, Seery and O'Connor, 2015; and Staker & Horn, 2012; Halverson & Graham, 2019). Furthermore, it should be noted that blended teaching (as used in this study) encompasses what learners do when learning in response to the teacher's actions and directives (Naaj et al., 2012). Based on this, the terms blended teaching and blended learning are used interchangeably in this study. The major aim of this study was to determine the effectiveness of blended teaching in developing South Africa Grade 12 learners' engagement and achievement in Organic Chemistry. This was done through comparing the efficacies of a blended teaching and traditional face-to-face teaching method in developing the learning engagement of two groups of Grade 12 learners in one South African school, and their academic achievement in Organic Chemistry.

As applied to this study, the traditional face-to-face teaching method is a formal teacher-centred instruction in which the teacher directly transmits knowledge to learners (Bonk & Graham, 2012; Staker & Horn, 2012; Seery & O'Connor, 2015; Lehesvuori et al., 2018; Chew et al.,

2008; Poe, 2015). For instance, Bonk and Graham (2012), assert that learners being taught using the traditional face-to-face teaching method assume passive roles of either listeners or note-takers during most of the lessons. According to Fischer et al. (2018), traditional face-to-face teaching methods still exist alongside digital, and technology driven teaching approaches such as blended teaching. Fischer et al. (2018) blamed these traditional face-to-face teaching approaches mainly among other issues, for their learner disengagement (opposite of learner engagement), and poor learning outcomes which this study recognises as poor academic achievement. This presents a problem, considering that basic education in South Africa needs to be learner-centred (Department of Basic Education, 2011; Vygotsky & Cole, 1978).

More importantly, research studies based on South Africa (Lehesvuori, 2018; Taylor, 2008; De Beer, 2016; Fisher et al., 2017) show that the traditional face-to-face teaching method is still prevalent in most South African schools, particularly those located in disadvantaged communities. Of interest in this study is that this may be an indication of a possible correlation among traditional face-to-face teaching methods, subdued learning engagement, and poor academic achievement. This generally reported low learner engagement in South African schools, which is associated with poor achievement (Taylor, 2008), is further exacerbated in subjects such as science (De Beer, 2016) more especially in topics such as Organic Chemistry, in which clearly learners persistently struggle.

The diagnostic reports on National Senior Certificate (NSC) examinations (Department of Basic) in three consecutive years (2019–2021) has shown that learners under-perform in this critical science topic. Nevertheless, Organic Chemistry is an important component of the science curriculum, which makes developing meaningful understanding of its concepts essential (Grove & Bretz, 2012; Salame et al., 2019). For example, Organic Chemistry is studied in many science-related courses at university (Mullins, 2008; Salame et al., 2019), which places an emphasis on the need to lay a firm foundation at high school level and ensuring that learners appreciate its relevance (Grove & Bretz, 2012), which may result in scientific literacy. Given this, the need to explore the effectiveness of other teaching methods that may constitute a potential replacement for traditional face-to-face teaching methods cannot be overemphasised. However, traditional face-to-face teaching approaches have their own merits, from which blended teaching has the potential of drawing.

Traditional face-to-face merits include the timeous feedback to learners and immediate assistance from the teacher (Yaghmour, 2016; Seery & O'Connor; 2015; Bonk & Graham, 2012; Garrison & Vaughan, 2008), hence the interest in a blended approach in this study. The premise of this study is that it is possible to combine the advantages of traditional face-to-face teaching and online teaching with a view to formulating effective blended teaching, which is responsive to the educational challenges alluded to above. Staker and Horn (2012) add that traditional face-to-face teaching occurs offline and does not require the use of technology, which also distinguishes it from the online teaching component of blended teaching.

For the purposes of this study, online teaching is understood as an instructional approach, which includes the use of web-based technology and internet services (Staker & Horn, 2012; Williams et al., 2008) and is formally mediated by the teacher (Staker & Horn, 2012). By specifically mentioning the need for formal mediation by the teacher, this excludes instances where learners browse the internet without instructions from the teacher (Staker & Horn, 2012). Some of the formal online activities may include videos, online quizzes, wikis, online discussion forums and simulations (Seery & O'Connor, 2015; Vaughan, 2014). There are certain advantages associated with online teaching and learning, such as flexibility which allows learners to work at their own pace and during times that are most suitable for them (Seery, 2015; Yaghmour, 2016; Bonk & Graham, 2012; Williams et al., 2008).

Even though most schools in South Africa still use traditional face-to-face teaching as noted earlier, it is important to acknowledge that some schools, particularly the well-resourced ones, have started using online learning more, as a mitigation measure against challenges brought about by the COVID-19 pandemic. However, research has shown that blended teaching, when used effectively, is accompanied by the benefits of both the traditional face-to-face and online teaching approaches (Garrison & Vaughan, 2008; Bonk & Graham, 2012; Seery, 2015; Seery & O'Connor, 2015; Sahni, 2019; Naaj et al., 2012; Yaghmour, 2016). For this reason, there is a growing popularity of the use of blended teaching (Seery, 2015; Yaghmour, 2016; Bonk & Graham, 2012, Sahni, 2019; Lin, 2018). Blended teaching has also been shown to be effective in fostering 'self-directed learning' (Vaughan, 2014), achievement, and learner engagement (Sahni, 2019; Lin, 2018, Halverson & Graham, 2019), mostly at university level, and at a few affluent private schools of South Africa (Fisher et al., 2017). Hence, this study focuses on the least advantaged schools of South Africa, by interrogating the effectiveness of blended teaching which combines both teaching approaches to identify the best elements offered by these two

different approaches to ensure the best blend for effective learner engagements to optimise academic achievement in Organic Chemistry.

Learning engagement has been defined in different ways by different scholars (Manwaring, et al., 2017, Kuh, 2009; Axelson & Flick, 2010; Halverson & Graham, 2019, Fredericks, et al., 2004). For example, Axelson and Flick (2010) defined learner engagement as referring to "… how involved or interested students appear to be in their learning and how connected they are to their classes, their institutions, and each other" (p.38). Despite the different conceptualisations of learning engagement, most scholars agree on the notion of learning engagement being a 'multidimensional construct', however, most of them do not agree on the number or the nature of these sub-constructs/dimensions/subtypes/subcategories/indicators of the learning engagement construct (Reschly & Christenson, 2012, Fischer et al., 2018; Fredericks et al., 2004; Bond et al., 2020; Finn & Zimmer, 2012).

Even though Reschly and Christenson (2012), summed up this issue by indicating that most researchers agree with the idea of three sub-constructs, however, most do not agree on the definition of each of these three sub-constructs. Furthermore, it is worth noting that this is in addition to the lack of consensus on what each of sub-constructs entails (Reschly & Christenson, 2012, Fischer et al., 2018; Fredericks et al., 2004; Bond et al., 2020; Finn & Zimmer, 2012), which creates measurement problems. For example, while asserting that learning engagement ought to be conceptualised in terms of three sub-constructs already implied in the Fischer et al. (2018) as cognitive, affective and behavioural, Fredricks et al. (2004) bemoan that most researchers focus on one or two sub-constructs, which results in measurement problems. Examples of this are presented by Halverson and Graham (2019) and Manwaring et al. (2017), to name a few. On the other extreme lies researchers that have presented four sub-constructs, such as Reeve (2012). Reeve (2012) focused on four sub-constructs (viz. cognitive, emotional, behavioural, and agentic engagements), given that these learning engagement subtypes are best exemplified using the learning tasks, which are alluded to in Reeve's (2012) definition of learning engagement.

By specifically mentioning learning tasks in the definition, Reeve (2012) stated above, it becomes self-evident that the learning engagement being referred to in the present study is activity-based (Reschly & Christenson, 2012). However, where Halverson et al. (2019) propose to stick to two sub-constructs as cognitive and emotional engagements, this also creates

problems as far as peer interactions are concerned. These peer interactions were embedded in the learning tasks that form a central role in fostering learning engagement (Manwaring et al., 2017). These learning tasks may take various forms, such as studying, interactions (learner to learner interactions, teacher to learner interactions, and learner to content interactions), participation in discussion forums, and application of concepts learnt to real life situations (Kuh, 2009; Vaughan, 2014) thereby impacting on academic achievement. Closely related to learning tasks mentioned above is the idea that blended teaching has an impact on learner interactions which have been presented as an essential by-product of blended teaching by several scholars (see for example, Naaj et al., 2012; Halverson and Graham, 2019; Bonk and Graham, 2012; Williams et al., 2008). At this point, it becomes important to position these learning tasks in the context of the three sub-constructs of learning engagement that receive focus in this study.

These sub-constructs are behavioural, affective (emotional), and cognitive (Fredericks, et al., 2004; Bond, et al., 2020; Mahatmya, et al., 2012; Reschly & Christenson, 2012; Anderman & Patrick, 2012; Skinner & Pitzer, 2012). Even though the present study focuses on three sub-constructs of learning engagements identified, for the purposes of measurement the emotional engagement scale includes aspects of behavioural engagement, which are participatory in nature such as working with peers, working in groups, or actively participating in projects, sharing ideas, or making a contribution to discussion (Fredericks et al., 2004; Anderman & Patrick, 2012), or peer interactions (Yazzie-Mintz & McCormick, 2012).

The premise for this is that the behavioural component is usually combined with emotional/affective component as indicated by Fredericks et al. (2004). This stance was taken mainly due to the fact that this study focuses only on peer interactions as part of only one behavioural engagement component which is concerned with participation. In addition, Fredricks et al. (2004) identified two components of behavioural engagement as ‘participation’ and ‘academic’, which includes time spent on educational tasks such as completing homework, for example (Fredericks, et al., 2004). Fredricks et al. (2004) are supported in their arguments on behavioural engagement (2004) by Reschly and Christenson (2012). In this study, the academic factors were accommodated in cognitive engagement as indicated by Halverson et al. (2019). Furthermore, Finn and Zimmer (2012) added that subtle differences exist between academic behavioural engagement and cognitive engagement, which further support the idea of combining the two. Additionally, in this study, emotional engagement is combined with the

component of participation behavioural engagement. On this note, it is important to highlight that Fredricks et al. (2004) appear to be against the idea of splitting sub-constructs of learning engagement that are slightly different, as this would result in too many sub-constructs, which in turn derail any efforts directed at making the construct clearer. The emotional component was identified as affective engagement for study purposes only. This stance had to be adopted due to the problems associated with the use of behavioural engagement, stemming from its significant interactions with cognitive engagement (Halverson & Graham, 2019). This overlap has further complicated the already complex learning engagement construct which is riddled with conceptualisations that lack clarity (Halverson & Graham, 2019; Manwaring et al., 2017). Having shed some light on behavioural engagement, it becomes imperative for affective engagement and cognitive engagement to be clarified as operational concepts.

According to Fredricks et al. (2004), affective engagement includes negative and positive reactions towards peers, teachers, or academics as well as the learning institution. Some of the positive emotions mentioned include happiness, enjoyment, confidence (Halverson & Graham, 2019), and feelings of belonging (Reschly & Christenson, 2012, Fredricks et al., 2004; Skinner and Pitzer, 2012) while the negative ones include boredom, anxiety, and frustration (Halverson & Graham, 2019). Interestingly, affective engagement is believed to have an effect on all the other sub-constructs of learning engagement including cognitive engagement (Finn & Zimmer, 2012). For the purposes of this study, cognitive engagement is conceptualised as the 'investment of mental energy' with the aim of achieving learning proficiency in a given subject or topic (Halverson & Graham, 2019). In this study, the focus is on Organic Chemistry proficiency.

Examples of facilitators of cognitive engagement include in-depth learning, perseverance, interest (Halverson & Graham, 2019) self-regulation/ self-directedness (Fischer et al., 2018). As pointed out, research conducted by some scholars has shown that learning engagement is intricately related to academic achievement (Kuh, 2009; Halverson & Graham, 2019; Oriab, 2015; Leslie, 2019; Bond, et al., 2020). The question still lingers as to what kind of relationship exists among the variables blended teaching (or traditional face-to-face teaching), learning engagement sub-constructs, and academic achievement. There is a need to develop an understanding of what academic achievement variable as used in this study entails.

For this study, academic achievement constitutes a measure of how much learners have learnt using grades obtained from standardised assessment tasks (York et al., 2015). These standardised assessment tasks take various forms, which include standardised tests or examinations such as the National Senior Certificate examinations. The decision to measure academic achievement using standardised tests is supported by other scholars, such as Back et al. (2016). Moreover, York et al. (2015) argue that academic achievement is limited to grades. The decision to use tests to measure academic achievement in this study was further motivated by its wider adoption in the field (York et al., 2015). In this study, academic achievement was determined through administering a post instruction standardised test in Organic Chemistry to Grade 12 Physical Sciences learners. This standardised test was used to assess learners' knowledge of Organic Chemistry facts, and practical skills as stipulated by the Physical Sciences CAPS document (Department of Basic Education, 2011).

Research underscores the need for improved academic achievement scores, which are determined using standardised tests (Back et al., 2016). Furthermore, Fischer et al. (2018) assert that the grades attained by learners are indicative of how much knowledge and skills they have attained and applied in order to achieve the learning outcomes for the subject matter being tested. On this note, it is important to highlight that some researchers have reported an improvement in both academic achievement and learning engagement due to blended teaching at university level (Seery, 2015; Sahni, 2019; Fischer et al., 2018; Ashraf et al., 2021).

On the other hand, scholars such as Axelson and Flick, (2010) explicitly mention that some learners are highly engaged, but still fail to attain any reasonable level of proficiency in the subject matter. Even though Axelson and Flick (2010) did not explictly mention the conditions under which this happens, it is not clear whether blended learning environments would be any better at ensuring more effective learning engagement that correlates with academic achivement. Considering the background above, several questions on the effectiveness of blended teaching remain unanswered.

1.2 Rationale of the study

Fazal and Bryant (2018) have concluded that blended teaching is still in the evolutionary stages, despite being around for some time. They emphasise the need to conduct rigorous studies,

which will benefit schools by illuminating a range of effective pedagogical practices from which to choose. Having said this, it is important to highlight the existence of several models of blended teaching, which need to be adapted to suit learner needs and ever-changing paradigms that define schools (Fazal & Bryant, 2019). This study has the potential to contribute more significantly to the knowledge on the effects of blended teaching by shedding some light on the type of 'blend' that is more likely to be effective when applied to the largest learner cohort in the South African basic education sector. At this point, it becomes important to highlight the idea that the success of blended teaching is dependent on several factors such as, type of blend utilised and the specific content area (Ashraf et al., 2021; Fazal and Bryant, 2019). Fazal and Bryant (2019:51) who conducted research on the effectiveness of blended learning on academic achievement of grade six learners recommended the following:

"…additional research needs to be conducted in multiple settings, grades, content, and diverse groups*."*

It is noteworthy that by stating this, Fazal and Bryant (2019) assert that one type of blended teaching is not a panacea for all pedagogical problems being experienced in a variety of educational settings. Additionally, a study by Fisher et al. (2017) showed that the few South African public schools that have been using limited nature of online learning mostly used it in the Mathematics classes followed by Natural Sciences which means that learners studying Physical Sciences, and more specifically Organic Chemistry, have not experienced these limited strides towards integrating technology into their lessons. On this note, it is important to take cognisance of the challenges associated with literature on blended teaching. These challenges include the non-equivalent nature of the blends used by different researchers (Dziuban et al., 2018). Moreover, Dziuban et al. (2018) emphasise the need to exercise caution when making interpretations based on research that evaluates the effectiveness of blended teaching in a specific context. Given this, the current study breaks important new ground.

The effectiveness of blended teaching on both academic achievement and learning engagement at university level has been reported by several studies (see for example, Seery, 2015; Sahni, 2019, Yaghmour, 2016). For example, a meta-analysis of studies focusing on the effectiveness of flipped learning as a form of blended teaching (Staker & Horn, 2012; Schell & Mazur, 2015; Fischer et al., 2018) showed that blended teaching develops learning engagement through a promotion of active learning resulting in an improvement in academic achievement (Seery, 2015). While these studies point towards the effectiveness of blended teaching in improving

learning engagement and academic achievement, most have focused on tertiary or university learners. The effectiveness of blended teaching in improving learning engagement and academic achievement on high school learners is still under-researched (Fazal and Bryant, 2019), particularly in the least advantaged schools of South Africa (Fisher et al., 2017). Moreover, some researchers have explicitly mentioned the need to investigate learner engagement in blended settings (Halverson and Graham, 2019; Manwaring, et al., 2017; Ashraf et al., 2021; Fischer et al., 2018). This highlights the existence of a gap in literature on learner engagement in blended settings. It is for this reason that the present study investigates the effectiveness of using blended teaching on developing learning engagement and achievement focusing on high school learners and Organic Chemistry.

Moreover, it is worth noting that not all studies on blended teaching literature agree on its impact or effectiveness on learning engagement and achievement. For instance, a study by Williams et al. (2008) showed that blended learning was ineffective in improving learner achievement in Inorganic Chemistry. In a related study, Manwaring et al. (2017) concluded that blended teaching does not foster learning engagement but notes that the design features of the learning tasks do. A similar conclusion was made by Axelson and Flick (2010), who suggest that learners disengage (opposite of engage) when the learning task is either too easy or too difficult which to some extent points towards design features of the blended learning system inclusive of the learning tasks utilised. Given this background, the current study is important, as it has the potential to add to the knowledge regarding the effects of activity-based blended teaching on high school learners' engagement and achievement in Organic Chemistry. Interestingly, most of the studies done in Chemistry Education, on the topic for this study were conducted in developed countries such as the UK (see for example Richards-Babb et al., 2015).

In addition, Fredricks et al. (2004) suggest that there is a chance that learning engagement may differ significantly among elementary and high school learners compared to that of learners in post-high school settings such as universities. For this reason, it is interesting to determine what the results will be like, focusing on a developing country such as South Africa, particularly the least advantaged schools. More importantly, the relationship among the variables: learning engagement, academic achievement, and blended teaching (or traditional face-to-face teaching) could not be clearly determined using existing literature.

Rodriguez et al. (2019) investigated the possibility of behavioural homework engagement assuming either a mediating or moderating function, while Shimizu (2022) focused on aspects of cognitive engagement (problem-solving), Mathematics anxiety, and self-efficacy. However, the second study by Shimizu (2022) appears to have focused on the facilitators of learning engagement and presented overall learning engagement as a moderator, which raises a lot of unanswered questions. Fredrick et al. (2004) appears to suggest the mediating and moderating functions of learning engagement but did not test for either mediation or moderation. To further complicate this issue, Reschly et al. (2012) is of the perception that learning engagement could be both a mediator and an outcome. None of these researchers focused on high school (Grade 12) Organic Chemistry in the context of South African learners from disadvantaged communities. Given that learning engagement is context-dependent (Fredericks et al., 2004), this study becomes a significant one.

Given that Shimizu (2022) found learning engagement to have a moderating effect in a different kind of context, with totally different variables, this study sought to determine the moderating effects of cognitive engagement, affective engagement, and participation behavioural engagement in a blended learning context, focusing on Organic Chemistry, and on learners from a South African school located in a disadvantaged community. This highlights an area that remains fertile, and which appears to be a largely uncharted territory in terms of research based on blended teaching. Based on this, and the rest of the brief discussion undertaken here, this study becomes an important one. This discussion led to the formulation of the research problem that follows.

1.3 Statement of the problem

Organic Chemistry is a compulsory topic in the Chemistry component of Physical Sciences in South African High school curriculum (Department of Basic Education, 2011). Additionally, given that Organic Chemistry is rated as an important sub-discipline of science, there is need for learners to develop deep conceptual understanding of the subject (Grove & Bretz, 2012; Richards-Babb, et al., 2015). Nonetheless, Organic Chemistry has been identified as a difficult topic at both high school and university levels (Brown et al., 2016; Flynn, 2015; Grove & Bretz, 2012; Richards-Babb et al., 2015; Tekane et al., 2020; Salame et al., 2019; Mullins, 2008), showing poor academic achievement in many countries, including South Africa. In South Africa, academic achievement in National Senior Certificate examination questions based on

Organic Chemistry has been consistently poor (Department of Basic Education, 2018; 2020; 2021). This points to the existence of deep-rooted problems in the broader South African schooling system.

In South Africa, the cause of these problems includes the persistent use of ineffective teaching approaches, such as traditional face-to-face teaching methods, which result in decreased learner engagement, leading to poor academic achievement (Lehesvuori et al., 2018; De Beer, 2016; Taylor, 2008; Padayachee & Harding, 2011; Fisher et al., 2017). Similarly, research conducted in other parts of the world, such as the UK, has linked teaching methods such as the traditional face-to-face instruction, which encourages memorisation of Organic Chemistry concepts, to poor achievement (Brown et al., 2016; Richards-Babb et al., 2015; Mullins, 2008; Salame et al., 2019), and learners that are not engaged (Fischer et al., 2018; Yurtseven & Ocak, 2021).

Furthermore, according to Flynn (2015), when clickers, demonstrations, and online homework were used for years to make traditional face-to-face teaching of Organic Chemistry more active, only basic work could be covered, leaving learners to attempt more difficult work that demanded higher order thinking skills alone, resulting poor academic achievement. It could be argued that this strengthens the case for blended teaching which would have the effect of creating more in-class time during which learners can be assisted. Moreover, Yurtseven and Ocak (2021) have identified teaching method, and nature of subject which includes the use of transmissive methods, subject being difficult, topics/subjects or lessons that are boring, and not interesting, lack of in-depth learning and contextual factors as causes of learner disengagement and poor academic achievement.

Based on the brief background just outlined, the current study looked at the possibility of utilising the blended teaching method to increase learner engagement (in terms of cognitive engagement and affective engagement and participation behavioural engagement as sub-constructs), thereby improving achievement (Vaughan, 2014). Considering this, the current study investigated the effectiveness of blended teaching in fostering learning engagement and academic achievement in the context of broad public South African schooling sector (Quintle 1) focusing on Grade 12 Organic Chemistry, as part of the Chemistry component of Physical Sciences. Moreover, according to Fisher et al. (2017), most of the few schools in this category that had some form of online teaching, or something that resembled blended teaching, did not measure the effectiveness of the largely unreliable technology-mediated teaching and learning.

In addition, these schools did not make any effort to move towards blended teaching, since the online and traditional face-to-face components were run as separate entities, with a few cases where only a few learners were exposed online learning for as little as once a week (Fisher et al., 2017).

Furthermore, as already noted, most of the previous studies on either learning engagement, academic achievement or both in blended settings were conducted mostly at university levels (Seery, 2015; Williams et al., 2008; Manwaring et al., 2017; Flynn, 2015; Seery & O'Connor, 2015; Sahni, 2019; Yaghmour, 2016; Lin, 2018). Notably, several of these studies compared the traditional face-to-face teaching instruction with the blended teaching approach. Additionally, most underprivileged schools in South Africa use traditional face-to-face teaching approaches, as indicated previously (Lehesvuori et al., 2018; De Beer, 2016). Given this background, this study sought to draw a comparison between the traditional face-to-face and the blended teaching methods in a different context at the high school level in South Africa. This study also investigated the extent to which each type of learning engagement influences the relationship between these two teaching approaches and academic achievement, with a view to develop a deeper understanding of the effectiveness of blended teaching.

The idea that learning engagement influences academic achievement is well documented in literature (Lin, 2018; Fischer et al., 2018; Kuh, 2009; Manwaring et al., 2017; Halverson et al., 2019; Reschly & Christenson, 2012). However, no research has explicitly tried to determine the type of variable that learning engagement assumes in the teaching and learning processes of High School Organic Chemistry within a South African context. The topic under investigation remains under-researched. Moreover, Axelson and Flick (2010) point out that there exists a group of learners who, even though they are usually highly engaged, perform poorly, which raises the issue of the quality of engagement in addition to whether learning engagement has an effect on academic achievement. This makes it imperative that this study be conducted particularly with a view to develop an understanding on the conditions under which learning engagement influences academic achievement.

Notably, learning engagement is placed inbetween the independent (contextual factors which could be teaching approach) and the (outcome of learning enagement such as academic achievement) dependent variables in an illustration which can be used to show the relationship among the three variables (Halverson & Graham, 2019; Reschly & Christenson, 2012). By

doing this, Halverson et al. (2019) imply that learning engagement could be either a mediating variable, which has a causal effect, or a moderating variable, which influences the strength of the relationship between teaching method and academic achievement. In this study, learning engagement is conceptualised as a moderator variable, which influences the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement, simply because academic achievement can still be achieved whether learning engagement is there or not (Hayes, 2022). Similarly, a study by Shimizu (2022) concluded that learning engagement had a moderating effect on the relationship between self-efficacy, Mathematics anxiety, problem-solving strategy, and vector problem-solving performance. It is worth noting that the research by Shimizu (2022) is different from the present study which could result in potential generation of new knowledge.

Furthermore, most researchers agree that learning engagement is a 'multidimensional construct' comprising cognitive engagement, behavioural engagement, and affective engagement as sub-constructs (Bond et al., 2020; Yurtseven & Ocak, 2021; Fredericks et al., 2004; Reschly & Christenson, 2012). However, the extent to which each of the three sub-constructs of learning engagement: cognitive or affective, or participation behavioural engagement moderate the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement remains under-researched. Furthermore, several issues, such as the failure to distinguish between different engagement types have been discovered, and these include making it difficult to determine the specific consequences of each type of engagement (Fredericks et al., 2004) on the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement.

In short, framing this aspect of this particular study this way made it possible to determine the specific contributions of each type of engagement, which undoubtedly makes this study an important one. The types of learning engagement that were investigated are cognitive engagement, affective engagement, and participation behavioural engagement. Taking this further step sets this study apart, as most studies only focus on two variables (viz. X and Y) (MacKinnon, 2011). Most importantly, there are several reasons for conducting moderation analysis, such as taking cognisance of the fact that relationships among variables are seldom straightforward (MacKinnon, 2011). More importantly, conducting a moderation analysis becomes mandatory in the event that the findings need to be implemented practically (MacKinnon, 2011). One such application undertaken in this study was the determination of

the nature of blend most suitable to contextual factors of this study. The suitability of the blend could provide an indication of the effectiveness of blended teaching or a lack thereof.

Contextual factors have been flagged as playing an instrumental role in determining the effectiveness of the blend (Dziuban et al., 2018; Fazal & Bryant, 2019). Similarly, learning engagement has been found to also be dependent on contextual factors (Fredericks et al., 2004; Maslow, 1943; Vygotsky & Cole, 1978; Mahn, 1999; Chew et al., 2008; Yurtseven & Ocak, 2021; Reschly & Christenson, 2012). For example, some of the contextual factors that could potentially influence learning engagement fall under four broad categories, which are, family, classmates, school, and community (Reschly & Christenson, 2012; Fredericks et al., 2004; Skinner & Pitzer, 2012) as well as more specifically, the effectiveness of instruction (Yazzie-Mintz & McCormick, 2012; Yurtseven & Ocak, 2021). Considering this, it would be interesting to determine the key design features of a blend that could be most suitable to this South African context, which is largely under researched.

Focus on the South African high school context makes this study a significant one, particularly given that the focus is on the largest learner cohort from a relatively low economic status community (Quintile 1), where resources are scarce. Equally important, the study also determined the key design features of a blend that could be suitable to this particular South African context. It was hoped that in doing this, the key design features of a blend that could be most suitable to the most disadvantaged schooling sector of the South African context which caters for the vast majority of learners might emerge. Given the discussion undertaken here, there is a need to clearly articulate study purpose.

1.3.1 Study Purpose

As already noted, the major aim of this study is to determine the effectiveness of using blended teaching (compared to traditional teaching method) in developing learning engagement and academic achievement in Organic Chemistry to South Africa Grade 12 Physical Sciences learners. Within this effort, the significance of the moderating effects of each of the sub-constructs of learning engagement on the strength of relationship between blended teaching and academic achievement will be determined. Still related to the determination of the effectiveness of blended teaching, the design features of the nature of a ‘blend’ that could be

effective in fostering learning engagement and academic achievement in the broader high school sector of South Africa was also determined as an application of knowledge on the effectiveness of blended teaching on learning engagement and academic achievement. To achieve the research purpose, the following objectives were formulated:

1.4 Research objectives

This study seeks to achieve the following objectives:

- Compare the effectiveness of blended teaching and traditional face-to-face instruction in developing learning engagement for South African Grade 12 learners in Organic Chemistry.
- Compare the effect of blended teaching and traditional face-to-face instruction method on South African Grade 12 learners' achievement in Organic Chemistry.
- Determine the significance of moderation effects (if any) of each of the learning engagement sub-constructs on the relationship between blended teaching (and traditional face-to-face teaching method) and academic achievement in the teaching of Organic Chemistry to South Africa Grade 12 Physical Sciences learners.
- Determine whether interview data on sub-constructs of learning of the experimental group are more positive than that of the control group.
- Study the nature of blend that could be effective in fostering learning engagement and academic achievement in the broader schooling sector of South Africa.

1.5 Research Questions

To achieve these objectives, the following research questions were addressed:

1.5.1 Research Question 1

Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in developing learning engagement in Organic Chemistry for South Africa Grade 12 Physical Sciences learners?

1.5.1.1 Hypothesis 1

Compared to learners taught using traditional face-to-face teaching methods, Grade 12 Physical Sciences learners taught using the blended teaching approach will score significantly higher in a post-instruction questionnaire on learning engagement during Organic Chemistry.

1.5.2 Research Question 2

Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in fostering achievement in Organic Chemistry at Grade 12 in a school in South Africa?

1.5.2.1 Hypothesis 2

Compared to learners taught using traditional face-to-face teaching methods, Grade 12 Physical Sciences learners taught using the blended teaching approach will score significantly higher in a post-instruction test on Achievement in Organic Chemistry.

1.5.3 Research Question 3

To what extent is the relationship between blended teaching (or traditional face-to-face teaching) moderated by each of the learning engagement sub-constructs in the teaching of Organic Chemistry to South Africa Grade 12 Physical Sciences learners?

1.5.3.1 Hypothesis 3

For South Africa Grade 12 Physical Sciences learners, each of the sub-constructs of learning engagement significantly strengthens the relationship between the use of blended teaching (or traditional teaching method) and academic achievement.

For all statistical tests, the level of significance was set at $p \leq 0.05$.

1.5.4 Research Question 4

How does comparative analysis of post instruction interview data demonstrate that, the learning engagement sub-constructs of the experimental group (blended teaching group) are more positive compared to the control group (traditional method group)?

1.5.5 Research question 5

What key design features of the nature of the blend that is effective in fostering learning engagement and academic achievement in the South African High schooling context (focusing on Quintile 1 schools)?

At this point and considering that this study utilises the mixed-methods research approach, it becomes important to clarify that Research questions 1, 2, and 3 were used for quantitative data collection only. Research Question 4 was addressed using qualitative data only, whose function was to provided explanations and triangulation for Research Question 1. Research Question 5 involved an application of the knowledge gained from all the four questions (1, 2, 3, and 4). This led to the subsequent development of a blended learning model which could be used by schools with limiting factors.

This study investigates the interactions among three variables. For the study, the teaching method (blended or traditional face-to-face) are taken as the independent variable (s) with learning engagement (cognitive engagement and emotional engagement-a combination of affective engagement and participatory behavioural engagement) as the moderator variables, and academic achievement as the dependent variables. Given that emotional engagement has been conceptualised as a multidimensional sub-construct (Yazzie-Mintz & McCormick, 2012) comprising affective engagement and participation behavioural engagement, these two components were treated as separate moderator variables in this study. Approaching the study this way requires that three moderator variables be considered. In this study, these three are cognitive engagement, affective engagement, and participation behavioural engagement. An additive multiple moderation scenario is therefore hypothesised. Given that most researchers assert that blended teaching leads to higher learning engagement, which in turn leads to higher academic achievement, this study goes further to investigate which question is under what conditions does this moderating effect occur and at what effect size (Hayes & Rockwood, 2016)? Equally important, which aspects of learning engagement have these effects on the relationship between blended teaching (or traditional face-to-face)? In this respect, the sum of the three identified moderators falls under the umbrella term ‘learning engagement’. Given the central role played by contextual factors, it becomes important to specify the study context.

1.6 The Study Context

The public schools in South Africa are categorised using a quintile system, which is dependent on how affluent or poor the school might be. The quintile level ranking ranges from Quintile level 1 (the least advantaged) to Quintile 5 (most advantaged). By virtue of being a developing nation, the bulk of learners in the South African schooling sector are catered for educationally in the lower quintile level schools, that is, those belonging to quintile levels 1, 2, and 3. These less advantaged schools consist of large classes averaging 60 learners (Fisher et al., 2017) with some as high as ninety learners. These large class sizes coupled with the fact that science materials such as apparatus, science equipment and other resources are scarce due to the low economic status of the schools, the pedagogical practices employed are usually traditional face-to-face teaching (Taylor, 2008). Despite this, at high school, the Curriculum and Assessment Policy Statement (CAPS) curriculum encourages the use of learner-centred teaching approaches, as pointed out by Taylor (2008). However, other researchers assert that the way in which the CAPS curriculum encourages the use of traditional face-to-face teaching instead (see for example De Beer, 2016 and Lehesvuori et al., 2018). For this reason, traditional face-to-face teaching appears to be more prevalent in the lower quintile schools of South Africa. This more plausible given that De Beer (2016) and Lehesvuori et al. (2018) focused on science education, and as pointed out earlier, given that that these lower quintile level schools are the least adavantaged ones that cater for the largest learner cohort in South Africa.

Furthermore, in South Africa, education is divided into three broad educational categories, namely the General Education and Training (GET) band, which includes Grades R to 9, while the Grades 10, 11 and 12 belong to the Further Education and Training (FET) and lastly the Higher Education and Training (HET) band, which comprises all the universities (Department of Basic Education, 2011). These two educational bands in the basic education sector are further split into four phases (FET phase comprising Grades 10 to 12), senior phase (Grades Seven to Nine), intermediate phase (Grades Four to Six), and the Foundation Phase consisting of Grades R to Three (Department of Basic Education, 2011). Physical sciences is an optional subject, which is offered in the FET band (Department of Basic Education, 2011).

In the CAPS High school curriculum of South Africa, the Chemistry section constitutes fifty percent of the Physical Sciences curriculum (Department of Basic Education, 2011). This Chemistry component includes Organic Chemistry, which is a part of the matter and materials

knowledge strand. Additionally, Organic Chemistry, which happens to be a compulsory topic, is expected to be taught for approximately 16 hours during term 1 of Grade 12 (Department of Basic Education, 2011). This is the case mainly because the Annual Teaching Plan from the Department of Education allocates three to four weeks to Organic Chemistry teaching, instead of five weeks and one day. During this allocated time, all the Grade 12 Organic Chemistry content, which includes the following: Organic molecular structures (functional groups, saturated and unsaturated structures, isomers), IUPAC naming, and formulae of organic molecules, structure and physical property relationships, reactions of organic molecules (elimination, addition and substitution), applications of organic chemistry, which includes plastics and polymers, has to be covered (Department of Basic Education, 2011).

It is worth noting that Organic Chemistry as a topic, just like the rest of Physical Sciences, also includes laboratory work. As emphasised by Department of Education (2011), practical work needs to be integrated with the theoretical component of the Physical Sciences. The Chemistry (Organic Chemistry, included) practical work is designed to develop a predetermined skill set in learners. This skill set includes measuring, gathering data, analysing data, stating precautions, drawing conclusions, writing hypotheses and identification of variables (Department of Basic Education, 2011). These practical activities may take various forms, such as demonstrations, experiments, or practical investigations. Some of the practical work recommended for Organic Chemistry is included in section 3 of the Physical Sciences CAPS document. According to Department of Basic Education (2011), Grade 12 learners are required to do three compulsory practical activities for the whole year, which can be two from the Chemistry component and one from the Physics component, and vice versa. Of these, only one practical activity on the preparation of esters from the Organic Chemistry section is compulsory and forms part of the formal assessment for the year (Department of Basic Education, 2011).

As noted previously, analysis of examination performance shows that most learners struggled with the question on preparation of esters, which is an Organic Chemistry concept (Department of Basic Education, 2019:165). This is an indication that this practical activity was not done adequately. It is further noteworthy that this practical activity which is usually done during the first term of Grade 12, contributes 15% towards the school-based assessment, which is combined with the final examination to determine the paper 2 (Chemistry) NSC examination score, which was used to anchor this study. The remaining 85% of the school-based assessment comprises a control test, two practical activities (one or both which may be based on the Physics

component or another Chemistry topic), mid-year examination, and trial examination. Twenty-five percent of the school-based assessment described above contributes towards the final NSC Physical Sciences mark (Department of Basic Education, 2011). This leaves a remainder of 75 percent.

The remaining 75 % consists of marks from the two final NSC examination papers (with Paper 1 focusing on the Physics component of Physical Sciences, while Paper 2 focuses on the Chemistry component which includes Organic Chemistry) (Department of Basic Education, 2011). Since there is no separate practical examination on both components of Physical Sciences, the practical skills are examined in one of the papers 1 and 2 questions. The Grade 12 trial are usually written during the month of August, while the final NSC examinations are written from the end of October to the end of November. The question that remains unanswered is, how effective is blended teaching (compared to traditional face-to-face teaching) in fostering academic achievement, as influenced by learning engagement in a South African context? Having said this, there is a need to look at the environmental conditions that prevailed during the conducting of this study. By virtue of being least advantaged, most of these schools do not have well-established technology-mediated learning, be it in the form of online learning, or blended learning.

The few public schools that use online learning were not using it consistently for all, nor was it being offered to all learners, while on the other hand, blended learning in its true sense (in which the online component and the in-class components are integrated) was rarely happening due to scarcity of time, lack of suitable software, and poor connectivity (Fisher et al., 2017). At the school in which the present study was conducted the situation was dire, as some of the learners did not even have suitable devices to use for the online learning component of blended teaching. Those with broken smartphones were therefore assisted with their repair. The few computers at the school were also used to mitigate this problem. According to Fisher et al. (2017), the schools similar to that in which the study was conducted lacked adequate funding to secure technology devices and software, a lack of security of the teachnology devices in addition to teachers lacking the necessary skills to effectively use it. It is important to note that technology problems were not the only challenge that came with study context, since this study was conducted during one of the most difficult times in South African history and indeed throughout the rest of the world.

Coincidentally, the data collection was done during third wave of the COVID-19 pandemic, which was the worst of all the waves. This was coincidental, because that was when the Organic Chemistry topic was taught, which is normally taught during the first term. The school was closed on a number of occasions in order to contain the virus that ravaged the country, claiming the lives of many, including the school principal, and two teachers in the school within a short space of time. The learners were also not spared, as they were missing lessons due to illness. This unprecedented time meant that extraordinary measures had to be taken during the collection of the data. This included collecting most of the data remotely and online as the school became inaccessible due to imposed COVID-19 protocols.

Being a less privileged school, the use of online services was hampered by unavailability of internet services and a shortage of suitable learning devices. However, limited internet services were secured for use on the online platform to ensure that blended teaching takes place. The other mitigation measures that were put in place included ensuring that the learners had an offline App, which they could access after school hours. While the offline App assisted, there were minor glitches that were experienced, when some of the learners could not attend school particularly after being exposed to the COVID-19, and when the school was closed for decontamination purposes. This meant that such learners, even though they were few in number, could not refresh their Apps on time in order to complete all the assigned work. Additionally, the online system could not be expanded to reach the initial planned capacity due to school closures during the course of the term to contain the spread of the virus. Furthermore, the researcher had to minimise visits to the school, which meant that other data collection methods, such as observations, were out of question. However, qualitative data had to be collected using interviews, which were conducted online using Zoom. Additionally, the surveys and the test had to be written in person. The papers were placed in a secluded place for three days before any data analysis could commence.

To further exacerbate the situation, the July unrest which spread through some parts of the country made it difficult for learners to move freely. This was in addition to the severe electricity blackouts, which further worsened an already bad situation. The other disturbances came in the form of protest action within the school, which was initiated by learners that wished to change subjects. This led to another unplanned school closure. All these issues dragged the collection of the data for longer than initially planned. Besides, due to the challenges that were brought on by the events just described, some of the learners came from child-headed families,

while others were renting backrooms so that they could be closer to school. This kind of set up came with its own challenges, which impacted negatively on some of the learners' ability to concentrate on learning. In addition, parental support was also difficult to secure in some instances. While the context described here paints a grim picture, it should be noted that most of the learners were resilient and strived to rise above their circumstances. Notably, most of them were highly motivated, and went to great lengths to ensure they completed the after schoolwork, which assisted in making the blended teaching project a success. As indicated by Garrison and Vaughan (2008), learners must be self-motivated to ensure the that blended teaching is successful. On another note, COVID-19 came with certain benefits, such as the reduction of the class sizes to between 18 and 22. In hindsight, while the study context appears to be dire, COVID-19 became a welcome disturbance in this respect.

1.7 Conclusion

The chapter describes the rationale for the study, motivating for its validity and value to relevant discourses. This background section of this chapter shows a persistent use of ineffective teaching methods in science education, which includes Organic Chemistry as a topic which has been identified as being difficult, resulting in poor achievement and low learner engagement. This chapter also unravelled many issues that still remain unresolved with regards to the effectiveness of blended teaching in the high school setting and the South African context focusing on Organic Chemistry. For example, there is limited research on the effectiveness of blended teaching at developing nation (South Africa) high schools, where an inconsistency in the literature on the effectiveness of blended teaching, the lack of equivalence of blends used in various studies, and varying contextual factors became evident.

Furthermore, a paucity of studies on the relationship among blended teaching (or traditional face-to-face teaching), learning engagement (in terms of the three sub-constructs), and academic achievement were noted. This is in addition to little evidence of extant studies that focus on high school and South African settings, particularly on the disadvantaged schools making the current study a significant one. Additionally, it became apparent that this relationship is not a straightforward independent versus dependent variable type. This meant that there was a third type of variables in the form of learning engagement sub-constructs. In addition, based on the scant and largely inconclusive research available, the third set of

variables appear to be moderator variables. As a result, there was a need to determine the significance of the moderating effects of sub-constructs of learning engagement, with a view of understanding the effects of blended teaching. This dearth of research on the significance of the moderating effects of some forms of learning engagement provides the rationale for this study.

Given that the effectiveness of blended teaching in the broader South African schooling sector, which is largely characterised by learners from less privileged communities, is under-researched, there was a need to go a step further and propose design features of a 'blend' that could potentially be more effective in fostering learning engagement and academic achievement in the schools with similar contextual factors. While examining the nature of this research problem, the need to conduct a more extensive literature review became unavoidable.

The literature review that appears in Chapter 2 provides more insight into how similar research studies on blended teaching were conducted, and an in-depth understanding of the ongoing debate on the effectiveness of blended teaching in fostering learning engagement and academic achievement. In addition, Chapter 2 also became instrumental in shaping the methodology presented in Chapter 4, by providing insight into how other researchers conducted their studies. Most importantly, the literature review also provided insights into how the data collected by other researchers were analysed, which again helped to shape chapters 4 and 5, 6 of this study. However, Chapter 2 was not only concerned with the issues pointed out already as it resulted in one of the most significant contributions of this study, which was the conceptual framework and the theoretical framework which draws from Vygotsky's socio-cultural theory (Mahn, 1999) and Maslow's hierarchy of needs (Maslow, 1943).

The use of Vygotsky's socio-cultural was motivated by the need to ensure that learner-centred teaching strategies are employed. Researchers have also pointed out that learning engagement is closely related to learning engagement which made it possible to also Maslow's hierarchy of needs theory to anchor this study in conjunction with Vygotsky's socio-cultural theory. These theories were devised to make sense of the data collected resulting in drawing the drawing of conclusions, making recommendations, and identifying limitations in Chapter 7. In addition to the theoretical framework, a conceptual framework which was developed from the reviewed literature (in the Chapter that follows) was used to complement the two dominant theories that form the theoretical framework.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This literature review examined various issues related to blended teaching. This examination highlights challenges associated with defining the term blended teaching and identifying blended learning models, with a view to showing why the present study selected a fusion of active blended learning and flipped learning models. This was followed by a section on Chemistry education and Organic Chemistry challenges, with a particular focus on showing how these can be addressed by adopting a blended teaching approach. An attempt to develop a deeper understanding of the learning engagement construct which is also riddled by definitions that are somewhat unclear, also figured strongly in this review of literature.

Additionally, this study also draws from selected studies on the impact or effectiveness of blended teaching on learning engagement and those that focused on blended teaching versus academic achievement. More importantly, this review of literature would have fallen short if an attempt had not been made to forge the relationship among variables: teaching method (traditional face-to-face teaching and/ or blended teaching), learning engagement, and academic achievement. This was deemed as an important exercise considering the study aims. Furthermore, learning engagement has been identified as a multidimensional construct comprising two or three sub-constructs, where it would be of interest to determine the significance of the moderating effects of each of these interconnected sub-constructs. Given that this study mainly focuses on blended teaching, the challenges of defining the term blended teaching had to be addressed first.

2.1.1 Defining ‘blended teaching’

As indicated earlier in the background to the current study, the terms blended teaching (what teachers do) and blended learning (what learners do as a result of teachers’ actions) are equally relevant. Given this, literature on both blended learning and blended teaching was consulted. The concept of blended learning is not a straightforward one. As noted by Dziuban et al. (2018), challenges emanate from the existence of an array of definitions, which make it difficult to determine whether what is being referred to as blended learning is acceptable, or whether it should be disqualified. This reality makes evaluation of previous research studies on blended

teaching a daunting task, due to the wide variety of contexts in which they may have been conducted. Dziuban et al. (2018) proceed to define blended learning as a teaching approach that integrates face-to-face teaching and online teaching. While this definition seems to be supported by many researchers (see for example Staker & Horn, 2012; Bonk & Graham, 2012; Kuo et al., 2014; Seery & O'Connor, 2015), it does not clarify the how this integration ought to be undertaken. On the same note, Armellini and Rodriguez (2012) raise an important point when they place emphasis on the need to ensure that the online instruction and the traditional face-to-face instruction operate as a single entity (not as two parallel systems). By saying this, these scholars emphasise the need to ensure that online learning platform is linked to the traditional face-to-face component, and vice versa. This view of blended teaching is also supported by Seery and O'Connor (2015). However, integration is not the only aspect of the blended learning system that must be considered in order to ensure its effectiveness.

Considering the above, this study adopts the definition proposed by Halverson and Graham (2019), which refers to blended learning as a 'thoughtful' combination of online learning and traditional face-to-face learning. However, the use of the word 'thoughtful" is open to different interpretations. Whichever way it is interpreted, this loaded word (thoughtful) has a bearing on the configuration of the blended learning system. One way of looking at it is that it places emphasis on the need to ensure that the blended learning system operates as an integral system.

On the one hand, it may be placing emphasis on the characteristics of online learning and traditional face-to-face learning that are meant to address learner needs (Bonk & Graham, 2009). On the other hand, thoughtfulness may be based on the notion that the constituents of a 'blend' needs to be determined by the learning needs, which has a bearing on how instruction is designed (Bonk & Graham, 2009). For this reason, it became clear that it is important to conduct a needs analysis before designing and implementing the blend to be used. Since the current study requires that the blended learning system be developed and established, it becomes important that a needs analysis be undertaken first. This, to a large extent, ensured that the learner needs are addressed. It became apparent through a review of literature that the term blended learning is identified using many other terms, which leaves one wondering if the different names are synonymous. This would further complicate any quest to arrive at a universal or more widely acceptable definition.

To further exacerbate the problem of arriving at a universal definition of blended teaching, Ashraf et al. (2021) provide a list of names that are synonymous with blended learning, which include the following:

"…hybrid learning, dual modal instruction, multi-modal instruction, brick and click instruction, Hy Flex learning, targeted learning, flipped learning."

However, most scholars use blended learning and hybrid learning interchangeably. Additionally, when flipped learning is presented as being synonymous with blended learning in general, questions as to how the so-called flipping takes place cannot be avoided. Moreover, 'flipped classroom' has been presented as a model of blended learning by some researchers (Stalker & Horn, 2012; Seery, 2015). Given this, it became imperative that literature on blended learning models and flipped learning be reviewed, which helped in shaping the research methodology.

2.1.2 Blended learning models

A blended learning model was described as an approach to blending instruction (Tomas, et al., 2019). Based on this definition and literature, several blended learning models become identifiable. However, most researchers identified four blended learning models (Staker & Horn, 2012; Picciano, et al., 2014; Beaver, et al., 2015). These are the 'rotation model' (which includes 'station rotation, 'laboratory rotation', 'flipped classroom', and 'individual rotation'), 'self-blend' model, 'enriched-virtual model', and 'flex model' (Staker & Horn, 2012; Picciano, et al., 2014). Contrary to the list of blended learning models mentioned, Tekane et al. (2020), suggest a different list, comprising four models as follows: replacement, supplemental, emporium, and buffet models.

Based on the above, it became clear that researchers do not agree on the types of blended learning models nor on how to categorise them. Nevertheless, it is important to emphasise that many researchers recognise flipped learning, as a blended learning model (Fischer et al., 2018; Schell & Mazur, 2015). Moreover, the present study mainly focuses on a fusion of active blended learning and flipped learning. For this reason, it becomes important to develop a deeper understanding of what flipped classroom (or flipped learning) entails.

The Flipped Learning Network (FLN) (2014:1) provided a working definition of flipped learning as follows: "…a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter."

The definition presented here places emphasis on several characteristics of flipped learning: one, the exposure of learners to learning material traditionally meant to be presented in the classroom by the teacher before the lesson; two, the use of individual learning first followed by whole class learning; three, the role of the teacher as a facilitator of learning; four, the creation of a learning space in which learners interact with one another, and with the content, during the whole class learning sessions (or in-class sessions), with a view to fostering learning engagement. Considering this definition, some researchers simplified flipped learning by describing it as representation of a classroom that has been inverted (O'Flaherty & Phillips, 2015; Seery, 2015).

Fischer et al. (2018) goes further to provide the rationale behind the reversal of the traditional classroom, by indicating that flipped learning is guided by the need to separate less cognitively demanding objectives of learning from the more demanding ones. Key to this idea is that learning objectives with a lower ranking guide learning that is designed to be done individually in a virtual learning environment away from the physical classroom. Similarly, higher order learning is then reserved for in-class learning, where learners have more opportunities to interact with peers and with the teacher.

Based on the above, it can be argued that one of the purposes of flipped learning is to foster in-depth learning, thereby improving academic achievement. Designing activities with lower levels could also encourage learners to complete the pre-class work, which is key in the South African context, where incentivising work done away from school is problematic as the curriculum does not give room to such innovation. O'Flaherty, and Phillips (2018) conducted a review of flipped learning concept that included twenty-eight articles.

The aim of O'Flaherty and Phillips's (2018) study was to establish the implementation strategies, types of technology employed, and learning outcomes achieved in addition to gauge

the extent to which the learners and teachers found the pedagogy acceptable. While acknowledging some of the benefits of flipped learning already mentioned, O'Flaherty and Phillips (2018) concluded that this approach to pedagogy has the effect of improving learners' ownership of learning through completing the out-of-class work. As mentioned earlier in this section of the study, this could be due to the idea of focusing on lower-level objectives when designing online work. More importantly, O'Flaherty and Phillips (2018) determined that the adoption of flipped learning has an effect of making more time available during the face-to-face component, thereby affording the teacher more time to offer help that is tailored to meet the needs of the individual learner. It can be argued that this individualised help has a positive impact on the learners' academic achievement. This also happens to be a benefit of blended teaching in general. Additionally, O'Flaherty and Phillips (2018) identify the need for the teacher to become aware of the learners' understanding and misconceptions as an additional key characteristic of flipped learning. This could be key to improving academic achievement when the identified misconceptions are cleared timeously.

O'Flaherty and Phillips (2018) also note that there appears to be a lack of understanding of important constituents of successful flipped learning, and the integration of the two components. By highlighting this lack of integration, these scholars underscore the need to ensure that the two components of flipped learning do not run as separate entities, as previously mentioned in this review of literature. This study will ensure that this particularly important factor is taken into consideration when the blended learning system is established. O'Flaherty and Phillips (2018) underscored the need to incorporate active learning strategies in order to motivate the learners. To achieve this, the flipped learning model will be infused with elements of active blended learning model, as mentioned earlier in this literature review. Infusing flipped learning with elements of active learning blurs the boundaries between flipped learning and active blended learning.

Armellini and Rodriguez (2012) put forward the notion of active blended learning (ABL) which is a form blended learning that promotes 'active learning'. Emphasis here is placed on ensuring that learners are engaged, which requires that learners do not repeat the passive learning processes by simply watching videos and doing nothing else. Armellini and Rodriguez (2012) pointed out that the active learning is aimed particularly at the development of skills in learners, foster learning engagement and perform tasks that promote higher order thinking capabilities. This will be achieved using flipped classroom (Poe, 2015; Armellini & Rodriguez, 2021),

gamification, that collaborative learning and quizzes to be attempted after watching videos. Interestingly, flipped learning is presented as playing a different role here, since it is being portrayed as a characteristic of ABL, which is contrary to the views of other scholars, such as Fischer et al. (2018), Schell & Mazur (2015), and Staker and Horn (2012).

These scholars present flipped learning as a separate blended model. For this reason, it becomes important to emphasise that the present study adopts this initial view in which flipped learning is presented as a separate blended learning model. This stance is informed by the idea that it is possible to expose learners to flipped learning, while still engaging in passive learning, such as watching videos alone, without doing anything else. To support this stance, it is necessary to revisit the key role of active learning, which includes development of learner skills, and fostering high order learning strategies (analysing, synthesising, evaluating, and creating), as pointed out by Armellini and Rodriguez (2021).

Additionally, according to Armellini and Rodriguez (2021), the key focus of ABL is construction of knowledge, reflecting on the subject matter, developing critical thinking, learning that is self-directed, and the achievement of learning outcomes. Notably, and in keeping with the need to develop learning engagement, these characteristics of ABL resonate with the facilitators of learning engagement construct discussed later in the current review of literature. Similarly, Poe (2015) implies that the pedagogical approach in question here involves reflecting critically and knowledge reconstruction and making learning relevant to the learners' daily lives.

Considering the importance of collaborative learning, a discussion forum becomes mandatory in order to encourage peer-peer interactions in the online learning platform as well. Having investigated blended learning models and highlighting the identifying the developing a model (which in itself is a blend of blended learning models), sensitive to the contextual factors of the current study, it is a question as to why to focus on Chemistry Education, and more specifically, why Organic Chemistry features so strongly. Addressing this question requires that literature on the challenges related to Chemistry Education (including Organic Chemistry) be examined.

2.1.3 Chemistry education and Organic Chemistry challenges

As noted previously, Organic Chemistry, is generally perceived as a subject that is difficult, and associated with both high failure and dropout rates, as well as with concepts that many learners struggle to master (Richards-Babb et al., 2015; Mullins, 2008; Grove & Bretz, 2012; Salame et al., 2019). Based on this, there is a need to develop an in-depth understanding of the challenges associated with Organic Chemistry and Chemistry education in general, with a view to ensuring that the blend is designed to mitigate the identified challenges. This becomes an important exercise, given that one of the main reasons for adopting blended instruction was to improve pedagogy with a view of enhancing outcomes of learning such as learner engagement and academic achievement.

Seery and O'Connor (2015) outlined some of the teaching and learning challenges associated with Chemistry education, Organic Chemistry included. These challenges can be placed into three groups, namely learner struggles and needs as Category 1, teacher needs (Category 2), and the nature of Chemistry education and more specifically, Organic Chemistry (Category 3). Category 1: Learners need to engage in meaningful discussions on the subject matter, particularly because they learn at a different pace, they struggle with problem-solving and therefore prefer to have more opportunities to test themselves.

Further exacerbation of these Category 1 challenges as perceived by Mahaffy (2015), is that learners struggle to cope with the cognitive load associated with chemistry concepts, as well as failure to apply new knowledge to their daily life experiences. It is hoped that the movement of some of the content to online learning would reduce this cognitive load in this study (O'Flaherty & Phillips, 2015) thereby improving cognitive engagement and academic achievement when learners get more time with the teacher, who would assist them with problem-solving strategies. In addition, factoring in learners' daily experiences would also go a long way in making Organic Chemistry relevant.

The main aspect for Category 2 is that teachers need to track learners' progress. In-class time is insufficient to addressing all the learning problems. Richards-Babb et al. (2015) add another Category 2 problem, which is characterised by teachers encouraging learners to memorise Organic Chemistry concepts. This finding was supported by Brown et al. (2016), who added

that teachers were not only encouraging learners to memorise Organic reactions, but instead they were also engaging in 'rote teaching'. The memorisation of reactions did not only result in poor grades, but in low confidence levels among learners as far as organic reactions were concerned (Brown et al., 2016).

Similarly, Mullins (2008) is also against memorisation and encourages teaching and learning methods that bolster conceptual understanding. However, some researchers are of the view that, while memorisation still plays an important role in the learning of Organic Chemistry, this should not be the ultimate goal of teaching as conceptual understanding plays a key role (see, for example, Salame et al., 2019; Mullins, 2008). In this study, the central roles of memorisation and conceptual understanding are acknowledged. The question in this regard is posed, how can conceptual understanding be developed?

According to Salame et al. (2019), approaching Organic Chemistry teaching and learning through fostering connections among the three levels of microscopic, macroscopic, and symbolic, could develop much-needed conceptual understanding. However, according to Mahaffy (2015), a 'tetrahedral' approach to teaching Chemistry is more appropriate, in which the three levels mentioned by Salame et al. (2019) are refined through the addition of a fourth dimension in the form of 'human activity' to form a tetrahedral. The 'tetrahedral chemistry' analogy places emphasis on ensuring that all the three levels previously mentioned are situated in the real life contexts of the people that are responsible for the creation of the substances, the culture that consumes them, and most importantly, the learners that who are making an effort to understand them (Mahaffy, 2015).

It is clear from the discussions here that research does not seem to agree on the best way of addressing the Organic Chemistry and indeed general Chemistry challenges, however, the clear direction that appears to emerge is that there is a need to foster conceptual understanding, while making Organic Chemistry relevant. Furthermore, learners come to class with preconceived information that could be riddled with misconceptions that must be cleared (Salame et al., 2019). It cannot be overemphasised that early detection of these misconceptions goes a long way in fostering conceptual understanding of Organic Chemistry. In this study, it is hoped that teachers will be able to track learners' progress timeously when the work is graded in real time using the online learning software. Category 3: More importantly, challenges specifically related to Organic Chemistry and Chemistry in general are identifiable.

Category 3 (nature of Chemistry and Organic Chemistry) includes the fragmented nature of Chemistry subject matter and failure to develop scientific literacy due to preoccupation with preparing learners for studying further (Mahaffy, 2015). It is hoped that more time created by the use of blended teaching would help mitigate these Category 3 challenges when the subject matter is applied to learners' everyday lives and used to develop scientific literacy. Within this Category 4, the challenge lies in the notions that Organic Chemistry demands; thinking in three dimensions; and consists of vocabulary that is largely unfamiliar to most learners; in addition to demanding largely non-algorithmic ways of solving problems (Tekane et al., 2020). More interestingly, what appears to set Organic Chemistry apart from the rest of Chemistry Education has its focus on reactivity-structure relationship that contrasts it with the largely quantitative aspects of general Chemistry (Tekane et al., 2020).

An analysis of the challenges identified here shows that most of them can be addressed by introduction of technology, which adds to the advocacy for blended teaching approaches. As pointed out by Seery and O'Connor (2015), there is a need to justify the introduction of technology. This will make it easier for the teachers to motivate their learners to accept the blended learning idea which makes implementation easier. Moreover, technology may potentially assist in making the development of high order thinking and/ learning skills easier, which will go a long way in addressing most the categories 1 and 2 challenges. Before demonstrating how the infusion of technology can potentially assist in the development of these high order thinking and learning skills, there is a need to understand what these skills entail.

Hofstein (2015:520) described high order thinking and learning skills as follows:

"Higher order thinking/learning skills and activities in the context of learning science are considered to be complex and non-algorithmic and involve applications of multiple criteria instead of memorizing [sic] facts. These activities include asking research questions, solving authentic problems, argumentation, metacognitive skills, drawing conclusions, making comparisons, dealing with controversies, and taking a stand."

Considering the definition of high-order thinking and learning given here and discussed earlier, it becomes clearer that freeing up some of the time during the face-to-face component goes a long way in creating an enabling environment for these much-needed skills to be developed.

Additionally, provision of more assessment opportunities through online quizzes will solve some of the categories 1 and 2 problems, where learners test themselves while teachers' collect more information on how learners are progressing including identifying misconceptions (Seery & O'Connor, 2015). Brown et al. (2016), while supporting the significance of creating opportunities for learners to assess themselves, added that the blended learning approach also allowed learners to reflect on their work. This kind of reflection can be perceived as evidence of high order thinking since it urges learners to move beyond simple recall of Organic Chemistry reactions which gives an indication of higher quality cognitive engagement. Interestingly, most South African learners' struggles with Organic Chemistry reactions were also mentioned in the diagnostic reports that were compiled by the Department of Education (2020 and 2019).

Taking some of the content online can also potentially address 'cognitive overload' related problems (Seery & O'Connor, 2015). This is particularly important considering that Organic Chemistry has a lot of new terminology that has the potential of throwing many learners off-course (Richards-Babb, et al., 2015; Tekane, et al., 2020; Mullins, 2008), as mentioned earlier in this section of the literature review. Closely related to this, Salame et al. (2019) also indicated that limited language proficiency contributes to learning impediments in Organic Chemistry. The reason for this is that the language largely unfamiliar, and the vocabulary has the potential to mislead the learners (Salame et al., 2019). However, while the contribution of the language factor cannot be downplayed, this study does not entirely agree with the notion that the Organic Chemistry content does not contribute learning problems that most learners experience, particularly given that this topic has been cited as being too abstract for most learners, in addition to concepts which are disconnected as pointed out earlier in this section of the present study.

The language problem is a contentious one, particularly in the science-related subjects, but this study supports the view that it is plausible that it interferes with learners' ability to understand Organic Chemistry concepts. Interestingly, and intricately linked to this study, Salame et al. (2019) went on to single out language as the main problem impeding the learning of Organic Chemistry, which these scholars blamed on ineffective teaching methods. Most importantly, these scholars concluded that traditional face-to-face teaching, in which learners have few opportunities to interact with one another or with the teacher, exacerbated learning struggles. While on this note, it is important to highlight that traditional face-to-face teaching was used

by Flynn to teach Chemistry to large university classes using clickers, demonstrations, and online homework, but that due to time constraints, learners had to grapple with difficult concepts on their own (Flynn, 2015). This shows that the use of traditional face-to-face teaching alone cannot address all the problems associated with Organic Chemistry. The question in this regard then becomes, is blended teaching efficacious in addressing the learning problems discussed here? However, the strategies employed by Flynn could go a long way in increasing learner interactions.

Increased interactions among learners and with the lecturer during the face-to-face sessions were also cited as an added advantage of using blended teaching (Naaj et al., 2012). Furthermore, according to Salame (2019), teaching methods that promote active learning and based on constructivist theories ought to be implemented. It could be argued that this pleads for the utilisation of ABL and flipped classroom discussed under blended learning models with a view reduce 'cognitive load' and promote active learning. While what has been discussed in this section of the literature review points towards blended teaching being efficacious for learning engagement, there is a need to develop an in-depth understanding of what the learning engagement construct entails.

2.1.4 The learning engagement construct

As mentioned previously, learning engagement, has been defined in a variety of ways. However, despite these definitional differences, researchers recognise the vital part played by learning engagement (Halverson & Graham, 2019; Fischer et al., 2018; O'Flaherty & Phillips, 2015) As Manwaring et al. (2017) point out, learning engagement can be viewed as a combination of two or three constructs. These are, cognitive engagement, and emotional engagement, and sometimes a third, namely behavioural engagement (Manwaring, et al., 2017). Nonetheless, it is important to highlight that contrary to Manwaring et al.'s (2017) assertion Reschly & Christenson (2012) pointed out that most researchers have presented learning engagement as multidimensional (Oriab, 2015; Fischer et al., 2018, Reschly & Christenson, 2012) construct that is made up of three sub-constructs: affective, cognitive, and behavioural. This stance is supported by other scholars (see for example, Fredricks et al., 2004; Bond et al., 2020; Skinner & Pitzer, 2012; Yurtseven & Ocak, 2021; Yazzie-Mintz & McCormick, 2012; Finn & Zimmer, 2012; Mahatmya et al., 2012). Manwaring et al. (2017)

indicate that the behavioural sub-construct is not consistently acknowledged by many researchers; an assertion which appears to be inconsistent with literature. On the other hand, some scholars have conceptualised learning engagement as comprising four sub-constructs (Appleton et al., 2006; Reeve, 2012). At this point, it becomes clear that the learning, despite the widely accepted notion of learning engagement being a multidimensional construct, researchers do not agree on the various types of possible sub-construct.

To further add to the lack of clarity of the learning engagement concept those that advocate for the exclusion of the behavioural sub-constructs have raised concerns over the blurry demarcation between behavioural and cognitive (Halverson & Graham, 2019; Manwaring et al., 2017). This study acknowledges these debates and takes a stance that the behavioural engagement component of learning is an important one. However, research does not agree on the nature of behavioural engagement, with most citing academic and participation components (Fredericks, et al., 2004), while others add the social engagement component (Finn & Zimmer, 2012).

In this study, the participation behavioural engagement has been used to accommodate peer interactions. However, considering Finn and Zimmer's (2012) view that subtle differences exist between academic behavioural engagement and cognitive engagement, there are concerns raised by Halverson and Graham (2019) and Manwaring et al. (2017) about significant overlaps between the two sub-constructs, where a stance was taken in this study to merge the two. Moreover, research has shown that the magnitude of the gains in learning is highest when emotional engagement and cognitive engagement interact at activity level (Manwaring et al., 2017). At this point, it becomes important to highlight that Fredricks et al. (2004) recognises the behavioural engagement and further indicated that this sub-construct of learning engagement consists of two components, which are, the academic (the one that usually overlaps with cognitive engagement), and the participatory component.

Fischer et al. (2018:4) have added that Learning engagement consists of the following: "..interest, enthusiasm, belonging, deep learning, self-regulation, time, and effort invested in studying, interaction, and participation, feeling of autonomy, and choice and control."

These characteristics of learning engagement formed part of the present investigation, as most of them were incorporated in the learning engagement questionnaire and in the semi-structured

interviews of selected participants. Contrary to the claims of Fischer et al. (2018) over what counts as learning engagement, Schell, and Mazur (2015) suggest that in-depth learning is a sign that learners are about to engage, which means that it is not exactly a characteristic of learning engagement. A point that appears to be refuted by other researchers, particularly those that view learning engagement sub-constructs, vary in intensity, giving rise to a wide range such as from recall to in-depth learning (cognitive) (Fredericks et al., 2004). This shows that in-depth learning cannot be viewed as signalling engagement, but that it actually lies at the highest level of engagement.

Nevertheless, these contradictions in literature on learning engagement are noted. They are considered insignificant in this study since this could be a question of misinterpretation of what learning engagement entails, or a case of over complicating issues. As a result, the current study recognises in-depth learning as a characteristic (facilitator) of learning engagement based on the adopted definition of this construct. Moreover, expenditure of mental energy is required for learners to learn anything deeply. While Fischer et al. (2018) make mention of the characteristics of learning engagement, it can be argued that the scholars did not do enough justice to the learning engagement construct by not identifying the sub-constructs or indicators of learning engagement. Identifying indicators and facilitators of learning engagement is considered important in this study, which utilises a sequential explanatory design.

According to Skinner and Pitzer (2012), studies that utilise explanatory research design must differentiate between indicators and facilitators. Skinner and Pitzer (2012) underscored the need to identify indicators and facilitators, with a view to developing an understanding of how learning engagement works. Indicators are defined as ‘markers’ or descriptions inside a construct, while facilitators are located on the periphery of the construct and having a causation effect (Skinner & Pitzer, 2012). For example, Halverson and Graham (2019) identified enjoyment and boredom as facilitators of affective engagement, while affective engagement becomes the indicator (Halverson & Graham, 2019).

Notably, contextual factors, including the social ones, also become facilitators of engagement, while academic achievement becomes an outcome (Skinner & Pitzer, 2012). It could be argued that this explanation on facilitators, indicators and outcome of learning engagement sheds some light on the relationship among variables in this study. It can be concluded that learning engagement and its sub-constructs are riddled with hazy conceptualisations, where gaps in the literature have been illuminated that requires that this study be conducted, particularly given

the unfamiliar context in which this study is situated. Given this, more studies on learning engagement in blended teaching settings had to be reviewed.

2.1.5 Blended teaching and learning engagement

Recently, literature investigating the impact or effectiveness of blended teaching has seen a noticeable growth. Within this domain, Manwaring et. al. (2017) investigated learning engagement in a blended setting and traditional face-to-face setting (lectures) using experience sampling and with the aim of using structural equation modelling. The study mainly focused on learning engagement at activity level, which is like the current study. Even though the study by Manwaring et. al. (2017) made use of experience sampling and intended on using structural equation modelling, it remains relevant to the study and insightful as far as this study is concerned. The research by Manwaring et. al. (2017) also investigated the impact of blended teaching on learning engagement, which again, is similar to this present study. Most importantly, the way in which learning engagement was measured, particularly, the administration of the survey questionnaire, helps in mapping the direction of this study by highlighting a good example of what to avoid.

Manwaring et al. (2017) conducted their research study at two universities. The sample comprised sixty-six learners. Given that they started off with sixty-eight learners, the number of participants that completed the study shows that the rate of subject attrition was extremely low. The fact that participants were drawn from various classes can also be viewed as a sign of general reluctance by many learners to participation. The use of two universities and drawing participants from different subject areas raises questions about equivalence of the ‘blend’ or blends utilised in the study under review. Given this, there is a chance that threats to internal validity were not sufficiently dealt with. Taking this into consideration, only one school will be used in the present study. The study was conducted over the entire semester, which was approximately sixteen weeks, mainly because the researchers were required to avoid repetition and interruption of classes due to surveys. This means that the current research study design needs to be structured in a manner that causes minimum disruption. Furthermore, spending the whole semester with that added burden of completing so many forms is something that would not be appreciated by many learners who are already extremely busy with their own studies.

Their research also focused on the two indicators of learning engagement, which are emotional engagement and cognitive engagement, as similar to the current study.

The learners were given surveys to complete at the end of the face-to-face component of blended teaching and again an hour after the online session. One thousand four hundred surveys were completed, which shows that some surveys were missing. Manwaring et al. (2017) also pointed out that some of the surveys were incomplete, despite ensuring that time as little as three minutes was required to complete the survey. An experience sampling method instrument was adapted from the longitudinal Sloan Study of Youth and Social Development together with the Skinner and Pitzer (2012) model (Manwaring et al., 2017). Items on indicators and facilitators of learning engagement were derived from the same Skinner and Pitzer model (2012), as Manwaring et al. (2017) indicates.

While the experience sampling method has been used by other researchers to measure learning engagement, mainly because it increases the validity of data, the completion of surveys many times can be overwhelming to the participants (Mandernach, 2015). There is a chance that participants may stop taking the surveys seriously, resulting in reports that are not entirely a true reflection of how they will be feeling or what they experienced. Given the numerous reports that the participants had to complete, it is not surprising that one participant stopped participating. The missing data can also be attributed to this experience sampling method. Furthermore, it is also noticeably unclear from the research study under review how much data was missing because if they were a lot then the validity of the study would be compromised.

Given the problems experienced by Manwaring et al. (2017), the present study will not consider experience sampling especially given that Grade 12 learners are already under pressure to complete the syllabus before the trial examination. Since the experience sampling method is heavily dependent on the self-reports from the participants, which according to Mandernach (2015), could result in dishonesty and inaccurate data, there was a need to use another data collection method such as interviews, for example, for triangulation purposes which would ensure reliability and validity of the research. In addition, Halverson, and Graham (2019:163) note that "Due to both the complex nature of engagement and the differences inherent to measuring it in multiple contexts, research on engagement in blended settings will often require mixed methods for collecting data." Based on the above, this study will utilise a mixed-method research design in which both self-report questionnaires and interviews will be used.

Furthermore, this idea is supported by Fredricks et al. (2004), who noted that most research on learning engagement only used self-report survey questionnaires, which often fail to capture the quality of learning engagement effectively.

Even though Sahni's (2019) research study mirrored that of Manwaring et. al. (2017), the former used more than one data source, as discussed later in this review of literature. In designing the research design, lessons will be drawn from Sahni's (2019) study. There is a chance that Sahni (2019) shared the same view that the use of survey questionnaires as the data source proved to be problematic. Contrary to the initial research design for the study under review here, the data collected were not analysed statistically as planned which entailed using Structural Equation modelling. It is important to note that other researchers such as Fan et al. (2016) have praised Structural Equation Modelling, because it can be used to measure 'latent variables' which makes it suitable in investigations where learning engagement facilitators need to be measured, some of which may be latent. However, it became apparent through this research that Structural Equation Modelling could not be used in this instance, mainly due to sample size. Research has shown that a sample size of approximately two hundred would have been ideal. In this study, if the sample size is two hundred or less, then other equally effective statistical analysis methods, such as moderated regression analysis, will be utilised.

Moreover, five variables were used, contrary to what other researchers recommend that the ratio of subjects to variable should be 20:1, with the lowest being 10:1. As a result, it appears that the research methodology has been flawed right from the beginning, because the researchers were supposed to have known that a sample size of sixty-six would not allow them to do what they intended to do, namely to use structural equation modelling. Even though there were issues with the methodology, conclusions could still be drawn after using different statistical analysis methods. For this reason, sample size for this study will also be guided by the intended data analysis techniques in this present study based on the statistical power. Manwaring et al. (2017) concluded that learner-to-learner interactions had a positive impact on cognitive engagement, but not on affective engagement, which was contrary to what literature states.

In most literature sources consulted, one of the main reasons for using the blended teaching method was the need to cater for learners' emotional and social needs. However, Manwaring et al. (2017) found that the traditional face-to-face component did not impact emotional

engagement as expected from literature. They also found that flexibility as a benefit of blended learning led to increased emotional engagement. It further became apparent through the research under review that both indicators of engagement (cognitive engagement and emotional engagement) impacted learning and not facilitators, as was expected based on literature. Most importantly, Manwaring et al. (2017) concluded that the pedagogical designs of learning activities and learner perceptions impacted learner engagement positively.

From the point raised above, it can be argued that it is not so much about whether blended learning has been used or not, but whether the blending processes focus on learning activity design. Additionally, the teachers' skills in designing learning activities in both the traditional face-to-face setting and in the blended learning setting needs to be determined before conducting research such as this. Manwaring et al. (2017) also arrived at the conclusion that learner engagement is not influenced by the component of the blended learning, which emphasises the fact that the design characteristics of the learning activity takes precedence over whether the activity was done online, or inside a physical classroom. In short, a careful consideration of most of the conclusions drawn here, can be viewed as clear demonstration of contradictions in literature on blended teaching and learning engagement. However, there exists studies that show that blended teaching impacts learning engagement. One such study was conducted by Sahni (2019).

A study by Sahni (2019) investigated the impact of blended teaching on learning engagement and its ability to support autonomous learning. The researcher focused on two learning engagement indicators (emotional engagement and cognitive engagement). Cognitive engagement was defined as the mental energy expenditure and emotional engagement as involving emotions such as happiness, enjoyment, frustration, and boredom, just to name a few (Halverson & Graham, 2019). These emotions would impact on cognitive engagement and quality of learning depending on whether they are positive or negative (Halverson & Graham, 2019). It is noteworthy that, despite the fact that it has autonomous learning as one of the variables, the study by Sahni (2019) is still relevant to the present study, mainly because it examines the impact of blended teaching on learning engagement. For instance, by focusing on interactions as part of learning engagement, this study is also centred on participation behavioural engagement. However, the participant characteristics and study context utilised by Sahni (2019) differ from that of the present study.

The study under review was conducted at a private female university in Saudi Arabia. It also became apparent during this review of literature that all the participants in the group participants were females (Sahni, 2019). However, the impact of gender on learning engagement is not under investigation in the current study, which utilises both male and female participants. This was be done as a precautionary measure so as to ensure reliability and external validity of results. Two groups (the control and experimental groups) were utilised during the study by Sahni (2019) even though not much about the second group is evident in the research. Sahni (2019) only gave details of the experimental group, which comprised thirty participants, who were studying a business course. However, what is evident from the study being reviewed is that the control group was taught using the traditional teaching method while the experimental group was taught using blended teaching approach.

A similar approach will also be used in this current study with the exception that more details about the control group will be clarified. The other time that the control group is mentioned is during a discussion of findings which compromised the clarity of the research. Without more information about the control group, confusion about whether all the variables were adequately controlled could not be avoided. It also became apparent that the university in question was using the traditional teaching method, which meant that the learning environment for the experimental group had to undergo several changes to convert it into a blended learning environment.

Some of these changes included making the Learning Management System easier to use in addition to making it 'more attractive'. However, no details were furnished in the research report on how this online component of blended learning was made more attractive. Most importantly, learners were given an opportunity to familiarise with the blended teaching and learning system before the data collection phase. This orientation phase is crucial to ensure successful blending, as Yaghmour (2016) points out. As such, a similar approach will be adopted for this proposed study. The other adjustments include the activation of the online discussion forum ensuring that interaction of learners online was also supported. Assuming everything was taken care of in terms of control of variables, there is a need to look at the data collection process.

Data collection methods used include interviews, student engagement surveys. This was in addition to the data which was recorded by the Learning Management System (LMS). The

LMS data were collected from activities such as quizzes, chat rooms, online assignments, discussion forums, videos, and class sessions. It can be argued that the use of the three mentioned data collection methods addressed issues of reliability and validity, even though details of how such data were mined is unavailable. Such details are particularly important, since they would shed some more light on the consistency of the methods used in both components of blended teaching.

A detailed description of how the teaching proceeded was supplied. Sahni (2019) also provided details of how the interviews were conducted. Furthermore, the researcher also developed the survey using Manwaring et al. (2017) and Lin et al. (2018). The adapted questionnaire was designed in a way that made it possible to gather background information of the participant, secondly, to collect data on both the identified learner engagement indicators (emotional and cognitive), while the third type of data collected were based on learner attributes such as self-efficacy, interest in the subject and 'tech-efficacy'. All the data collected were analysed and discussed.

Interview data on learning engagement were coded and transcribed followed by the establishment of patterns, themes, and categories. Content analysis and SPSS 22 were also used to analyse qualitative data such as that from the interviews. The analysed data were then compared with the survey data. A similar approach to the analysis of qualitative data will be used in this proposed study. Descriptive statistics (means and standard deviations) were also used during the analysis. Without going into a detailed data analysis, Sahni (2019) concluded that blended teaching enhanced learning engagement. What is evident from the two studies which specifically examined the impact of blended teaching on learning engagement is that they portray the inconsistency alluded to in the background section of this study. As an added advantage, the average academic achievement of the experimental group was also slightly higher than that of the of the control group. Could this be ascribed to increased learning engagement, or specifically due to the blended teaching approach that was adopted? This question requires that studies on the impact of blended teaching on academic achievement be reviewed.

2.1.6 Blended teaching versus academic achievement

Considering the benefits of blended teaching mentioned in the background section of this study, it would not be surprising fort blended teaching to have a positive effect on academic achievement. However, when studies on effectiveness of blended teaching on academic achievement are considered, the picture becomes somewhat unclear, where the actual research findings become inconsistent, as demonstrated in this section of study. Studies conducted by Yaghmour (2016); Seery (2015); Naaj et al., (2012); and Williams et al. (2008) exemplify this inconsistency, as demonstrated in this study.

Yaghmour (2016) conducted a study on the effectiveness of blended teaching on achievement of third grade in Mathematics in which two independent variables were identified as follows: teaching method (blended teaching compared to traditional face-to-face methods), and gender (male compared to female). The dependent variable was academic achievement. The sample size used was ninety-seven learners, consisting of forty-five males and fifty-two females. These participants were chosen from two schools, with many third-grade classes. Two classes were then randomly selected. One class was then taught using the blended teaching method, while the second class was taught using the traditional method. Both classes were taught by the same teacher. The researcher used a quasi-experimental design in which the class taught using traditional method was the control group, while the class became the experimental group.

Since the impact of gender on achievement had to be determined, of the two teachers one had to be male while the other one had to be female. The achievement test, which was developed and validated by the researcher, was used as the research tool (Yaghmour, 2016). The need to ensure reliability and validation of research instruments is a key factor to ensure the instruments are indeed measuring what they are supposed to measure. In this regard, it can be argued that the processes followed by Yaghmour (2016) were adequate as demonstrated below.

This achievement test (research tool) was subjected to a thorough validation process by the mathematics, and elementary education supervisors as well by ten instructors (curricula and education specialists), and by the third-grade teachers. These reviewers checked whether the test was grade appropriate and in line with the objectives. Some items that were found to be unsuitable were removed or replaced with more appropriate ones. To determine the test's reliability, it was administered twice on 15 male and female learners. The current study will

also consider running this pilot test so as to ascertain the suitability of the questions and determine their clarity. Reliability score of 0.84 and a consistency coefficient of 0.89 were obtained (Yaghmour, 2016). This ensured that the achievement test measured what it was designed to measure which makes the research findings credible. In the current study, a similar validation process will be adopted. The development and validation of the achievement was followed by data collection process.

The data were collected during a five-week period. Computers were supplied to schools that did not have them. The data collected were analysed statistically using two-way ANCOVA, which was preceded by calculations of means and standard deviations. The collected data were then used to address the research questions, and compared to the studies that were part of the literature review. Even though no major disparity in the achievement of learners based on gender was evident, the study showed that blended teaching effectiveness on academic achievement in Mathematics was ascertained. This was attributed to several factors, such as the fact that teachers had mastered the skill of teaching using blended teaching, the learners in the experimental group were not bored, which means that they were attentive. Furthermore, the use of blended teaching could have led to negligible differences in achievement based on gender (Yaghmour, 2016).

Before proceeding to the next study, there is a need to highlight the close relationship between the moderating and dependent variables of this study, which are learner engagement, and academic achievement, respectively. By mentioning attention and a lack of boredom, which were cited as reasons for improved achievement in the experimental group, also happen to be learner engagement facilitators (Halverson & Graham, 2019). This further confirms the idea that learning engagement is causally linked to academic achievement. However, this will be discussed in greater detail in the section of this literature review that attempts to establish a relationship between learning engagement and academic achievement. Yaghmour (2016) also outlined the conditions for successful blending as the need for the instructor to provide guidance and communicate effectively, encourage learners to participate, repetition, affordance of choices that are flexible, and involvement of learners in the choice of a suitable blend.

Since Yaghmour's study was a clear case of successful blending, it would be fair to conclude that successful blending is conditional. However, details of how the mentioned conditions were considered is noticeably not clear, especially regarding how these conditions were achieved.

Nevertheless, these conditions offer a non-prescriptive starting point for anyone wishing to use blended teaching for the first time. These outlined conditions can also provide guidance in the present study, given that the learners in the experimental group are being exposed to blended teaching for the first time. At this point, it would be interesting to review one more example of a study on blended teaching and academic achievement, which provided more details of the activities employed.

Williams et al. (2008) embarked on a project to introduce blended learning of Inorganic Chemistry at Kingston University. The sample consisted of twelve learners that were studying Chemistry honours degrees. This blended teaching project under review was designed to impact academic achievement and satisfaction. Only one inorganic chemistry group was taught using blended teaching method, which would then become the experimental group. Williams et al. (2008) conducted the study in question over a period of three years.

Even though the duration of the study was long, the teaching staff were the same for most of the time (2003/4 and 2004/5), except for 2005/6, when one staff member retired. Emphasis on the fact that most of the teaching staff were the same highlights the importance of minimising the impact of using different teachers on reliability and validity of the study. However, conducting the research in this manner may not be possible in this study, due to the availability of resources such as computers. Notably, Williams et al. (2008) used resource-based learning in which limited use of lectures was employed.

The learners were exposed to the learning through study packs, which were sometimes augmented with video and audio clips, workshops, as well as assessments that were administered online and feedback (Williams et al., 2008). Each workshop was concluded by a multiple-choice quiz. Online learning platform such as Blackboard was used for the purposes of allowing for online learners and staff interactions, uploading online resources delivery of content, online assessment, feedback, and communication with learners as well as for monitoring of learner activity. The impact of blended teaching became apparent when the achievement of in Inorganic Chemistry during the 2004/5 and 2005/6 periods was compared with the performance for 2003/4 period which was before the introduction of blended learning. Interestingly, a learning styles questionnaire was also administered to the learners after it had been validated. The learning styles questionnaire was designed to give learners an opportunity to think about their learning processes. This approach confirms the notion that the blended

teaching caters for wide variety of learning styles (Naaj et al., 2012). The research design, findings and discussion thereof raise several questions, as shown in the next paragraph.

Learner satisfaction increased significantly because of the introduction of blended learning. This positive outcome was also supported by Naaj et al. (2012) who indicated that satisfaction is key to successful blending. As a result, this study will endeavour to ensure that learners in the experimental group are satisfied to guarantee successful blending. To ensure this the following will be done: provision of administrative support, ensuring that learners have access to technology and reliable devices, maintain presence in the online component and communicate regularly with the learners as well as providing feedback for assignments timeously (Naaj et al., 2012). However, the improvement in academic achievement could not be linked to blended teaching, since the groups that were not exposed to blended teaching also experienced an increase in performance.

Even though Williams et al. (2008) noted the increase in achievement scores of learners in the experimental group, it could not be concluded that this was a result of the blended teaching intervention, due to variables that were not adequately controlled. On the same note, the conclusion on the findings which related to learner satisfaction appear to be problematic, because only the other Inorganic chemistry groups that were not exposed to blended teaching were supposed to be dissatisfied by the traditional lecture method.

Furthermore, the change of teaching staff also introduced another factor, which was never acknowledged as a limitation of the study. Arguably, the impact of this introduction of a new staff member or the retirement of one member of the teaching team could have compromised the reliability of the research project findings. Another cause of concern is that there is no documented evidence of the validation of the tests and examinations used during this study. Besides the failure to adequately control variables, the sample size was also too small. At this stage, it becomes unclear as to whether any of the findings can be generalised, which makes it difficult to use the same approach adopted in a study such as this one.

The study under review also determined the impact of blended teaching on academic achievement, which makes it less relevant to this particular the study compared to one conducted by Yaghmour (2016). On the contrary, the study under review was based on a Chemistry topic, making it more relevant to this study despite being conducted at university level. The research also focused on promoting active learning, which would make it a learning

engagement issue as discussed later in this section of the study. Since the study under review, which was on blended teaching, appears to have impacted on learning engagement, can it be concluded that blended teaching enhances learning engagement?

2.1.7 Relationship between learner achievement and engagement

A study by Lin (2018) investigated the relationship between learning engagement and academic achievement at university level. The study, which was conducted at University of Shanghai, utilised a sample of seventy-one (sixty females and eleven males) studying a statistics course in psychology degree programme. Interestingly, the study by Lin (2018) is similar to the current study in many respects. Firstly, it investigates academic achievement and learning engagement in a blended setting.

Second, it attempts to utilise a mixed method research paradigm, which include self-report questionnaires, to measure learning engagement in conjunction with interviews in a bid to increase the validity and reliability of the findings. Thirdly, an attempt to converge the quantitative (self-report questionnaire data) and qualitative (interview data) was done, which makes the research findings more reliable. The research findings were used to forge a relationship between achievement and learning engagement.

On analysis of the results, Lin (2018) concluded that learner participation in terms interactions in terms of learner-to-learner and learner-to-content had a positive impact on achievement. By saying this, Lin (2018) emphasised the importance of one component of emotional engagement, behavioural engagement. This is concerned with participation and can be traced back to another learning engagement type, which is not consistently used in literature. As indicated previously in this study, behavioural engagement further complicates the 'multidimensional construct' of learning engagement, as it tends to overlap with other learning engagement sub-constructs more significantly (Fredericks et al., 2004; Halverson & Graham, 2019).

This correlation between peer interactions and academic achievement was established after analysing the test, which was written during the face-to-face component of blended teaching. This appears to agree with Fredricks et al. (2004), who indicated that generally, self-reports by

teachers and learners point towards a correlation between behavioural engagement and academic achievement, even though the extent to which this correlation exists is questionable, as it tends to vary across research studies. In addition, when the type of behaviour and its subsequent measurement techniques are considered, an even more blurry picture emerges.

Even though Halverson and Graham (2019) insist that learning engagement needs to be conceptualised in terms of two sub-constructs-cognitive engagement and emotional engagement, which essentially excludes behavioural engagement, factor analysis becomes essential to determine this. To back this assertion, Halverson, and Graham (2019) appear to issue some caution as to whether behavioural engagement ought to be conceptualised as simply cognitive, or affective engagement, manifesting themselves in the physical. For the same reason, the learning engagement measurement scales need to be subjected to factor analysis in this study so as to determine the factor structure. Given this brief background, it is important to note that Lin (2018) also measured the number of clicks that could have been a result of the technical glitches impacting negatively on emotional engagement during the study under review. The learners reported emotions such as frustration, which could have impacted negatively on motivation, and which had a knock-on effect on achievement.

Interestingly, Halverson and Graham (2019) appear to have downplayed the impact of frustration by indicating that it is inevitable in both positive and negative learning environments, which would leave one wondering as to the extent to which the frustration experienced by participants in the study being reviewed could have influenced poor academic achievement. This aspect of emotional component of learning engagement requires further investigation in order to determine the conditions under which frustration becomes positive and which conditions it becomes negative. The downplaying of frustration appears to have been heightened when Halverson and Graham (2019) indicated that it is not as severe as boredom. It could be argued that emotions are a strong determinant of academic achievement which shows that emotional component of emotional engagement plays a key role in determining the effectiveness blended teaching on academic achievement. This is more so when Halverson and Graham's (2019) assertion that emotions serve as the "fuel" that propels the behavioural and cognitive engagement, thereby leading to increased learning quality is considered.

In this way, emotions indirectly influence academic achievement (Finn & Zimmer, 2012). Based on this, emotions could have influenced learner interactions (as arguably a part of behavioural engagement) and cognitive engagement. Interestingly, prompt feedback was praised for being able to soften the blow from emotions such as frustration (Halverson & Graham, 2019). Nevertheless, it became apparent from the study by Lin (2018), that there is a need to have a technical support person to minimise the number of technical glitches that have the potential of compromising the research findings. In addition, immediate feedback will also be factored in during the design of the blended setting for this study.

Furthermore, the design of the learning activities also came under the spotlight since the participants did not understand the essence of the discussion forum. It could be argued that opportunities for learners to interact with one another may have been reduced by the lack of online peer interaction. As such, the current study will ensure that the teacher teaching the experimental group is skilled in designing online activities that can motivate the learners by insisting on the use of Salmon's (2002) five stage framework principles, which will be elaborated on in later sections. Additionally, the fact that the learners were being exposed to blended teaching for the first time could have impacted negatively on the research findings, and for this reason, there is a chance that even the other aspects of learning engagement could have had more significant impact on academic achievement.

On the other hand, this exposure to blended teaching could have resulted in increased excitement and motivation, particularly in learners that are fascinated by technology. Nevertheless, the relationship between academic achievement and learning engagement was also confirmed by other scholars such as Seery (2015); Halverson and Graham (2019); Yaghmour (2016), and Oriab (2015). For example, an analysis of Halverson and Graham's (2019) research placed learning engagement inbetween blended (or traditional face-to-face) teaching in their diagrammatical representation of their study, which essentially points towards the existence of a third variable.

This third variable could be a mediating variable or a moderator variable. Without any details of the mediation or moderation tests provided, the nature of this third variable could not be concluded. However, as mentioned earlier in this study, the closest identification of learning engagement as a moderator was conducted by Shimizu (2021). Given that the circumstances of this research study are different, it remains unclear as to whether learning engagement indeed

has any moderating effects on the relationship between blended (or traditional face-to-face) teaching and academic achievement.

Researchers have identified the moderator variable as a third variable that strengthens or weakens the relationship between the independent and the dependent variables (MacKinnon, 2011). This study endeavours to contribute on the clarification of the possible moderating effects of learning engagement sub-constructs on the relationship between blended (or traditional face-to-face) teaching and academic achievement. This piece of information is regarded as crucial in explaining the effectiveness of blended teaching on academic achievement, if any is determined in this study.

Of particular interest is the study conducted by Seery (2015), which was a meta-analysis of literature on flipped learning, which this study recognises as a form of blended teaching. To perform this analysis, Seery (2015) surveyed twelve Chemistry articles from different scholars-Smith, 2013; Christainsen, 2014; Yeung and O'Male, 2014; Butzler, 2015; Fautch, 2015; Flynn, 2015; Rein and Brookes, 2015; Rossi, 2015; Fitzgerald and Li, 2015; Yestrebsky, 2015; Seery, 2015; and Trogden, 2015). Notably, most of the meta-analysed literature was on Organic Chemistry which accounted for seven out of the twelve studies selected for the meta-analysis. These articles were selected using predetermined criteria, which included the following: articles had to be published in peer reviewed publications, based on the implementation of flipped learning in a higher education context, and included an evaluation of flipped learning on learner opinions or learner engagement and or academic achievement.

A discussion of the results showed that blended teaching (in the form of flipped learning) had a positive impact on learning engagement and achievement in addition to reducing the attrition rate. Of particular interest is the fact that Fautch (2015) and Flynn (2015), whose studies were based on Organic Chemistry, reported an improvement in both learning engagement and academic achievement in terms of increased interactions and a general active learning. Additionally, this type of blended teaching was enjoyed by most learners as reported by Seery (2015). It is worth noting that enjoyment of the learning material is a part of affective engagement, which Lin (2018) considers as key in fostering academic achievement.

The fact that blended teaching influenced both learning engagement and achievement highlights a relationship between achievement and learning engagement. As a result, this study

recognises this kind of relationship. Seery (2015, citing Flynn, 2015) added that learners were afforded an opportunity to construct their own knowledge through formal interactions with peers as well as with the content, which is in keeping with Vygotsky's socio-cultural theory (Mahn, 1999) which has been used to anchor this study. Arguably, the expenditure of cognitive energy (cognitive engagement) in knowledge construction would have an impact on learning engagement while impacting positively on achievement.

Given that some of the scholars in this meta-analysis were driven by the need to improve interactivity through the implementation of this form of blended teaching approach (flipped learning), emphasises the central role played by interactions in the teaching and learning process. As indicated previously, this study recognises the need to foster the three types of interactions, with a view to positively impacting on academic achievement through blended teaching. For this reason, flipped learning as a form of blended teaching will be utilised in this study in conjunction with another form of blended teaching such as the ABL model. Furthermore, having established that the relationship between blended (or traditional face-to-face) teaching is not a straightforward, one due to the possible existence of a third variable in the form of learning engagement, possibly moderator variable, it becomes important to interrogate this issue further.

2.1.8 Moderating Effects of Learning engagement types

According to Shimizu (2021), who investigated the role of learning engagement in terms of cognitive engagement and emotional engagement facilitator, focusing on mathematics anxiety on vector problem-solving performance, with particular reference to the strategies employed in problem-solving. The study under review is relevant in that that it was conducted in an educational setting and that it presents learning engagement as a moderating variable. However, the conditions in which learning engagement was investigated for possible moderating effects are different from that of the current study. For example, the study focused specifically on one of the facilitators of emotional engagement in the form of mathematics anxiety, and on two facilitators of cognitive engagement in the form of problem-solving strategy and self-efficacy.

The study being reviewed contrasts sharply with this study, which considers more than just two facilitators of cognitive engagement and only one of emotional engagement. By focusing on the only the facilitators this study effectively focused on a totally different relationship, even though the ultimate aim was to determine academic achievement in term of vector problem-solving performance. Aside from identifying learning engagement as moderator, this study by Shimizu (2021) failed to provide any plausible leads to follow in this study. For example, Shimizu (2021) indicated that learning engagement could potentially have acted as a moderator variable on the relationship between cognitive and emotional factors and vector problem-solving, which would create a lot of confusion. Since not much could be drawn from the study under review, coupled with the idea that it focuses on Mathematics, the current study remains relevant. Having looked at this, it becomes important to develop an understanding of what moderation of the importance of moderator variables.

There are several benefits associated with the inclusion of moderator variables in research studies, such developing an awareness that individual learners are different and providing direction on implementation of intervention (MacKinnon, 2011). The practical implications associated with the inclusion of learning engagement sub-constructs as moderators cannot be overemphasised, given that this study wishes to propose the design features of the blend could be effective in fostering learning engagement and academic achievement in the broader South African high school context.

2.2 Conclusion

This rigorous review of literature helped to develop a clearer picture of what blended teaching entails. It became apparent from this literature review that different researchers have different conceptions of what blended learning is all about. However, it became clear that most researchers agree on the surface features of blended learning, as a combination of traditional face-to-face component, and the online or virtual component. Unfortunately, issues pertaining to the configuration of the blends remain unclear. What also became apparent from this review of literature was that what constitutes an effective blend is conditional. These conditions include contextual factors. For this reason, what was found to be effective under different conditions needs to be tested in different contexts. Given this, it can be concluded that the South African context and the high school setting still require more extensive research. To further exacerbate the problem is the vast differences found in the resourcing of schools in South

Africa. The paucity of research on the effectiveness of blended teaching on learning engagement and academic achievement, particularly in Organic Chemistry in the identified settings, is still evident. Additionally, it can also be concluded that literature on the effectiveness of blended teaching on learning engagement and academic achievement was largely inconclusive in addition to being riddled with gaps.

One such gap was that research studies that were particularly concerned about the relationship that exists among variables such as teaching method, learning engagement and academic achievement were also scarce (at least at the time of current study). Furthermore, attempts to utilise structural equation modelling was associated with a lot of advantages but has not used extensively, which made it difficult to provide more clarity on the latent variables. For example, it remained unclear whether learning engagement is a moderator variable or not. For this reason, the current study utilises moderated regression analysis to determine the moderating effects of the learning engagement sub-constructs. Based on the review of the literature, it can be concluded that the current study therefore remains a significant one. However, this review of literature was instrumental in shaping the research methodology for the current study, which is described in detail in the chapter that follows, (Chapter Four) as pointed out earlier in the in the conclusion to Chapter One. Furthermore, to make sense of the data that will be collected in this study, theoretical and conceptual frameworks will be used.

CHAPTER THREE: THEORETICAL AND CONCEPTUAL FRAMEWORKS

3.1 Introduction

Research has shown that most conceptual and theoretical frameworks have failed to adequately support research in settings that utilise blended teaching (Chew, et al., 2008; Halverson & Graham, 2019). For instance, blended teaching is constantly changing-dynamic in nature (Chew et al., 2008; Halverson & Graham, 2019; Vaughan, 2014) due to technological advances. It is for this reason that this study is grounded in the conceptual framework derived from some of the tenets of four selected models as illustrated in **Error! Reference source not found.**. Chew et al. (2008) underscore the need for any blended teaching framework to be informed by educational theoretical underpinnings. In this study, two key educational theories were used to select blended teaching and learning models that contributed significantly to providing tenets that inform the derived conceptual framework in **Error! Reference source not found.** and the research methodology to be employed. These two educational theories are Maslow's hierarchy of needs and Vygotsky's socio-cultural theory, as pointed out by Chew et al. (2008). By using the conceptual framework illustrated in **Error! Reference source not found.**, this study indirectly draws from the theoretical framework that comprises the educational theories just mentioned.

3.2 Theoretical framework

3.2.1 Vygotsky's Socio-cultural Theory

Lev Vygotsky's socio-cultural theory indisputably plays a significant role in developing an understanding of how learning takes place in social and cultural settings, thereby impacting education in its entirety (Mahn, 1999). Vygotsky's work was originally written in Russian, and this study therefore utilises the English translations. This theoretical framework is focused on the methodology adopted by Vygotsky, which gave rise to significant contributions towards the development of the socio-cultural theory (Mahn, 1999), that was used to partly anchor this study.

Additionally, in order to make a more comprehensive description of socio-cultural theory and the consequent implications to education, other supporting sources were used (see, for example, Vygotsky & Cole, 1978). The methodology adopted was arguably scientific, and highly analytical in nature (Mahn, 1999), however questions have been raised as to some aspects of this scientific method as a result of the qualitative deductions made. This notwithstanding, logical analysis played an important role in developing and understanding tools and symbols, such as language, as well as aspects of culture, while paying particular attention to children (Vygotsky & Cole, 1978).

By focusing on children, Vygotsky underscored the importance of the idea that children have a tendency of speaking to themselves, thereby directing their thought processes with an effect of helping perform the task at hand (Vygotsky & Cole, 1978). Moreover, when an adult assists a child and talks through the stages of problem-solving, this demonstrates to the child the importance of self-regulation (Mahn, 1999). When applied to education, such an interaction emphasises the important role played by the social interactions that constitute the teaching and learning process. For this reason, this study investigated the significance of social learning through interacting with other learners. Following such an interaction, a child learns to use speech in order to direct the way they perform tasks.

As indicated by Vygotsky and Cole (1978), during the early stages, this private speech tend to follow actions, however, as time progresses, private speech will occur prior to the actions, thereby serving as a guide. Furthermore, Vygotsky concluded that more difficult tasks underscored the requirement for children to engage in speech (Vygotsky & Cole, 1978). These verbal conversations with oneself that a child undertakes are not necessarily meant social conversations with other people; on the contrary, they are for the benefit of the individual child (Mahn, 1999). This speech is initially verbalised and later on ceases to be verbal and become restricted to confines of the child's mind (Mahn, 1999). However, as Vygotsky points out, social interaction and internal, individual processes are not mutually exclusive, and they depend on one another.

Additionally, Vygotsky expanded the functions of speech by indicating that it also regulates the behaviour of the child (Vygotsky & Cole, 1978). When this happens, the speeches assume a planning role, which may be followed by a transformation when the child becomes more proficient in language acquisition, resulting in the child being able to perform more

complicated tasks (Vygotsky & Cole, 1978). In this way, problem-solving skills, capacity to be imaginative, and to think, and level of creativity, are all enhanced (Mahn, 1999). When applied to this study, this points towards cognitive engagement. Interestingly, when children cannot draw from speech acquired socially, they resort to private speech, and they are encouraged to use this inner speech when confronted with a complicated task (Vygotsky & Cole, 1978).

By extension, this social setting could arguably be classmates (participation behavioural engagement) or the teacher. Taking this into consideration, high levels of engagement would be expected when the work is complicated (not too easy). However, this is not always the case as, according to Vygotsky & Cole, when the private speech fails to provide the answer, then the children seek the help of an adult (Vygotsky & Cole, 1978). When applied to this study, the learners would seek help from the teacher when they are struggling with the work given. Closely related to the problem-solving is the formation of concepts, which flow from private speech and self-regulation.

According to Mahn (1999) there are factors that interfere with the formation of concepts such as language acquisition, concrete versus abstract thinking, and constant shifts from general to specific and vice versa. As a result, concepts that are not entirely accurate (pseudo concepts) and may be formed by children. For example, the initial language development may fail to provide links between what the children already know and the connections between external objects (Mahn, 1999). Furthermore, the child's words are sometimes more or less similar to those of an adult, which provides an opportunity for interactions that are social in nature.

When applied to education, this could also be participation behavioural engagement. Additionally, Fredricks et al. (2004) identified social context as facilitators of learning engagement. Through a series of trial and error, which are not necessarily informed by the actual problem (that is failure to make the necessary connections), the child begins to make minor changes to the several words that they have in their vocabulary. During these efforts, the child begins to develop complex and abstract thinking, coupled with attention that is driven by the child and being able to draw comparisons/sources of variation leads to the development of concepts (Mahn, 1999). The process of developing concepts places emphasis on Vygotsky's zone of proximal development (ZPD), which lies at the heart of the socio-cultural theory.

This boundary between what the learner is capable of achieving independently and the higher level of capability is being referred to as the zone of proximal development. The zone of proximal development enables teachers and psychologists to make sense of the mental development of learners (Vygotsky & Cole, 1978). The zone of proximal development is based on the premise of shared knowledge construction (Mahn, 1999). This co-creation of knowledge happens when an individual is assisted by peers and the teacher by engaging in social interaction.

When applied to the present study, it could be argued that all the three sub-constructs of learning engagement are implied, for example, when peers are working together then participation behavioural engagement becomes evident. Cognitive engagement becomes evident when learners are creating knowledge together, which signifies an investment of mental energy. As applied to this study, affective engagement is facilitated by teachers working with learners, with a view to helping them during the learners' zones of proximal development. Furthermore, emphasis was placed on the significant role played by culture and language in terms of words in facilitating knowledge construction (Vygotsky & Cole, 1978; Mahn, 1999). Mahn (1999) explicitly mentions that these interactions occur between more proficient and less proficient learners, which represents the participation component of the behavioural engagement sub-construct. As a result of this, building a learning community where learners are ready to assist one another becomes an important instructional consideration.

A blended learning framework that promotes this sense of community becomes important in order for successful blending to occur. The concept (ZPD) takes cognisance of the idea that different learners who are of the same chronological age may not necessarily have the same mental age. Moreover, this means that the learner's chronological age only provides an indication of what the learner is capable of accomplishing independently, but not necessarily what the learner can achieve at that point in time (Mahn, 1999). This is more so the case, given that learners start learning before setting their feet in a classroom and that learning continues to happen after formal lessons (Mahn, 1999). This means that learners do not come to the lesson without some form of knowledge relating to the concepts to be learnt. This also means that the starting points, as far as learning is concerned, would differ giving rise to different *zones of proximal development*. Taking this into consideration, a teaching approach that caters for learner differences would be expected to be more effective. However, this does not mean a

child that is lagging behind should stay in that space permanently, as there is a need to ensure that all learner needs are catered for.

One way of achieving this would be through the use of teaching methods that take into consideration the variety of *zones of proximal development* that are synonymous with most of our classes. The question then becomes, can blended teaching help mitigate this problem of a wide variety of *zones of proximal development*? If so, how? To answer the questions posed above, there is a need to examine a quotation from Vygotsky, and Cole (1999), "Children can imitate a variety of actions that go well beyond the limits of their own capabilities. Using imitation, children are capable of doing much more in collective activity or under the guidance of adults" (p. 88). It can be argued that all learners, regardless of their level of development, are capable of achieving more than what their circumstances dictate (in terms of contextual factors such as cultural factors). Implicit in this quotation is also the notion that group work or collaborative work and help from an adult (who can be a teacher when educational settings are considered) ensures that learners break boundaries imposed by their socialisation and/or culture. The role of the teacher in Vygotsky's socio-cultural theory is that of a facilitator.

It can be argued that learners working with peers in group work or being assisted by the teacher (social interactions), exposed to demonstrations and asked questions designed to guide them while they are in the *zone of proximal development*, can indeed achieve what is expected of them based on their chronological age (Vygotsky & Cole, 1978). By encouraging social interactions in educational processes, it could be argued that Vygotsky underscored the need for learning engagement as a precursor to academic achievement as illustrated in the conceptual framework in **Error! Reference source not found.**. In a bid to promote social interactions, the teaching approach to be adopted in this study needs to include discussion forums, wikis, and peer assessment, in the form of group work. Nevertheless, it could be deduced that learners working independently may not be missing out particularly if their level of development is higher than that of their peers.

The quotation referred to previously in this section of the study concerns imitation, which is generally regarded as lower level of learning (Vygotsky & Cole, 1978). However, research has shown that a learner is only capable of imitating what is in the level of development of that particular learner (Vygotsky & Cole, 1978). Based on this, and when applied to educational settings, imitation becomes an accurate indicator of a learner's level of development. For

example, imitation being alluded to here (when applied to education) implies that a learner may be trying to replicate the problem-solving techniques demonstrated by teacher (Vygotsky & Cole, 1978).

It could be argued that the interventions just discussed are not only dependent on the willingness of the learner to engage in social interactions, accepting help from their peers and from the teacher but also on motivation. As a result, Maslow's theory of the hierarchy of needs was used to augment Vygotsky's socio-cultural theory, with a view to drawing from both theories to anchor this study. Drawing from theories on motivation such as Maslow's hierarchy of needs was deemed necessary, given the nature of Organic Chemistry, which is generally perceived as a difficult subject in which learners generally feel discouraged and perform poorly (Salame et al., 2019).

3.2.2 Maslow's Hierarchy of Needs

Maslow's hierarchy of needs theory consists of five distinct stages and among other applications they figure strongly in education through providing the necessary conditions for motivation of learners (Chew et al., 2008). This theory was adopted for its significant potential to support this study, based on the relationship that exists between research on cognitive engagement and motivational goals, as well as self-regulated learning (Fredericks et al., 2004). Additionally, Maslow (1943) was concerned about cognitive needs when Stage 1 comprises the basic needs, Stage 2 is concerned with needs for safety, Stage 3 is made up of the needs to be loved and to belong, Stage 4 comprises needs for esteem, while Stage 5 is concerned about self-actualisation (Maslow, 1943). Having outlined the five categories of needs that must be satisfied in order to ensure motivation there is a need to develop an understanding of what each of these categories of needs entails.

The physiological or basic needs can be perceived as the fundamental needs that must be satisfied to guarantee any form of motivation (Maslow, 1943). One example of such needs is hunger. Maslow (1943) emphasised the importance of these basic needs by indicating that a person with all five categories of needs that are not satisfied would be preoccupied about satisfying hunger needs, while all the other forms of needs are considered insignificant. Other examples of these basic needs include healthcare, adequate sleep, and ability to access learning

materials (Chew et al., 2008). Maslow (1943) pointed out that the satisfaction of the basic needs is conditional. These conditions include various forms of freedoms, values such as honesty, justice, fairness, and being organised. These conditions also happen to be important in educational contexts. It is only when the basic needs are satisfied that an individual begins to focus on goals which are more of a social nature (Stage 2).

Interestingly, when basic needs are satisfied, they cease to be source of motivation (Maslow, 1943). The next level of needs, which have to do with safety, then become the greatest source of motivation. In educational settings, Maslow's safety needs can be perceived as emphasising the need to create a safe learning environment during Stage 2 (Chew et al., 2008). For instance, this would require that rules of *online etiquette* be established as part of methodology, so as to ensure that all learners feel safe to voice their opinions and be heard without fear of being judged as a part of blended teaching. These rules can be established during the orientation phase. Several threats to one's safety exist. For example, Maslow (1943) indicated physical harm, noisy environments, insufficient support, and health has the potential to precipitate feelings of being unsafe (Maslow, 1943).

Additionally, another source of threat to a child's safety is an unstable environment devoid of order (Maslow, 1943). Under such circumstances the child is motivated by need to have an environment which is free from severe disruptions and where justice and fairness prevail (Maslow, 1943). When applied to this study, it could be argued that a chaotic learning environment deprives learners of (a sense of) safety. Some of these threats to a child's safety may stem from a home environment characterised with a lack of consistency, which leads to anxiety, breakdown of the family unit through divorce, separation or death of a family member, constant quarrels, and being assaulted physically (Maslow, 1943).

When applied to education, such a hostile environment in the school setting where tensions exist, threats of physical violence and being punished physically can potentially demotivate a child. Notably, research on classroom disengagement has shown that children that experience some forms of discomfort are more likely to disengage (Yurtseven & Ocak, 2021). Additionally, moving a child to an unfamiliar location, where the child meets new people and exposure to new tasks and threats to health are also perceived as dangerous and unsafe (Maslow, 1943). It can be argued that a classroom environment coupled with unstable home backgrounds riddled with some of these threats to safety can only result in demotivation of the

learners, and aspiring for the satisfaction of higher needs may be put on hold. Furthermore, natural disasters, disease, war situations and high prevalence of crime also trigger feelings of being unsafe (Maslow, 1943). More importantly, this becomes significant given this study was conducted during an unprecedented time of third wave of the COVID-19 pandemic. When the safety needs are reasonably satisfied, then the individual's focus shifts towards the need to satisfy love and belonging needs, which are part of Stage 3. When applied to this study, this sense of belonging becomes a facilitator of affective engagement as pointed out by Fredricks et al. (2004).

When an individual's basic and safety needs are satisfied to a large extent, the individual begins to actively pursue the need to fill the void created by lack of friends, spouse, or children. The individual in this kind of space tends to forget about the basic and safety needs that took centre stages before they got satisfied. Interestingly, Maslow (1943) emphasised the fact that love needs entail being capable of receiving love, as well as reciprocating it, or merely giving it. When applied to this study, learners tend to disengage when the teacher shows favouritism and withdraws love from other learners (Yurtseven & Ocak, 2021). Intricately linked to love needs is a sense of belonging. While this was placed in Stage 3, it appears that the development of a sense of belonging would be better placed in between safety needs and love needs, simply because the lacking a sense of belonging can be due to a hostile environment, in which the child is ridiculed and dismissed, or disrespected by other learners. When the needs pertaining love needs, basic needs and needs for safety have been reasonably satisfied, then the individual considering issues of self-esteem which are categorised as Stage 4 needs.

In Stage 4, individuals become concerned with needs relating to self-esteem, which were placed into two sub-categories by Maslow (1943). On the one hand, one sub-category includes the goals to gain strength, to achieve, confidence, to attain a state of being adequate in addition to acquiring independence and freedom (Maslow, 1943). On the other hand, the second category is related to a desire to gain reputation or prestige, being recognised by others, receiving attention, and being appreciated by others (Maslow, 1943). However, Maslow does not place these sub-categories into any rank order.

Self-confidence refers to when the self-esteem needs are satisfied one develops feelings of being capable, self-worth, self-confidence, being adequate in the sense of being useful and needed (Maslow, 1943). However, the opposite is true when the self-esteem is not satisfied as

it leads to inferiority feelings, feelings of being weak, and worthless (Maslow, 1943). According to Maslow (1943), individuals harbouring these kinds of feelings usually feel discouraged, or engage in compensatory behaviour. Based on this, it can be argued that self-esteem/confidence will encourage learners to push boundaries and persevere, resulting in higher academic achievement (Halverson & Graham, 2019). When the basic needs are satisfied and stages 2-4 needs either satisfied or partially satisfied, an individual begins to pursue Stage 5 needs.

Stage 5 needs are self-actualisation goals. They are driven by the need to become all that one can achieve (Maslow, 1943). These needs are based on the desire to ensure that everything that is humanly possible to achieve is achieved. This particular need depicts people as constantly searching for new challenges so as to ensure everything they desire is achieved. A look at this prompts the question as to whether the goal of satisfying Stage 5 needs is ever fully accomplished. The question being raised is based on the idea that some goals may have been partially achieved, even at the time one will be looking to achieve self-actualisation in a specific area. As indicated by Maslow (1943), self-actualisation needs appear in a variety of forms among individuals. When applied to educational context, Stage 5 would be characterised by highly motivated learners that are determined to reach their full potential, which is driven by the need to self-actualise (Chew, et al., 2008). It could be argued that self-directedness also occurs in this stage.

Importantly, Maslow (1943) provided a disclaimer relating to the rank order of these basic needs, partly because some people do not conform to it. He went on to illustrate his point by indicating that, for some individuals, self-esteem may become a more immediate need than love. The thought process behind this reversal may be based on the idea that for one to be loved one has to be self-confident, command respect, and be powerful, which means the real need here is love (Maslow, 1943). Based on this, there is a need to establish the real need being pursued. Additionally, what the explanation provided shows is that an assumption that lower needs have satisfied by merely looking at what the individual is chasing can be misleading. Considering the example given, it can be argued that it is not always easy to determine which goal an individual is seeking to satisfy when reversals of needs happen.

Another interesting point raised is that an individual with an unsatisfied need may lack aspiration, to the extent that the need is satisfied as long as basic needs are met. Furthermore,

there exist situations in which people may skip some of the lower basic needs, due to the peculiarities of their personal life circumstances (Maslow, 1943). Once again, the need to check if the lower needs have been satisfied becomes apparent.

Maslow (1943) indicates that there is a possibility that an individual may have an unsatisfied basic need, simply because they perceive it not to be important and may go on to pursue a need that is at a higher level, which may be due to the lower-level basic need becoming unsatisfied later on in life. As a result, a situation of perpetual lack is created. On the other hand, being accustomed to a lack of certain basic needs may develop some kind of endurance (Maslow, 1943). The points raised here appear to contradict each other, which raises the question as to which of these two competing schools of thought take precedence over the other.

Another issue which has the potential of upsetting the seemingly linear order of the hierarchy of needs is the extent to which each of the needs is satisfied before a new need emerges. Most importantly, Maslow (1943) was very practical when indicating that, in reality, there exists a situation in which some of the needs are not necessarily completely satisfied before an individual begins to pursue a high-level need. The situation described leaves room for an individual to be trying to satisfy more than one need at any given time, thereby disrupting the rank order. However, the expectation is that the lower-level needs would have been satisfied to a greater extent (Maslow, 1943). When applied to education, this means that learners who evidently exhibit traits of low-level needs can still be pursuing the higher-level ones, which implies that it does not necessarily mean those learners lagging behind in skills acquisition cannot be disqualified when higher level skills are being considered.

Furthermore, Maslow (1943) cautioned against overreliance on his theory, by stating that most behaviours are motivated by a variety of reasons. To illustrate his point, Maslow pointed out that people do not always eat because they are hungry, because food is also consumed for ritualistic reasons. When applied to education, it would be fair to expect learners pursuing education for different reasons which means the teaching method applied should aim to cater for a wide variety of sources of motivation. For example, as already noted in (Fredericks, et al., 2004) children generally find schooling boring which means they are not going to be learning most topics just because they find them interesting. To put this into perspective, Organic Chemistry is one such topic/subject that most learner do not enjoy, but which most

would persevere at because of the bigger goals they wish to attain. Another important factor which can lead to the reversal of Maslow's hierarchy of needs is culture diversity.

Maslow (1943) acknowledges the importance of the role played by culture in shaping behaviour, by indicating that some of the needs are insignificant in certain cultures, thereby rendering them less effective as sources of motivation. However, Maslow was quick to point out that some the cultural differences are not exactly fundamental in nature and that many share a considerable amount of similarities, which still makes the hierarchy of needs relevant. Nonetheless, it becomes important for teachers to develop an awareness of the different cultures to which learners in their classes subscribe, with a view to structure the motivation from this particular point of departure. Additionally, even though somewhat downplayed, culture has the potential of upsetting the proposed hierarchy of needs.

Based on the discussion, Maslow's hierarchy of needs becomes a powerful tool that can be used to make sense of behaviour, however, as already demonstrated, it falls short in some instances. Similarly, the same can be said about Vygotsky's socio-cultural theory, which shows that this theoretical framework cannot be used exclusively to support this study, leading to the need for a conceptual framework. Notably, this conceptual framework also draws directly and indirectly from this the two powerful theories just discussed, as well as from models that are mostly informed by these two theories.

3.3 Conceptual framework

The four models that contributed to the conceptual framework (Figure 3.1) are the inquiry-based Framework by Garrison and Vaughan (Chew et al., 2008), the e-moderation model from Open University (Chew et al., 2008), Vaughan (2014)'s work on assessment and student engagement and blended learning, and from Halverson and Graham's framework on learner engagement in blended settings. These four models were chosen because among other things, they have been specifically used in blended teaching contexts (Chew et al., 2008, Halverson & Graham, 2019; Vaughan, 2014). Most importantly, these four models are intricately linked to key educational theories, such as Maslow's hierarchy of needs, and Vygotsky's socio-cultural theory (Chew et al., 2008) which form part of the theoretical framework already discussed.

Chew et al. (2008) underscored the need for blended teaching models to primarily focus on learners and educational theory, as opposed to being preoccupied with the incorporation of technology. While it is important to do this, it can be argued that neglecting the technology component can be problematic, as it could lead to many problems, resulting in increased levels of learner frustration. Additionally, a consideration of definitions of key concepts was also made during the selection of the models from which to draw, and this figures strongly in the conceptual framework. In this study, the conceptual framework derived is based on the variables of this study and their relationship. These important variables are teaching method, which is divided into two categories: blended and traditional face-to-face teaching (independent), learning engagement sub-constructs as the moderator variables, and academic achievement as the dependent variable as shown in the conceptual framework in Figure 3.1.

It is important to note that there are three moderator variables because emotional engagement is not a unidimensional sub-construct, since it includes two distinct dimensions, which in this study have been named as affective engagement and participation behavioural engagement, respectively. Research on learning engagement does not agree on the number of sub-constructs of learning engagement, with some scholars focusing on two (cognitive and emotional engagements, others three sub-constructs, and others still four sub-constructs (Yurtseven & Ocak, 2021). Moreover, these sub-constructs assume different names in most of the research (Yurtseven & Ocak, 2021). Combining emotions and learner interactions is not peculiar to this study, as other researchers have also done the same and labelled the two components as emotional engagement (see for example Manwaring et al., 2017; Lin, 2018). Having said this, the three types of learning engagement for this study are cognitive engagement, affective engagement, and participation behavioural engagement. These three sub-constructs were then represented in the learning engagement survey questionnaire as discussed in Chapter 3 to follow. These sub-costructs represent the three moderators, which are denoted as moderator 1, moderator 2 and moderator 3 in the conceptual framework (Figure 3.1) with the overall caption of learning engagement. At this point, it is important to highlight that the moderator variables were represented by the letter (W) or (Z) in Chapter 4.

It is important to note that the three sub-constructs of learning engagement are presented in the form of a range, which extends from positive, to mixed, to negative. Doing it this way makes it easier to capture the comparisons of the two groups. This notion of using continua was suggested by Skinner and Pitzer et al. (2012). For example, cognitive engagement would range

from simple memorisation, to in-depth learning, which reflects on the quality of the learning engagement happening. Furthermore, Halverson (2019) refers to positive and and negative emotional engagement. However, Skinner and Pitzer et al. (2012) considered the range for all the the types of engagement which is arguably a more comprehensive way of conceptualising the various forms of learning engagement particularly in situations where comparative analysis has to be undertaken. This also became the basis for drawing comparisons between the two groups.

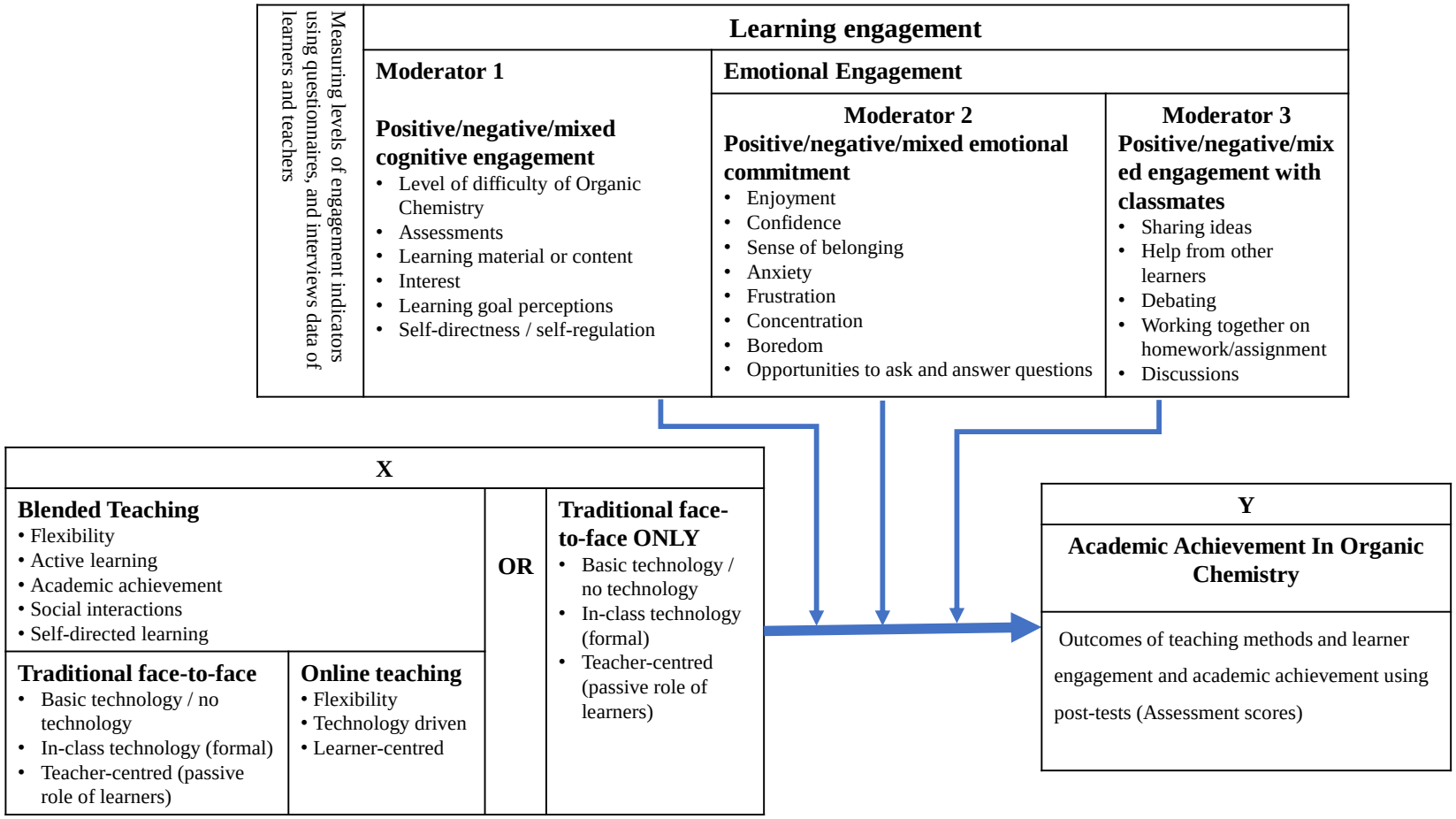


Figure 3.1: Conceptual Framework

Halverson and Graham (2019) as well as Vaughan's (2014) work provides the key definitions of blended teaching, learning engagement, and components of blended teaching, because their definitions are comprehensive. On the one hand, academic achievement is defined using Vaughan (2014)'s work also figures strongly in providing a link between blended teaching and learning engagement with assessment. On the other hand, Salmon's e-moderation model (Chew et al., 2008) in conjunction to Garrison and Vaughan's inquiry-based framework (Chew et al., 2008) were used to provide directions on the design of teaching and learning activities thereby impacting on the research methodology. By promoting social interactions, knowledge construction, reflection, and collaborative learning, the models just mentioned also contributed towards this derived conceptual framework through the promotion of learning engagement-related factors. This was achieved through making contributions towards both cognitive and emotional engagement (which is a combination of affective engagement and participation behavioural engagement) in conjunction with Halverson and Graham's (2019) framework. It is important to note that the relationship among blended teaching, learning engagement, and academic achievement is more clearly spelt out in Vaughan's (2014) meta-analysis of studies, which was designed to link a blended teaching to assessment.

Having said this, it is important to consider the definitions of key concepts that apply to this study while applying them to the derived conceptual framework. For instance, the definition of blended teaching which has already been captured in the introduction to this study was adopted from Halverson and Graham (2019). Similarly, Vaughan (2014) also contributed to this conceptual framework by clearly specifying the definitions of traditional face-to-face teaching and online teaching which are included in the introduction to this study and summarised in Figure 3.1. Vaughan (2014) further outlines the benefits of blended teaching which are again summarised in Figure 3.1 under blended teaching. It is noteworthy that all these benefits have been discussed in the introduction to this study.

It is self-evident that Vaughan's (2014) work has contributed immensely to this conceptual framework by providing more clarity to definitions of key concepts. Furthermore, in this study, the relationship between blended teaching (or traditional face-to-face) and academic achievement is influenced or moderated by cognitive engagement, affective engagement, and participation behavioural engagement. Nonetheless, there is a need to define learning engagement as the moderator variable in this study, which is measured through learning

engagement survey questionnaires, and interviews of selected participants (teachers and selected learners).

3.3.1 Learning Engagement

By virtue of being placed between teaching method employed (independent variable) and academic achievement (dependent variable) in the derived conceptual framework, learning engagement fulfils the function of a moderator variable, which is in three parts. Halverson and Graham (2019) made significant contributions to the conceptual framework by defining learning engagement and identifying the indicators of learning engagement as cognitive and emotional engagement (which consists of two forms of learning engagement which this study has identified as affective engagement and participation behavioural engagement to give a total of three sub-constructs) as shown in Figure 3.1, which is the conceptual framework designed to provide more detail. It is important to note that, for learners to engage in the designed learning tasks, they require intrinsic and or extrinsic motivation in order to feel safe, have a sense of belonging and feeling loved (Chew et al., 2008). These conditions are emphasised by Salmon's e-moderation model.

In this model, learners go through a series of stages starting with Stage 1, when they access the blended teaching and learning system, and they go through an orientation phase to ensure that they develop skills needed to navigate the virtual platform (Chew et al., 2008). This is followed by socialisation online (Stage 2) (Chew et al., 2008). Exchanging of information occurs during which social interactions and a sense of belonging develops as a result (Stage 3) (Chew et al., 2008). Construction of knowledge, where learners engage in reflections and start helping one another, occurs during Stage 4 (Chew et al., 2008). Lastly, in Stage 5, self-directed learning takes place (Chew et al., 2008). Emphasis is placed on the design process of the teaching-learning activities in order to ensure that motivation is sustained, which includes interesting introductions and specifying the purpose of the activity (Chew et al., 2008). This is especially important considering that the High School Physical Sciences curriculum is not particularly flexible in terms of how teachers can award marks in formal tasks. This constitutes cognitive and emotional engagement (consisting of two sub-constructs, which are affective engagement and participation behavioural engagement), as indicated in conceptual framework illustrated in **Error! Reference source not found.**.

Furthermore, learning engagement in terms of interactions is also encouraged by Garrison and Vaughan's model, which places emphasis on the need to develop a community of inquiry (COI) at the point of intersection of teaching presence, social presence, and cognitive presence (Chew et al., 2008). The main objective of this is to promote learner interactions (participation behavioural engagement) and learning in blended and online contexts. Additionally, the COI framework emphasises the development of a sense of belonging among learners, which leads to satisfaction (Chew et al., 2008; Anderson, 2018). The social presence element promotes communication, which is usually initiated using an icebreaker, where learners introduce themselves and communicate their expectations, and share any information about themselves that they feel comfortable sharing (Chew et al., 2008; Anderson, 2018). As learners participate in ice-breaker activities, they familiarise with important parts of technology while building social relations.

The teaching presence's main aim is to ensure learning activities designed promote collaboration, encourage learner participation, provision of feedback, and provide a good example of problem solving for learners to emulate. Furthermore, the cognitive presence element encourages critical appraisal of information by learners, creates opportunities for learners to test knowledge that they would have created (Chew et al., 2008; Anderson, 2018). Additionally, multiple representation of information is encouraged which considers diverse learning styles in learners. Once again, this constitutes emotional engagement (a combination of affective engagement and participation behavioural engagement) and cognitive engagement as illustrated in **Error! Reference source not found.**. **Error! Reference source not found.** explains how the three moderator variables came about. These are cognitive engagement, affective engagement, and participation behavioural engagement as used in this study.

3.3.2 Academic achievement

Vaughan (2014) indicates that blended teaching has the potential of offering an improvement in the way that: content, social interaction and reflection, higher-order thinking learning through collaboration, assessment linked to real-life situations, and problem-solving, are dealt with. In saying this, Vaughan made a direct link between teaching method (blended teaching or traditional face-to-face teaching) and academic achievement and between learning engagement and teaching method. Furthermore, Vaughan (2014) conducted a study on learning engagement and academic achievement and arrived at the conclusion the two constructs are

linked, which is demonstrated by the derived conceptual framework, as illustrated in **Error! Reference source not found.**. It also became apparent through this study by Vaughan (2014) that learners who exhibited high levels of engagement or were highly motivated were the same learners with high levels of aptitude. Most importantly, positive correlations between final grades (academic achievement) and active and collaborative learning, academic level challenge, learner-faculty interaction as measures of engagement, as well as engagement in effective educational practices. Moreover, responses from surveys conducted shows that self-assessment, teacher assessment and peer assessment and related use of collaborative learning technologies were rated as being of high value. This further demonstrates that learning engagement enhances academic achievement, which is supported by the research (see for example, Seery, 2015, Sahni, 2019; Lin, 2018; Halverson & Graham, 2019, Lehesvuori et al., 2018; Oriab, 2015). Some of these studies form a part of the literature review and they have assisted in shaping the research methodology used in this study. Details of the research methodology used are in Chapter 4 which follows.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This chapter provides details of the research paradigm used which in this case was mixed methods and what it entails while providing reasons on why it was the best-suited for this this research purpose. In the process, the various mixed methods designs were described following which the design utilised in this study was identified and motivation for its choice was also provided. The research instruments used were described in addition to how they were designed and utilised. The steps of the data collection procedures used were described starting with the situation analysis and needs assessment. Following this the establishment of blended learning system which was designed to address the issues that became apparent from situation analysis. This Chapter also includes the details of how blended teaching and traditional face-to-face teaching were undertaken. Details of the administration of the research instruments were also provided. The data analysis procedures utilised were also identified in the process. Since this study involved human participants, ethical considerations were made. At this point, there is need to develop an understanding of the research paradigm that was used first before selecting the mixed method research design which was deemed most appropriate to address the research Questions that guided this study.

4.2 Research Paradigm Utilised and what mixed methods entails

For this study, a mixed method approach which is rooted in the pragmatist research paradigm was utilised which entailed combining the quantitative and qualitative research approaches. According to Johnson and Onwuegbuzie (2004), the philosophical underpinnings of mixed methods pragmatism (proposed by John Dewey, William James and Charles Sanders Peirce) require that meanings of ideas be appraised based on their consequences. In this study, blended teaching as an educational phenomenon is primarily being judged based on outcomes suggested by literature such as learning engagement and academic achievement. While acknowledging ongoing debates on quantitative versus qualitative approaches to research, Johnson and Onwuegbuzie (2004) argue that pragmatism provides a more neutral philosophical standpoint that is results-driven in addition to getting rid of any doubt such as one that surrounds prior research on the effectiveness of blended teaching when applied to varying contexts.

Furthermore, pragmatist philosophical underpinnings are centred around the notion that researchers ought to be free to use research methodologies that are best positioned to address their particular research questions (Johnson & Onwuegbuzie, 2004) which makes them (researchers) more effective. The other tenets of pragmatism that make it suitable in this study include is that it embraces the use of ideas from an array of sources as demonstrated in the theoretical and conceptual frameworks that anchor this study in addition to having a strong focus on the determination of what works. The latter made it important that the nature of blend that could be suitable for use in under-resourced schools located in South African context and indeed other many other countries in situations where similar limiting factors exist. However, the pragmatist paradigm also has limitations such as resulting in basic research being overlooked compared to applied research and promoting the use of theories that may not exactly true based on the notion that they are deemed useful which requires a lot of reflexivity on the part of the researcher (Johnson & Onwuegbuzie, 2004). Nonetheless, Johnson and Onwuegbuzie (2004) argue that the mixed methods approach has already positioned itself as being driven by the desire to draw from the strengths of both quantitative and qualitative research approaches, thereby demonstrating that the two can be combined in a manner that is more fruitful.

This approach to research is better suited to address the research questions that guide the present study in which previous studies that employed either quantitative (majority) or qualitative have resulted in seemingly perpetual contradictions. The use of a mixed-methods approach was motivated by the need to tap into the strengths of both quantitative and qualitative research, with a view of reducing the weaknesses that may be associated with using either of them (Johnson & Onwuegbuzie, 2004; McMillan & Schumacher, 2010; Warfa, 2017; Ivankova et al., 2006). Furthermore, Warfa (2017) argues that research in education demands that the mixed methods research approach be used for the purposes of providing better contextualisation, offering explanations to results in addition to making findings stronger, while minimising the weaknesses of either quantitative or qualitative reasoning.

Given the above, the need to utilise the mixed method research approach in the present study was compelling. Furthermore, the nature of research, whose focus in part demands that learning engagement be measured with a view to determine the efficacy of blended teaching, is best understood when both qualitative and quantitative data are merged (Fredricks et al., 2004). In this respect, it could be argued that mixed method research is better placed to address the

research questions that guide the present study. However, questions over what qualifies as mixed method research cannot be avoided. This demands an understanding be developed of the several ways in which any research can use to lay any claims of mixed method.

According to Tashakkori and Creswell (2007), a mixed methods study can be identified using seven categories in which both quantitative and qualitative research questions, methods of sampling, procedures of data collection, data types such as text and numerical, data analysis types such as statistical and thematic analyses, and conclusions which are subjective and objective. These scholars clarified that the presence of at least one of these categories just mentioned would qualify to be referred to as utilising a mixed method design. At this point, it becomes important to highlight that, in the present study, more than one of these categories was utilised.

For example, in this study, the Research Question 5 was addressed using both quantitative and qualitative approaches, Research Question 4 was addressed using qualitative data only and Research Questions 1, 2, and 3 were addressed using quantitative data only. Data collection took the form of research (quantitative and qualitative), forms in which surveys and interviews of focus groups were used, and data was collected in both numerical form and text. Additionally, data analysis approaches used were descriptive and inferential statistics, moderation, regression analysis as well as thematic content, and comparative analyses, and conclusions drawn are both subjective and objective (Tashakkori & Creswell, 2007). Based on this, it could be argued that the present is a true representation of what mixed method research design entails, due to the numerous integration points of both quantitative and qualitative approaches, which have been highlighted.

Having said this, it is important to acknowledge that debates on what qualifies as mixed methods approach is not a straightforward issue (Creswell, 2011). Questions on what is being mixed are bound to feature in most studies (Creswell, 2011). This is further complicated by an array of definitions of mixed methods research that are in existence (Creswell, 2011). In this study, Greene's (2008) definition of mixed methods suffices. Creswell (2011) presented Greene's (2008) definition of mixed method approach as one "…that actively invites us to participate in dialogue about multiple ways of seeing and hearing, multiple ways of making sense of the social world, and multiple standpoints on what is important and to be valued and cherished" (p. 20).

This approach to defining mixed methods is supported by Warfa (2017). Warfa (2017) describes this definition as one that adequately captures the value of mixed methods through widening and deepening the research findings, in a way that cannot be achieved using quantitative or qualitative research alone. Creswell (2011) rated this definition as 'useful' but went on to emphasise the need to go beyond universal definitions and concentrate more on the characteristics of what a truly mixed method approach should entail. At this point, it becomes important to introduce Onwuegbuzie, and Johnson's (2006) definition of mixed methods research, in which the scholars provided a slightly different way of conceptualising mixed methods.

They indicated that mixed methods research is a combination of qualitative or quantitative, which can be identified as concurrent, sequential, conversion, parallel, or fully mixed. Based on this definition, it could be argued that Onwuegbuzie and Johnson's (2006) definition is centred on the various types of mixed methods research designs that are identifiable as 'concurrent', 'sequential', 'conversion', 'parallel' or 'fully mixed'. Conversely, Creswell (2011) identifies four types of mixed methods design as parallel, sequential, conversion, and fully mixed. It is evident from this that researchers do not agree on the actual types of mixed methods designs, or how many there are (Creswell, 2011). Moreover, some researchers have provided more designs, as many as forty at times, however, it is noteworthy that some are more popular than others (Ivankova et al., 2006).

4.2.1 Research Design

Sequential explanatory design happens to be the most popular due to the general perception that it is relatively straightforward. However, other researchers have emphasised the need to choose design based on research questions to be addressed (Creswell, 2011). In the sequential mixed designs, data collection consists of two dependent stages of qualitative and quantitative research approaches and the analysis of the data informs the stage that follows (Onwuegbuzie & Johnson, 2006). Implicit in this is the notion of two subtypes of sequential designs, which Warfa (2017) has identified as the exploratory and explanatory sequential designs, which are dependent on the purpose of the study, and the research questions to be addressed. This typically has a bearing on the weighting assigned on the quantitative and qualitative approaches to research.

The exploratory sequential design and the explanatory sequential design in which the former involves collection and analysis of qualitative data in the first stage, while in the latter it is vice versa (Creswell et al., 2003, Warfa, 2017). Typically, the approach utilised first assumes greater weighting than the other (Ivankova et al., 2006; Creswell et al., 2003). To communicate this, Morse's (1991) system of notation which is illustrated in Creswell et al. (2003) is used in which the more dominant approach is written in capital letters. For example, QUAL → quan denotes sequential exploratory while QUAN → qual denotes sequential explanatory (Creswell et al., 2003). While decisions on which approach needs to be undertaken, it is also possible to conduct a mixed methods study in which neither approach is dominant over the other, which means the weight assigned is equal (Creswell et al., 2003; Ivankova et al., 2006; Johnson & Onwuegbuzie, 2004).

The present study utilises mainly the QUAN → qual type of sequential explanatory design, which is fused with elements of other mixed methods research designs as discussed later. Implicit in the use of the word 'mainly' is in keeping with the pragmatic philosophy adopted, which means the research design does not have to be purely sequential explanatory in a bid to address the research questions more comprehensively, while taking cognisance of the the need to enhance legitimation or validity. Additionally, placing more emphasis on the quantitive component instead of equalising them due to time constraints, which constitute the main disadvantage of using the sequential explanatory design (Creswell et al., 2003). Moreover, this problem was going to be further exarcerbated if the design placed equal priority on both components which is more ideal in a research programme as opposed to an individual study (Creswell et al., 2003).

Conducting the study this way better addresses most of the research questions such research questions 1, 2 , and 3 (quantitative) which are driven by theory (Onwuegbuzie & Johnson, 2006; Fredericks et al., 2004; Reschly & Christenson, 2012; Halverson & Graham, 2019; Skinner & Pitzer, 2012) on learning engagement, academic achievement, and blended teaching from existing literature. This was in addition to research questions 4 and 5 whose focus was to explain the quantitative data while capturing the context (Ivankova, et al., 2006; Onwuegbuzie & Johnson, 2006) which in this case is the South African High School context focusing firstly on the least advantaged schools, and secondly, on Organic Chemistry.

Furthermore, the explanatory design was more appropriate as it afforded an opportunity to develop an in-depth understanding of unexpected results such as the outliers (Ivankova et al., 2006). Furthermore, the main focus of present study was based on variables (blended teaching or traditional face-to-face teaching as the independent variable, academic achievement as the dependent variable, and sub-constructs of learning engagement as moderator variables), which required that the quantitative phase precedes the qualitative phase.

The second group of mixed methods design is the concurrent type. According to Onwuegbuzie and Johnson (2011), in the concurrent design, the quantitative and qualitative data are collected as separate entities in which the interpretation phase of the data analysis proceeds separately as well with only the discussion being integrated. Quantitative and qualitative datasets are merged then followed by a consolidated interpretation with a view to triangulate or corroborate or alternatively highlight convergence, divergence (Warfa, 2017). It is worth noting that it is not only convergence or corroboration which serves an important function, as divergent data can lead to even more complicated understanding and illuminate areas in which further research studies can be conducted (Creswell, 2011).

The present study also drew from this particular research design when in-depth analysis of the quantitative data was done almost at the same time as the qualitative analysis. Drawing from this design was partly motivated by the need to ensure that the resultant design would adequately address the research questions leading to a combined inference that has fewer threats to 'legitimation'. This procedure is supported by Creswell and Creswell (2005). Closely related to concurrent studies is the parallel mixed design in which both approaches are utilised without any form of integration which often raises questions on whether this depicts a mixed research design at all (Onwuegbuzie & Johnson, 2006). On the other hand, there are studies in which both approaches are utilised at almost every stage, beginning with research objectives, through to the data analysis stage, and these represent the fully mixed types of mixed methods design, which are more preferable (Onwuegbuzie & Johnson, 2006).

The third category of mixed methods designs is the conversion designs also described as transformational is concerned with conversion of qualitative data into quantitative or vice versa followed analysis or reanalysing of the data (Onwuegbuzie & Johnson, 2006). In this study, the use of content analysis allowed some of the qualitative data to analysed quantitatively (quantitating), when the prevalence of the codes was counted for the purposes of drawing a

comparison between Group 1 (experimental) versus Group 2 (Control). A similar approach was also used by Ivankova et al. (2006). However, in this study, two groups were used instead of four. As shown in the Figure 4.1 which follows, a decision was made to start collecting qualitative data by conducting interviews after the preliminary quantitative data analysis, which comprised descriptive statistics on both sub-constructs of learning engagement and academic achievement.

While preparing for Phase 2 (qualitative stage), interviewees were purposely selected form both groups which in line with Ivankova, et al. (2006) did which helped to enhance what Onwuegbuzie and Johnson (2006) referred to as 'population transferability' (generalisation to the population), since the interviewees were true a representation of the two groups of participants from which they were drawn. Conducting the study this way reduced the problem of integration, which has a knock-on effect regarding the extent to which the research findings are generalisable to the parent group or larger group and the population of learners from which the groups were derived.

Since the data analysis phase for the QUAN stage was not yet complete, this meant that the evidence of the research (from the first stage) was not going to be overwhelming enough to sway the qualitative data collected. In this way, the qualitative data became more dependable as it ensured that the reversal of the sequence would not still yield the same results. In addition, it also ensured that any form of bias or forced corroboration was avoided. This went a long way towards improving the 'legitimation' of the present study. However, evidence of other research designs, such as concurrent, and conversion were evident which makes the present study a modified sequential explanatory design. As proposed by Ivankova et al. (2006), there is a need to provide a graphical representation Figure 4.1of how the study was conducted following the rules gathered from literature.

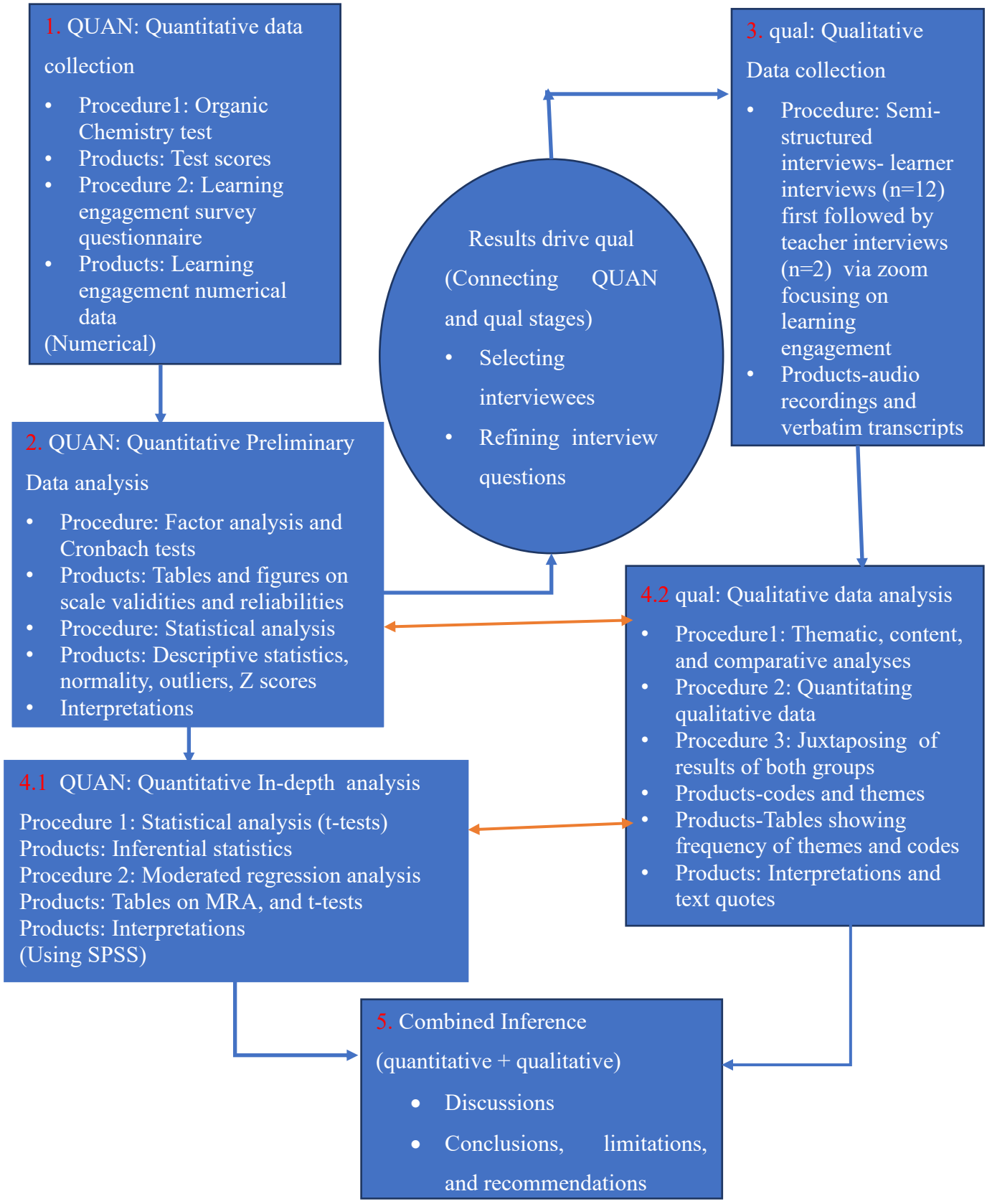


Figure 4.1: Graphical Representation of Sequential Explanatory Research Design Used

All the steps followed in the sequential explanatory design are written in red in each of the boxes forming Figure 4.1. Each step comprises the list of procedures undertaken and the products. The circle shows how the quantitative and qualitative phases were connected, while the orange double headed arrows show that the interpretations of the quantitative data analysis were combined with the qualitative analysis findings. The interviewees were selected by the researcher based on the preliminary analysis of the quantitative data which also helped in eliminating teacher bias. The selected interviewees were therefore had not been coached by the teacher what to say. The teachers were also not allowed any access to the marks or marked achievement tests since they test was not intended to be used for end of term or end of year marks. All the participants had agreed to be interviewed when they signed the informed consent forms which allowed the researcher to choose the interviewees based on the clarifications of responses required. Some of the interviewees' responses exhibited traits of what could be regarded as outliers which required that their explanations be understood. Efforts were also made to ensure that the interviewees were a true representation of the participants since only six could be interviewed from each group. As shown in Figure 4.1, the data collection started in the box representing Step 1with Figure 1, written in red. In this step, all the quantitative data were collected using the knowledge of Organic Chemistry test (KOOCT) and the Organic Chemistry Learning Engagement Survey Questionnaire (OCLESQ). These instruments were administered after the teaching of the Organic Chemistry had been completed, starting with the achievement test (KOOCT), followed by the learning engagement survey questionnaire. Numerical data were collected.

In Step 2, the learning engagement scales were subjected to factor analysis and their validities and reliabilities were determined. Some of the data from factor analysis were tabulated, such as the scree plots as well as CFA diagrams. Following this, the numerical data collected in Step 1 were subjected to a preliminary statistical analysis using SPSS in **Error! Reference source not found.**. As a result of this, descriptive statistics were determined followed by tests for normality of test scores (representing academic achievement) and sub-constructs of learning engagement scores, outliers were detected of outliers and treated.

Following this, in Step 3 of **Error! Reference source not found.**, the procedure undertaken was the semi-structured interviews of purposefully selected learner participants and the two teachers of both groups (Group1 and Group 2). The interview questions were based on the preliminary analysis of the academic achievement test scores and the sub-constructs of learning

engagement scores form Step 2. As shown in **Error! Reference source not found.**, the products were audio recordings and verbatim transcripts. Subsequent to this, the qualitative data (text) and data quantitative (numerical) were interpreted in an integral manner in steps 4.1 and 4.2. This involved converting the qualitative data into quantitative data through a determination of the frequency counts of the subthemes and complementary themes (mixed, positive and negative) which tallies the conceptual framework.

The codes were also counted which formed the basis for comparison of the two groups. The relative frequencies of the complementary subthemes were used to determine the overall learning engagement sub-construct. Essentially, the transformation of the qualitative data constituted integration of the quantitative and qualitative datasets. For example, if one group had a higher frequency of negative cognitive engagement and a lower positive cognitive engagement then the overall cognitive engagement was considered to be lower for that particular group compared to the other group. The discussion of the quantitative and qualitative research findings for both groups were discussed side by side and followed by the drawing of comparison the groups while also linking with existing literature on learning engagement in addition to the theoretical and conceptual frameworks. Any outliers were either explained resulting in generation of new knowledge or recommended for further research. The two research approaches were therefore integrated at the interpretation and discussion stages.

Research shows that this is best stage at which to integrate the QUAN and the qual phases, when using sequential explanatory design, or a design that resembles it (Creswell et al., 2003; Ivankova et al., 2006). Given that in this study, the quantitative component was driving the qualitative component, the in-depth analysis of the quantitative data had to be completed first. Furthermore, the themes from the quantitative phase were imposed on the qualitative phase data since the study had to be integrated and the relatively more subordinate qualitative data had to explain the quantitative data. This took place even though it fulfilled other functions such as triangulation and capturing the context. Approaching the data analysis in this way meant that deductive thematic analysis became the dominant analytical tool used to make sense of the qualitative data. As shown in **Error! Reference source not found.**, the procedures utilised in Step 4.2 also included content analysis, which resulted in the themes and codes being counted and presented in frequency tables, which, according to Onwuegbuzie and Johnson (2006), has an effect of enhancing legitimation, thereby making the study findings valid and more reliable.

In Step 4.1 of **Error! Reference source not found.**, the t-tests were conducted, and the means were compared. This was followed by moderated regression analysis, whose function was mainly centred around variables and the relationships among them. Research findings from steps 4.1 and 4.2 were reported in an integrated manner, as mentioned previously. In Stage 5 of **Error! Reference source not found.**, the research findings (both quantitative and qualitative) were discussed. This discussion included the use of verbatim quotes from the interview participants with a view to further improve the legitimation of the study.

4.3 Sampling and sample

The study was conducted in the Mpumalanga region of South Africa. This study employed a combination of convenience and purposive sampling technique. According to McMillan and Schumacher (2010), purposive sample requires that participants with specific characteristics be chosen. In this case, these specific characteristics were that the learners had to be in Grade 12 and studying Physical Sciences, because they had to learn Organic Chemistry at some point as part of the requirements of the syllabus since Organic Chemistry content is only taught in Grade 12 as stipulated in the Physical Sciences curriculum. McMillan and Schumacher (2010) also define convenience sampling as a sampling technique by which the participants are drawn from the population to which the researcher has access.

The choice of Mpumalanga region was motivated by the idea that the researcher has worked in the region, so it was easier (convenient) to approach schools in that region. The total number of learners that participated in the study was 200, and they were all Grade 12 learners, studying Physical Sciences in 2021. These were in already existing subgroups (Group 2-the control group, and Group 1-the experimental group), according to their subject combinations, which differed slightly. For example, learners within each of the subgroups chose between History and Geography. Owing to the idea that this study is centred on comparison of two groups in Grade 12 and studying Physical Sciences, subgroup sampling was utilised on the basis of teaching method chosen by the teacher. Each of these subgroups consisted of at least 100 learners. A combination of convenience and purposive sampling techniques were used to select the school that participated in the study.

Convenience sampling was considered so as to ensure ease of access. This means that only schools close to the researcher's place of stay were considered. Purposeful sampling was also used to select the school with a large learner population, particularly the Grade 12 learners, making it possible to secure a large sample size. The school was also chosen based on availability of resources, such as computers (even though they were not enough for all the learners), and smartphones, which some of learners could use. However, availability of internet services at homes was a challenge for most of the learners since they were all from underprivileged communities.

The group for which blended teaching was not chosen by researcher as these were classes that were being taught by the experimental group teacher. The classes were in existence from the beginning of the year and the teaching of Organic Chemistry occurred towards the end of Term 1. The point is these classes were already in existence before the commencement of the data collection process. As such no interference of the natural processes occurred. Most of the learners in both groups had access to computers, tablets or smartphones. The few that did not have suitable devices were supplied with second-hand devices to facilitate learning. However, there still existed a few learners who had to be provided with second-hand smartphones for learning purposes. The learners from both groups were also allowed to use the school computers. However, no effort was made to ascertain if all Group 2 learners had suitable personal devices since the teacher was not interested in using blended teaching. Nevertheless, any learners from this group that did not have suitable devices could still access the online learning platform if they wanted to, using the school computers but most of them chose not to, as shown in the gaps in the screenshot below. This was the case because the Group 2 teacher did not structure her lessons us in a way that required the learners to make use of the online learning platform. Given the sampling details explained, it is noteworthy that the two groups emerged without any interference from the researcher since more of quasi experimental design was used.

The capability and willingness of the teacher to use blended teaching was also considered to be part of the selection process, just like what was done by Yaghmour (2016). This was done through asking the teacher to state the skills that he was comfortable using, and to indicate the kind of assistance needed, if any. This made it necessary that a work workshop on blended teaching which was attended by all the Physical Sciences teachers be conducted, as explained

earlier. The workshop was also necessary because there exists a wide variety of blended teaching models as explained in the literature review section of the present study.

One group, experimental group (or Group 1). The second group, control group (Group 2), which was from the same school as Group 1 learners consisted of Grade 12 learners that were taught Organic Chemistry concepts using the traditional face-to-face teaching approach. The teacher for this particular group chose not to use blended teaching which resulted in the group becoming the control group since the learners were only exposed to traditional face-to-face teaching. These learners were also enrolled on to the online platform but they did not use it because their teacher did not structure her lessons to include online learning. Once again, the researcher who had limited access to the school due to COVID-19 restrictions did not interfere in the selection of the groups. It is noteworthy that the two groups came about because of the teachers' decisions to use blended teaching or not to. Additionally, the learners in both groups were not initially placed into classes according to performance.

The learners in both groups grouped themselves according to friendship lines and relative proximity of their homes so that they could work together on their homework and help one another when studying after school. This is how what resembles random assignment came about. However, all the Grade 12 learners studying Physical Sciences had passed it in Grade 11 and no learner was forced take a subject they were not comfortable with. Additionally, research on learning engagement shows that learners generally perceive schooling as a means of obtaining good grades without putting a lot of effort (Fredericks, et al., 2004). It can be argued that learners would not opt to take subject that they are finding difficult as this would require them to apply a lot of effort. Based on this, there is sufficient evidence that the Physical Sciences learners constituted a relatively homogeneous group since they were all doing the subjects which are considered to be relatively more difficult such as Mathematics (which is a prerequisite to study Physical Sciences) which they also had passed in Grade 11. Given that the present study was conducted during Term 1 of Grade 12, Grade 11 results as an indication of competency sufficed.

This study sample study of 200 (each subgroup being n=100), which allowed for the statistical analyses (t-tests and moderated regression) for the quantitative component. The sample size also allowed for the normality assumption to be used and during the testing of hypotheses testing (Borg et al., 2008, McMillan & Schumacher, 2010). Furthermore, a relatively large

sample size was used in order to avoid running into the problem encountered by Williams et al. (2008), where the sample size was too small, to the extent that statistical analysis of the collected data became impossible. As a result, the impact of blended teaching on achievement was of a limited nature, as concluded by Williams et al. (2008) cited earlier. The envisaged statistical analysis played a significant role here since research showed that some researchers had to abandon the planned statistical analysis (see for example, Manwaring et al., 2017).

For the purposes of interviews, a total of twelve learners were selected purposefully (six girls, and six boys). These were interviewed on learning engagement in Organic Chemistry. Six (three girls, and three boys) were from the control subgroup (Group 2), while the other six (three boys, and three girls) were from the experimental subgroup (Group 1). While there was a need to ensure that the sample size of interviewees made it possible for saturation of data to occur, it could be argued that the sample size utilised was adequate given that there were only two subgroups that had to be compared. This is based on the guidelines provided by Onwuegbuzie and Leech (2007) who assert that the least sample size that can be utilised is also guided by the number of subgroups. Furthermore, the scholars just mentioned indicated that two subgroups having a minimum of three respondents each. The Physical Sciences teachers were involved not involved in the direct selection of the learner interviewees from the pool of learners that were above age of 18 years since the selection based on the responses in the questionnaires. The teachers were not allowed access to these neither the questionnaires nor the preliminary data analysis of the quantitative data. This necessary to eliminate bias in the selection of the learner interviewees as some of the questionnaire items were related to teacher as a part of the teaching method.

Most importantly, performance in the academic achievement tests was particularly important criteria for selection of interviews as these interviewees were supposed to a representation of each of the two groups. For example, the learner participants, with more or less average scores, those with relatively high scores (outliers), and those with relatively low scores, were interviewed. Furthermore, the responses provided in the learning engagement questionnaire were also considered, as these learners were supposed to give explanations. The Physical Sciences teachers teaching the control and experimental groups were also interviewed on learner engagement and academic achievement. For this reason, two teachers were included in the interviewee sample.

Only the two teachers teaching the control and experimental groups were selected, because they were also supposed to shed some light on the responses of their learners, which were derived from the post-instruction tests and the interview responses. However, during analysis what the teachers said did not necessarily carry a more weight compared with what learners said and at times some of the responses from the teachers had to be compared with those of learners and vice versa. This also helped to eliminate expert bias that could potentially result from the involvement of teachers. Interviewing the curriculum implementer from the Department of Education who was also on the MOODLE as a Physical Sciences expert would have introduced expert bias as well. Additionally, an awareness of the different types of research bias helped prevent any possible expert bias particularly when the researcher became more critical and reflexive. More importantly, any bias that was not noticeable to the researcher was also identified by other researchers, especially the supervisors when they critiqued the write up. The demographic information of the participants is outlined in the section that follows.

4.3.1 Participant Demographic Information

All the participants (both learner and teacher) were black Africans, which ensured that any possible differences due to race or ethnicity, if any, were prevented. However, there was a marginal difference in gender, in terms of male and female, of the learner participants, where Group 1 (Experimental) had 52 girls (52%) and 48 boys (48%); while Group2 (Control) had 47 (47%) girls and 53 (53%) boys. While there are differences in the composition of the groups in terms of gender it is evident from the percentage composition that they are insignificant, and that both groups consisted of a somewhat equal number of boys and girls. Furthermore, the chronological ages of the learner participants ranged between 17 and 19 years, with the majority being 18 years old, or at least turning 18 before the end of the year. Given that the two groups were almost balanced in terms of gender, one teacher participant (Control Group) was female, while the second one was male, and both teachers had postgraduate qualifications. At this point, it becomes necessary to highlight how the carefully developed research instruments were used to collected data from these selected participants.

4.4 Research Instruments

The research instruments that were used included the Knowledge of Organic Chemistry Test (KOOCT), Organic Chemistry Learning Engagement Survey Questionnaire (OCLESQ) and the Learning Engagement Interview Guides. Two interview guides were used-one for the selected participating learner interviewees and the other for both participating Physical Sciences teachers. As shown in **Error! Reference source not found.**, these interview guides had to reviewed considering the preliminary quantitative data analysis that which was done prior to the collecting the qualitative data. This step was deemed necessary in order to ensure that the quantitative data were adequately explained (Ivankova et al., 2006).

Given that it was decided that it was not necessary to administer a pre-test because Organic Chemistry content is taught for the first time in Grade 12 in South Africa which meant that there was no previous Organic Chemistry knowledge to test. Administering a pretest based on a difficult topic such as Organic Chemistry could also have had an effect of demotivating the learners prior to the commencement of the teaching process. Additionally, according to Tekane et al. (2020), the content covered in general chemistry is different from that covered in Organic Chemistry since the latter mainly focuses on the reactivity versus structure. It is also noteworthy, that Bodner (2015) assert that prior proficiency in general Chemistry does not translate to proficiency in Organic Chemistry given that the scholar's research did not find any correlation between prior competency in general chemistry and Organic Chemistry as learners that were excelling in general chemistry performed poorly in Organic Chemistry. The Knowledge of Organic Chemistry test used was therefore a post-intervention test.

4.4.1 Knowledge of Organic Chemistry Test

The post-instruction test (KOOCT) was designed to measure academic achievement in Organic Chemistry and the results were used to answer the second research question of this study (Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in fostering achievement in Organic Chemistry for South African Grade 12 Physical Sciences learners?) This test question was developed by the researcher and the two teachers for the two groups and reviewed by two Physical Sciences teachers who had been teaching Grade 12 Physical Sciences for over twenty years and were seasoned examiners and three Chemistry education experts – all with Ph. Ds in Chemistry related disciplines. One of these is a university

professor while the second one is a senior director at one of the local universities. The completed validation reports are available in Appendix L of this study. These reviewers checked the test items or questions for clarity, grade appropriateness mark allocation, and time allocation. Similarly, the instructions were also checked. Any questions that were found to be unsuitable were removed and replaced by more appropriate ones. After several revisions the test was deemed suitable. The marking guide for the test, was also validated alongside the test. All the questions were derived from past examination papers which had been standardised.

The test was then piloted using fifteen learners and administered as described in this section of this study. Any questions that were found to be unclear to the learners were also revised by the teachers. This test had to be set with the teachers, because it was decided that it was going to be written as part of the weekly tests, which ensured that most of the participating learners were present. The few learner participants that were absent were given an opportunity to write the test during the morning lesson. The achievement test was out of a total of fifty marks and comprised of three questions. Question 1 consisted of seven multiple choice questions, which is in line with the structure of the Grade 12 NSC examination, which consists of approximately 13.3% multiple choice questions. Each multiple-choice question was designed to carry two marks to give a total of 14 marks for Section A. Question 2 (longer section) consisted of different types of questions, which included short answer questions, calculations and open-ended. Question 3 (shorter section) assessed learners' practical skills based on Organic Chemistry. These questions were adapted from the Department of Basic Education Physical Sciences past examination bank, and were at different cognitive levels, with the recall questions constituting approximately 40%, which was in line with the assessment guidelines for NSC (Department of Basic Education, 2020) which ensured that the questions used were validated. The modifications of these questions were on minor details such as the names and also included reshuffling of the multiple-choice responses so that what was originally option D would become option B.

The test was written in one hour, which corresponds with the 1,2 minutes per mark that is used at NSC level. All the three questions tested the four cognitive demands in the proportions stipulated by the Physical Sciences CAPS curriculum (Department of Basic Education, 2011:144). These cognitive levels are recall (15%), comprehension (40%), analysis and application (35%), and evaluation and synthesis (10%) (Department of Basic Education, 2011:144). It is important to note that the level of difficulty of the questions was similar to

Bloom's taxonomy. The achievement test was based on all the Organic Chemistry concepts taught during the 16-hour period, which was divided into three-one-hour long lessons per week. This meant that the teaching was supposed to be completed in five weeks. However, this teaching of this topic coincided with the third wave of COVID-19. The following Organic Chemistry content was tested: molecular structures (functional groups, saturated and unsaturated structures, isomers), IUPAC naming and formulae of organic molecules, structure and physical property relationships, reactions of organic molecules (elimination, addition, and substitution), applications of Organic Chemistry (plastics and polymers). This achievement test was administered to both the control and experimental groups at the same time and the question papers were collected.

Content and construct validity of the achievement test was undertaken. This validation process was undertaken by two physical sciences teachers-one of whom is a marker of NSC Physical Sciences examinations (one with a Ph.D. qualification in Chemistry education) while the second one was head of department for Physical Sciences who also had a postgraduate qualification as well as by three Chemistry education experts with Ph.D. qualifications, so as to ensure that it is free of any form of bias, and that it is in line with the objectives of Grade 12 Organic Chemistry. The grade appropriateness of content tested was also checked by the same validation team that is involved in the validation process. The checking of content alignment was also done using the Physical Sciences CAPS document, so as to ensure that what is being tested is in line with the stipulated content. Any issues raised in the validation reports were corrected. The final stages of the validation process involve administration of the test to fifteen Grade 12 Physical Sciences learners in 2021 during a pilot test. The marked scripts were analysed to determine whether there were any questions that were ambiguous or unclear.

4.4.2 Organic Chemistry Learning Engagement Questionnaire

The Organic Chemistry learning engagement survey questionnaire used to collect data that were utilised in answering research Question 1 of this study was developed and validated (Compared to learners taught using traditional teaching methods, Grade 12 Physical Sciences learners taught using the blended teaching approach will score significantly higher in a post-test on learning engagement during Organic Chemistry). The validation process checked for both content and construct validity so as to ensure that both the cognitive and emotional

indicators of the learning engagement construct were being measured. The questionnaire design was adapted from Sahni's (2019) learning engagement survey questionnaire. This ensured that field-tested items were used. This entailed modifying adapted items to ensure a focus on Organic Chemistry since the study by Sahni (2019) focused on a business course. These items were also converted into Likert-type with five response levels making it possible to collect quantitative data. The items in the survey questionnaire focused on the two sub-constructs of learning engagement, or indicators, which are cognitive engagement and emotional engagement (affective engagement and participation behavioural engagement) sub-construct. The cognitive engagement defined in the background of this study sub-construct. Similar activities based on Organic Chemistry were used to teach and assess learners in both the experimental and control groups during this study. The survey questionnaire consisted of three distinct sections as for the study conducted by Sahni (2019).

The first section was designed to gather the respondent's background information, the second section gathered data on cognitive and emotional engagement, which is like what Sahni (2019) did. Items from other learner engagement survey questionnaires such as CLASSE (Classroom Level Student Survey Engagement by Ouitmet and Smallwood (2005) were also considered here to develop an instrument that is most appropriate for the present study. A five-point Likert system was used to rate the learning engagement. The learning engagement questionnaire was also validated to ensure that the items are not ambiguous and administered to two high school learners (Grade 12) on a trial basis. The learning engagement survey questionnaire was further checked by the two Grade 12 teachers from the school, one of whom was the Head of Department for Physical Sciences. Any items that were deemed unsuitable were removed before the questionnaire was administered to the participating learners. It became apparent after all the rigorous checking of the items that it was not necessary to add any new items since none had been removed completely.

The learning engagement survey questionnaire was then piloted using fifteen high school learners. This was necessary in order to ensure that any necessary further adjustments were done accordingly. This was followed using suitable software to determine the reliability and internal consistence of the questionnaire. To achieve this, Cronbach's alpha coefficient test utilised by Sahni (2019) and Yaghmour (2016) was used. The targeted coefficient was between 0.7 and 0. 9 to guard against duplication and to ensure that the various items designed under the same learning engagement sub-construct indeed measured that specific sub-construct. This

rigorous validation process was deemed necessary to ensure that questionnaire items were going to measure what they were supposed to measure. The statistical software was used to perform the Cronbach's alpha test. Use of the R software package was motivated partly by its cost-effectiveness because of it being a free software, and because the researcher was proficient at using it.

This instrument was administered to 15 learners (pilot test) from a school that was not located close to the selected school to prevent test sensitisation in case the learners shared information with their friends from nearby schools. The clarity of the items was checked by the teacher and the learners understood all of them. The learners' responses to the Organic Chemistry Learning Engagement Survey Questionnaire were recorded on an excel spreadsheet, which is in Appendix Q of this document. This questionnaire was also reviewed by the same review team that consisted of two Physical Sciences teachers and three Chemistry education experts who included university Chemistry education lecturers, and it generally found to be valid and reliable with the exception of a few minor issues that were raised and addressed accordingly. The validation reports are available in appendix L. A Cronbach's alpha test was then conducted to determine the reliability or internal consistency of the questionnaire using R. A Cronbach's alpha coefficient of 0.8260078 was obtained, which was found to be reliable. Based on this, it can be concluded that the questionnaire is a reliable instrument. Considering that the questionnaire has 24 items, the use of the Cronbach's alpha test was appropriate. An alpha coefficient of 0.8260078 shows that the instrument in question can be used to measure what it was designed to measure. Nevertheless, this had to be repeated due to variations in sample size and other contextual factors. Details on how to the Cronbach's alpha test was conducted and calculated are available in the appendices.

4.4.3 Learning Engagement Interview Guides

An interview guide for the learners was developed based on items in the learning engagement survey questionnaire mentioned above, with a view to collect qualitative data on learning engagement. Essentially, what it means is that research Question 4 would be addressed using qualitative data from the interviews of teachers and learners. This was prepared by the researcher after the questionnaire had been validated. The interview guide was used to collect data that was aimed to answering the first research question, just like in learning engagement

survey questionnaire described above. Since this was a guide, the questions were stated broadly. Moreover, the interview served a confirmatory purpose of what was indicated in the learning engagement survey questionnaire. The content validity and qualitative validity was determined during the validation process. This learner interview Guide was reviewed by three Chemistry lecturers and two Physical Sciences teachers teaching the selected classes and was found to be valid and reliable (see Appendix L). In situations where any issues were raised were noted and addressed. The interview guide in question, and the learning engagement survey questionnaire were compared initially by the researcher and then by the reviewers (Physical Sciences teachers, and the supervisor). This interview guide was then piloted using five high school learners studying Physical Sciences at different schools in 2021. Since this interview Guide is meant to prob participants' responses was once again subjected to further revision after the learning engagement survey questionnaire had been completed by the learners. The interview guide questions which were the same as those used by Lin (2018) formed the base onto which further questions based on learners' responses to the questionnaire were added.

Similarly, the interview Guide for the two Physical Sciences teachers teaching the treatment groups was developed based on the learning engagement survey questionnaire that has been developed and validated. The teachers' interview was also reviewed by a team of experts that were highly skilled in teaching Chemistry. Any items deemed unsuitable were removed and if necessary, any new items added. This interview guide was piloted using two Physical Sciences teachers in 2021and no adjustments were proposed.

4.5 Data Collection Procedure

4.5.1 Situation analysis and needs assessment

Before the data could be collected, a situation analysis and needs assessment was conducted. The situation analysis was done by the HOD for Physical Sciences (who also happened to be the Group1-experimental group teacher). with the help of the researcher who simply pointed out the kind of additional information that may be required. This Physical Sciences teacher was also selected based on his ability to use the computer effectively and his openness to try out new ideas such as the blended teaching approach. Notably, most of the Physical Sciences teachers at the selected school were either not computer literate or were not willing to use the

blended teaching approach. The willingness of the teacher to try new ideas was important because using a blended teaching approach also demanded an input of extra time from the teacher particularly with regards to the preparation of online material, such as the videos and quizzes used to teach Organic Chemistry concepts.

The situation analysis also showed that the school from which the data were to be collected was Quintile level 1 school with many learners (approximately over 2000). By virtue of being a large school with such a large learner population, the Physical Sciences learner cohort was also large. The situation analysis also showed that the school had a few desktop computers and a few laptops that were allocated to the teachers only as explained in the section on situation analysis. However, these computers were not enough for approximately half of three hundred Physical Sciences learners at the school, who were initially before approximately fifty of them (those that were struggling with Physical Sciences) opted to take other subjects such as 'Tourism'. For this reason, smartphones had to be used. It can be deduced from this movement to other subjects which the learners deemed easier that the learners that opted to continue with Physical Sciences were all coping with the subject. This means that learners in both groups were coping with Physical Sciences.

Another hurdle was that the selected school was using blended teaching for the first time. However, the selected school had used online teaching before during the hard lockdown period of 2020, meant to contain the spread of the COVID-19 infection. This was a positive development because the learners were also not being exposed to online learning for the first time. However, it became apparent from the situation analysis that the online system previously utilised was not coordinated as each teacher used their own system. The selected school was using blended teaching for the first time. This meant that the online learning platform had to be developed upfront. Fortunately, there was ample time for this since the Organic Chemistry topic was taught during the last five weeks of Term 1. However, being a Quintile level 1 school also ushered in more challenges.

Some of these challenges included the idea that most of the learners either had limited access or no access at all to internet services at home. There were financial constraints and a serious shortage of other resources. One of the challenges was developing and establishing an online learning platform. This had to be funded by the researcher. The school internet service did not allow many learners to go online at the same time- the use of additional data, *'Rain'* which did

not include long term contracts was secured by the head of physical sciences. A package for R479 per month sufficed. This made it possible for more learners to update the content of their Moodle apps at school and then work offline at home, which required that the mobile app content becomes accessible offline. The researcher also funded the internet services for the school at the rate R250 per month for the duration of the data collection, which lasted for about four months.

Several options of possible learning management systems had to be considered alongside the other learning needs. A consideration of the learning needs was emphasised by researchers (see for example, Seery and O'Connor 2015; Schell & Mazur, 2015). This assessment of learning needs showed that most of the learners at the selected school were not proficient in English, which happened to be the language of teaching and learning (LoTL), which was also confirmed by Fisher et al. (2017). This problem is further exacerbated as Organic Chemistry just like most of the other Chemistry topics has a lot of discipline specific language and symbols as Tekane, et al. (2020) and Salame et al. (2019) point out. This made the use of videos which learners could watch during times that were most suitable for them and the idea that learners could pause and rewind the videos would help these learners with a limited English proficiency (LEP) understand the concepts better.

Closely related to the use of videos the idea that learners had a lot of schoolwork to do in addition to household chores-the amount of work learners had to do was monitored strictly and avoid overloading them had to be considered. One accommodation which had to be made was controlling the length of the videos or screencasts. However, most of the videos that were utilised were YouTube videos. These ranged between six and ten minutes as suggested by researchers such as Seery and O'Connor (2015). Additionally, it also became apparent that learners needed more opportunities to assess themselves, which made the use of quizzes that are marked online, and feedback provided in real time a necessity. This was important considering the teacher needs had to be considered as well.

Teachers were already overloaded due to the splitting of large classes, which left them with little or no time to design and upload online activities. Teachers for the control and experimental groups were encouraged to work as a team, which included planning lessons together and administering the same assessment and practice activities where possible. It had to be 'where possible' because some of the activities such as the flashcard game could only be

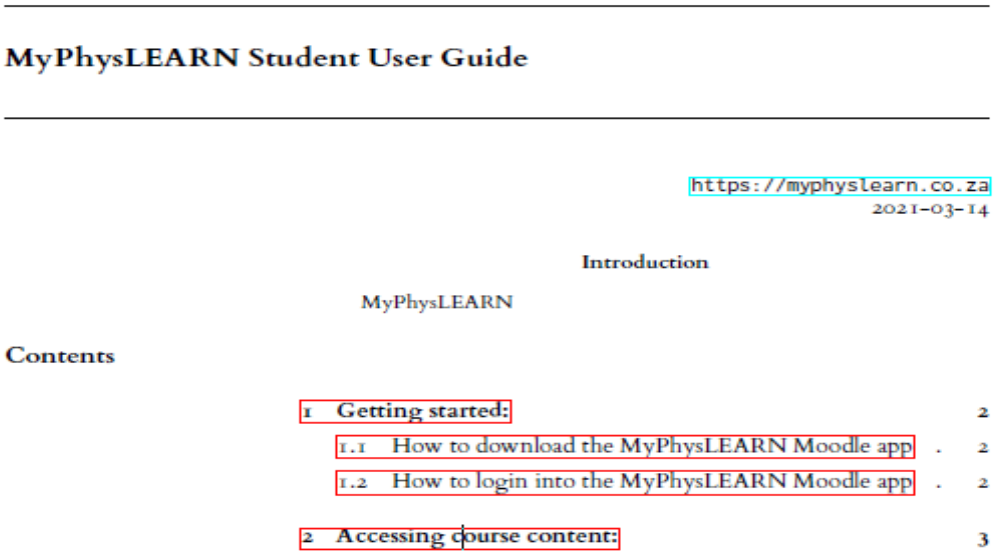
administered with the help of technology. As a result, the teachers were left with little time to grade the quizzes and other written exercises. The teacher for the control group was encouraged to consider using peer assessment but this still ate into the time which could have been used for the development of high order learning. This also already shows one of the benefits of incorporating technology as was the case during blended teaching.

Learning needs assessment also showed that the learners needed a lot of motivation. This was provided by allowing learners to attempt quizzes three times and recording only the highest grade. This afforded learners an opportunity to experience success and feel motivated to do more work. To make effective use of the online platform (as a component of blended learning), a suitable Learning Management System (LMS) which has inbuilt capabilities to support a wide range of educational activities was considered. The data collection procedure followed the stages that follow starting with the establishment of the blended teaching system.

4.5.2 Establishment of the blended learning system

Considering the situation analysis and learning just described, Sakai, Moodle and Blackboard were considered as possible options for the Learning Management System to power the online component of the blended learning system. Blackboard was quickly dismissed due to the exorbitant amount required to purchase this software. The options were then narrowed down to two, viz. Sakai 20.3 and Moodle. Sakai 20.3 (LMS) was considered first, since the researcher was familiar with the use of Sakai as an e-tutor and as a university student. Another consideration which made Sakai a worthwhile option was the fact that it was open source, which did not require financial outlay. Two weeks were spent trying to develop this much-needed online platform, but this resulted in too many problems. This led to the abandonment of Sakai. Given this, it was time to move to the second option, the Moodle. Despite claims that Moodle had improved its offerings as an LMS, the researcher was still sceptical, particularly given that Moodle was initially used as a repository of online resources (Florian & Zimmerman, 2015). This scepticism prompted further research into the Moodle as an effective LMS, particularly against the backdrop of the situation analysis and the learning needs that were supposed to be met.

Research has underscored the need to take learning needs into consideration to guarantee the potential effectiveness of blended learning (Naaj et al., 2012; Armellini & Rodriguez, 2021; Schell & Mazur, 2015; Seery & O'Connor, 2015). Furthermore, research showed that using Moodle came with a lot of advantages. For example, it was easier to install an offline mobile app that learners with no access to computers and internet services could use to access the online learning platform. This important point made Moodle a learning management of choice particularly given that the situation analysis had shown that not all learners had access to internet services at home, including some of those that were in the experimental group, or Group 1. Furthermore, the Moodle was also an open source (Florian & Zimmerman, 2015), even though webhosting fees R279 had to be paid monthly. These webhosting fees were dependent on the number of users on the online platform. It was therefore decided that only Grade 12 Physical Sciences learners be accommodated first. It was agreed that, since Moodle is expandable (Florian & Zimmerman, 2015), more learners were going to be added when the school secured more funding. An online platform that accommodated 500 users was developed using the steps outlined in the appendix section of the present study. The site was then named MyPhysLEARN, which became available on https://myphyslearn.co.za as shown in the screenshot of that follows.



MyPhysLEARN Student User Guide

https://myphyslearn.co.za
2021-03-14

Introduction

MyPhysLEARN

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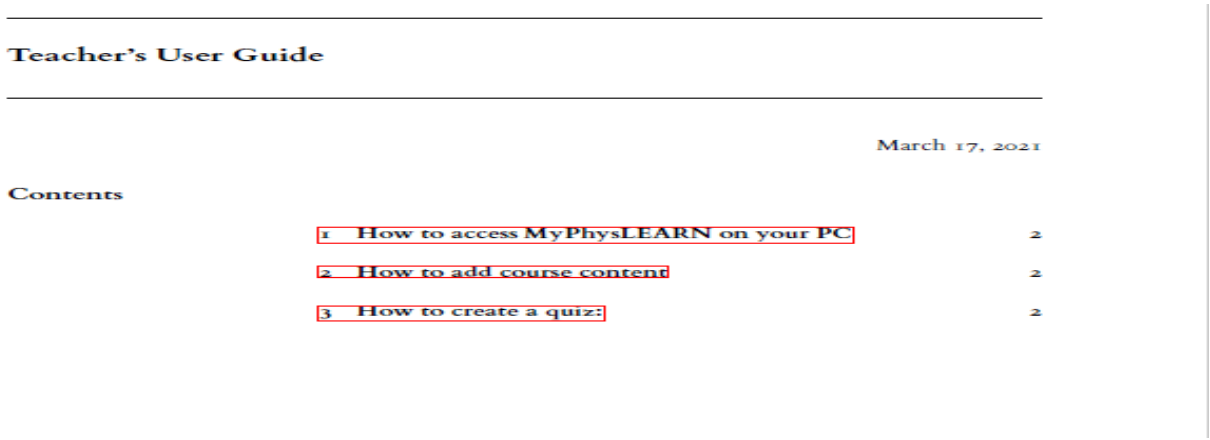
1 Getting started: 2
1.1 How to download the MyPhysLEARN Moodle app . 2
1.2 How to login into the MyPhysLEARN Moodle app . 2
2 Accessing course content: 3

As shown above, the introduction was tailored to ensure that learners were able to access to and getting acquainted with the online learning platform with the help following instructions outlined in the student user guide. One of the important steps was making sure that all learners downloaded the Moodle which they could access offline. Login instructions and introducing themselves on the discussion forum after reading the welcome message by the teacher.
Similarly, the teachers were also provided with a teachers' guide which included instructions on how to upload the activities like quizzes as shown in the screenshot below in addition to tracking learner progress.



Teacher's User Guide

March 17, 2021

Contents

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2 How to add course content 2
3 How to create a quiz: 2

1 How to access MyPhysLEARN on your PC

1. Go to Google chrome browser type "https://myphyslearn.co.za".
2. Log in with username and password that was provided to you.

2 How to add course content

Once you are logged in to upload do the following:
Site Home → Available Courses → Physical Science Grade 12 → Turn editing on → Add activity or resource.

3 How to create a quiz:

Once you select **Add activity or resource**: select **Quiz** then do the following:

1. Name the quiz
2. Give a quiz description, tick the box that says 'Display description on course page'.
3. Under timing tick enable on both Open the quiz 'Open the quiz' and 'Close the quiz', and select the dates for how long you want the quiz o be available for.
4. **Do not set a time limit on the quiz as it will hinder its offline availability.**
5. Under 'Layout' how many questions you want displayed per page.
6. Under 'Question Behaivour' select no for 'shuffle within questions' and make sure you select **Deferred feedback** under 'How questions behave'.
7. Under **'Extras restrictions on attempts'→ 'Show more' → 'Allow quiz to be attempted offline using the mobile app'** and click yes.
8. Click **Save and display**
9. Click **'Edit quiz'** change the maximum grade to whatever you desire the quiz to be out of.
10. Click **'Add'**→ new question then choose the type of question and fill in the relevant fields click save changes.
11. If you want add another question repeat sets 9 and 10.

Refer to following image for a multiple choice setup below:

The steps above ensured that both teachers and leaners were able to access and navigate the online learning platform. After establishing this online learning site, the next phase was to put systems in place to guarantee security of users and their information.

One extremely important security feature which was included ensured that no outsiders would be able to log into the system. Other security features considered included disabling 'guest log in' to avoid unauthorised access, protecting the Moodle database with a password to avoid random access to the site, and disabling self-enrolment to ensure that no bots and unauthorised people were unable to access the site. As a result, the login details were generated by the researcher with the help of another system administrator that had been hired to assist. To facilitate the creation of the login details, the Group 1 learners were encouraged to create email addresses, which proved to be a difficult task for the learners that were already struggling to access internet services. This meant that the researcher with the help of the system

administrator had to create the email addresses for the learners after receiving the class lists for Grade 12 physical sciences learners. Login details for the teachers and the Gert Sibande district curriculum implementer (the C.I.) for Physical Sciences did not take long to create, since they all had working email addresses. This was followed by the enrolment of the learners and the teachers on to the online learning platform. The company that provided webhosting services also provided a security licence (SSL), which made it possible to convert the online learning site into to an https site. This added security was an important one as the antivirus kept blocking the initial http version of site which was considered a security threat. Besides the security features, some cosmetic features were also considered as for what Sahni (2019) had done.

The site was made visually appealing to the learners and three-dimensional model of an atom was also added to the landing page to remind the learners of the educational purpose of the site. A welcome message was then placed on the landing page. This welcome message explained the reasons for using the blended learning and encouraged participation as well as communicating the rules of engagement. A copy of the welcome message is available in the appendix section of the present study. These steps to establish the virtual learning platform were followed by steps to ensure that all the learners were able to navigate the system. These included directing learners and teachers to the user guides (illustrated in the screenshots above which included a help email- help@myphyslearn.co.za) which were posted on the landing page of the online learning site followed by a series of workshops. The workshop for the teachers was conducted by the researcher online via Microsoft teams to minimise contact which was important considering that the country was going through the third wave of Covid-19 infections.

The workshop for the teachers was mainly centred around blended teaching and its benefits. The sample workshop is available in the appendix section of this report. The second workshop was conducted by the teacher teaching the experimental group. This second workshop was for learners. The third phase of ensuring that the learners and the teacher were able to navigate this learning site was in the form of an orientation in which learners were given activities that did not have anything to do with Organic Chemistry, such as introducing themselves and sharing a little bit of information about themselves. This important exercise was meant to help the learners and the teacher to become more comfortable in using the online learning platform. Instructions and words of encouragement for the learners were posted by the teacher in the group chat which was activated. The learners also utilised this chat to direct questions on

Organic Chemistry related issues to their peers and to the Physical Sciences teacher. After the establishing the online learning platform, conducting training sessions and the orientation phase as discussed in this section of the methodology, the teaching of Organic Chemistry began.

4.5.3 Teaching of Organic Chemistry

All the selected Physical Sciences classes, which were divided into two equal groups (Group 1-Experimental and Group 2-Control) were taught by two teachers that were working together closely. The two teachers planned the lessons planning together and engaged in team-teaching. For example, the Grade 12 learners had to attend extra lessons in the afternoons (after the normal teaching time), mornings before the normal teaching commences, on Saturdays, and during the April and June/July school holidays. These two teachers took turns to teach all the learners during these extra lessons. This helped to minimise any the teacher effect, which was cited as having an impact on learning engagement (Yurtseven & Ocak, 2021). For example, all learners had opportunities to be taught by both teachers. Once again, both teachers also engaged in team-teaching during the revision period. Team-teaching and sharing of resources as well as the use of similar lesson plans helped to minimise the teacher effect. Both teachers were assisted by the researcher with the preparation of learning material, such as the short assessment exercises such as the quizzes when necessary. Both teachers agreed on the teaching and learning activities.

These lesson plans were done following guided by the Physical Sciences CAPS curriculum and the Annual Teaching Plan (ATP) from the District Office. These lesson plans, which guide the teaching and learning that took place, were agreed upon by the researcher and both selected Physical Sciences teachers for the experimental group and the control group upfront. The lesson plans were made adaptable to make them usable for both blended learning and traditional face-to-face teaching. The major difference was that the experimental group was making use of technology, which could have created more benefits for the learners and the teachers such as the use of technology to grade the quizzes. The experimental group was taught Organic Chemistry concepts using the blended teaching approach as described below.

4.5.3.1 Blended Teaching

A blended teaching cycle was formulated by the researcher and the selected Physical Sciences teacher for the experimental group. A blended learning cycle, similar to that which was

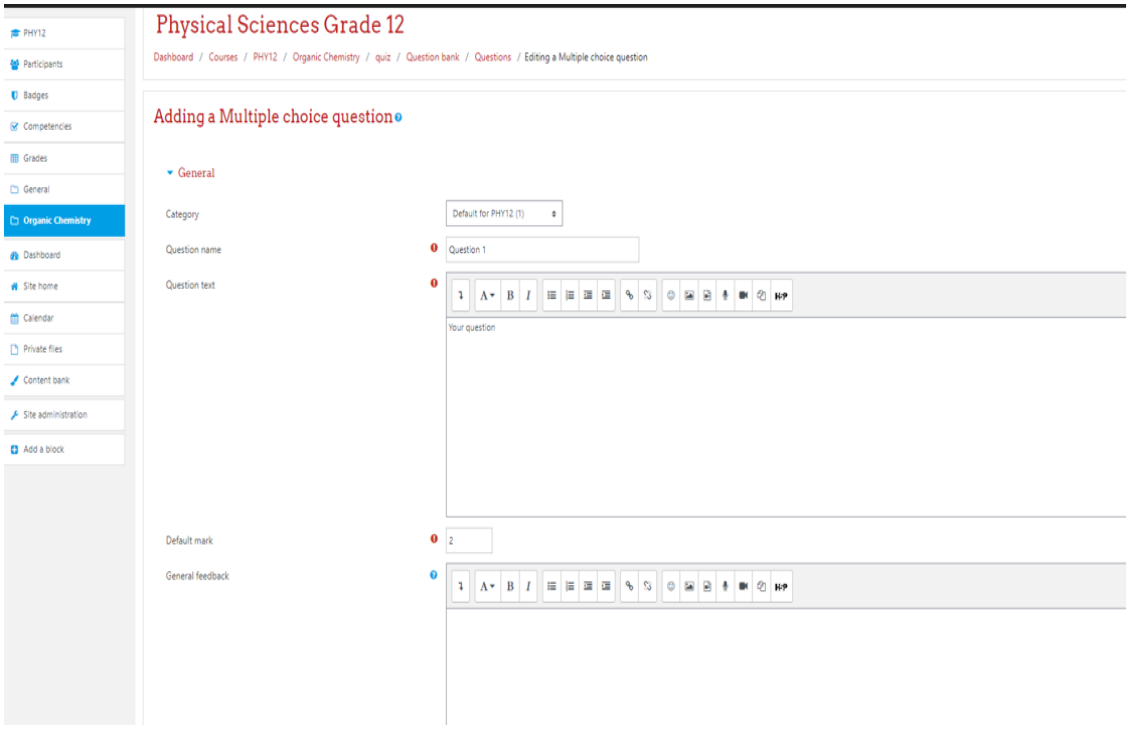
developed by Seery and O'Connor (2015) was developed. This was done by both the researcher and the Physical Sciences teacher for the experimental group classes. The teaching was scheduled to take place towards the end of Term 1 of 2021 for approximately 12 to 16 hours (in-class time), as stipulated in the ATP. This data collection phase was scheduled to last for approximately five weeks, considering that the total teaching time for Physical Sciences is three hours per week. However, the teaching of the Organic Chemistry topic took longer than anticipated, due to the COVID-19 pandemic.

The collection of data coincided with the third wave of the COVID-19 pandemic in South Africa. Even though schools did not close totally during this period, there were times when the school had to briefly close in a bid to contain the number of COVID-19 cases that were increasing among the learners and the teachers. This situation was further exacerbated by the deaths of some of the teachers that succumbed to COVID-19 which resulted in the reshuffling of some of the classes.

This reshuffling of classes meant that the learner participants had to be traced and moved back to their original classes. As if disturbances due to COVID-19 were not enough, the Grade 12 learners also embarked on a protest action early on, just after starting the Organic Chemistry topic, which resulted in some learners dropping some subjects that were purely in the sciences category. This led to a randomised reconfiguring of the classes to ensure an even distribution of classes and avoid overloading some of the Physical Sciences. While this was an unfortunate event, it also assisted with further random assignment of learners to classes which further ensured homogeneity of the two groups. At this point, there is a need to look at how the teaching and learning progressed.

All the Grade 12 Organic Chemistry concepts outlined in the Physical Sciences CAPS document were taught by the teacher with the assistance of the researcher who was helping with the design of assessment activities and the maintenance of the online platform. This maintenance included attending to any technical glitches experienced by the teacher and the learners. This study utilised flipped learning model (as described by Stalker and Horn, 2012) which was infused with elements of active blended learning (ABL). Details of the ABL blended learning model were described by Armellini and Rodriguez (2021).

The learners were tasked with watching videos after school (some of them at home particularly those that had access to internet services) on the content that was going to be taught during the next lesson inside the physical classroom. Some of these videos were prepared by the Physical Sciences teacher for the experimental group, while the others were selected from YouTube. These online activities included videos (or screencasts) which were 10 minutes long at most, online quizzes based on the video for the day to promote active learning.



To exemplify this, a video on ‘isomers’ was posted and then followed by quiz 5 which is illustrated below.

Quiz 5-Organic Chemistry on isomers

1. Isomers have the _____
2. Study the following hydrocarbons: (a) $CH_3CH_2CH_2CH_3$ and (b) $CH_3CH(CH_3)CH$

answer questions 2 and 3 that follow.

3. Write down the IUPAC of (b), $CH_3CH(CH_3)\ CH_3$ _____
4. Compounds (a) and (b) are

A. functional isomers

B. Chain isomers

C. Positional isomers

4. Aldehydes and ketones with the same molecular formula are

A. Positional isomers

B. Chain isomers

C. Functional isomers

5. Alcohols with more than two carbon atoms have more than one structural isomer.

study the alcohols (c) and (d) below and answer the question that follows.

(c) $CH_3CH(OH)CH_2CH_2CH_3$ (d) $CH_3CH_2CH(OH)CH_2CH_3$

Compounds (c) and (d) are which type of isomers?

A. Chain isomers

B. Positional isomers

C. Functional isomers

These two activities above were preceded by a revision and advance teaching of the concepts of molecular formula, structural formular and IUPAC naming during the last part of the traditional face-to-face teaching. This introduction also served the function of integrating the two components of the blended system utilised. It is also worth noting that even though videos were paired with quizzes learners were also referred to pages of the resources posted such as page 13-16 of the Study Guide compiled by the Department of Basic Education in addition to the resources prepared by the teacher. This was deemed to cater for learner diversity as some learners preferred to use notes instead of videos. For the same reason, a discussion forum was also created.

Discussion questions were also posted on the discussion forum. For example, the learners were asked to give examples of Organic compounds from their everyday lives that they could think of and to explain the importance of Organic Chemistry. As the system expanded, the learners were introduced to game learning. The Moodle (online learning) platform was also used a repository for extra resources such as notes and any other interesting and helpful reading material on Organic Chemistry.

The learners were encouraged to do all the online work by the teacher and by their parents just like what was happening in the control group), who had been made aware of the study. After watching the videos, the learners attempted the online quiz for the day. These online quizzes were marked immediately by the online system, which relieved pressure of time from the teacher. Each learner was given three chances to attempt each quiz and only the highest mark was recorded by the online learning platform, which was powered by Moodle. This gave learners an opportunity to experience success, which had an effect of improving learners' confidence in Organic Chemistry topic, and to develop positive feelings about it. This was also designed to improve acceptance of the new pedagogical approach by the learners.

Doing it this way helped free up some of the in-class time for exploration of high order learning activities as proposed by some researchers (Seery & O'Connor, 2015; Schell & Mazur, 2015). This online work was mostly individualised as learners had to attempt it after school in the comfort of their homes for those that had access to internet while those that did not did the work at school after the normal teaching time and during a time that was most suitable to them apart from the flashcard game and discussion forum.

The learners were also exposed to gamification in the form of a flashcard game, which they had to play in pairs. This flashcard game was partly designed to help learners with the mastering of the new terminology associated with Organic Chemistry. The learners were tasked to play this game during their own spare time as a way of revising the Organic Chemistry concepts. It is worth noting that some of the Organic Chemistry problems which earned it the reputation of being a difficult subject were blamed on the terminology associated with the subject or topic (Salame et al., 2019).

The introduction of gamification was also designed to spark learners' interest in the Organic Chemistry subject matter, which was deemed necessary since some of the learners studying

Organic Chemistry were found to lose interest in the topic and lacked the motivation (Salame et al., 2019). This was achieved through embedding Quizlet onto the online learning platform. One problem that came with this was that some the concepts covered were not part of the NSC syllabus. The Group 1teacher had to guide learners on which quizlet items to answer and which ones to avoid. This was more time efficient compared to setting the items from scratch. The teacher's cooperation was guaranteed, as a result.

The face-to-face component was mainly utilised for problem-solving questions, based on Organic Chemistry concepts, to afford learners an opportunity to ask questions based on the online activities, to reflect on the online activities, and to debate issues. To ensure that the two components support each other, questions from learners that struggled with the online quizzes were tackled first, and feedback for the rest of the class on the online quiz followed thereafter. In some instances, if the assessment took place during the face-to-face component, then, feedback was provided online as well. As proposed by Seery and O'Connor (2015), guiding learners on how to approach difficult problems can also form part of the online version of the blended teaching cycle. This way both the online and face-to-face components operated as an integral system as indicated by Seery and O'Connor (2015) as implied in the definition of blended learning.

Some of the laboratory work was discussed on the online platform before the practical work could be done as an in-class activity subject to availability of apparatus and equipment. It can be argued that insisting that learners attempt quizzes after watching videos incorporated elements of active blended learning. Learners were provided with an opportunity to exchange information and interact with their peers as well as with the teachers on the discussion forum. Lesson notes were also posted on the online learning platform. Additionally, the online activities were asynchronous, which allowed the learners to do the activities at a time suitable for them as indicated by Lin (2018).

Considering what Flynn (2015) stated, about the completion of online activities by learners being problematic, which motivated Seery (2015) to incentivise the online work, the design of the online learning activities required careful consideration. In this respect, the teacher's ability to design effective online learning activities was also ascertained before the data collection process. Given the fact that incentivising the online work was not possible due to regulations from the Department of Basic Education, where school-based assessment tasks that count for

end-of-term marks, there was a need to follow a stipulated format of designing teaching activities.

Based on the point raised above, it became imperative that the intrinsic and extrinsic motivation of learners is embedded in the design of these online activities in addition to ensuring that the purposes of the activities as well as the time to be spent on each activity were clearly stated and carefully considered. In this regard, the Gilly Salmon's (2002) five stage framework for designing e-activities played a significant role alongside the communities of inquiry framework by Anderson (2018), and Maslow (1943). Since the control group was taught using strictly the traditional face-to-face instruction, there is need to clarify how the teaching was conducted.

4.5.3.2 Traditional Face-to-Face teaching

The traditional face-to-face teaching occurred strictly within the confines of the school. All the Organic Chemistry concepts mentioned in the study context were taught by the teacher where with the help of the experimental group teacher while being supported by researcher. It has already been mentioned that the two teachers for both groups engaged in team teaching. Just like in the blended teaching Group, the researcher supported with the control group teacher with learning activities where necessary. The teaching took place during term 1 of 2021, from the end of April. However, this extended into Term 2 to allow for revision to take place before the administration of the test on knowledge of Organic Chemistry (KOOCT) learning engagement survey questionnaire (OCLESQ).

Furthermore, the teaching of strictly Organic Chemistry concepts took approximately five weeks, excluding the revision, which was done during the extra lessons as part of the preparation for the midyear examinations. Where possible, the three-hour Physical Sciences lessons were taught per week by both teachers on a rotational basis. As mentioned earlier, the researcher provided support such as the preparation of the quizzes and ensuring that the teachers were working together. Short check-in meetings were conducted to ensure the teachers were working together and to monitor progress. No formal online learning took place for this group, Group 2.

Given that there was no formal use of online learning, this meant that no videos were used to teach the Organic Chemistry concepts and the same quizzes that were given to the experimental group were also given as homework, which had to be marked in class the following day by the

peers with the guidance of the control group teacher. Similarly, the teacher for this control group (Group 2) also taught the concepts covered in the videos given to the experimental group during the in-class meetings. This had the effect of drastically reducing the teaching time which could have been used for high order learning skills. All the laboratory work was also done as in-class activities subject to availability of apparatus and science materials just like in the experimental group. Given that this was a Quintile level 1 school, the textbooks and the learner study guides were the main teaching aids used. As mentioned previously, learners were also given an opportunity to revise the Organic Chemistry work during extra lessons, which were taught by both the control group and experimental group teachers during the school holidays. As pointed out previously, this was an important exercise, which helped to minimise the teacher effect on the research. The end of this revision period was followed the administration of the Organic Chemistry achievement test, the KOOCT.

4.5.3.3 Administration of Achievement test

The achievement test (KOOCT) was used gather data that addressed research Question 2 (Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in fostering achievement in Organic Chemistry at Grade 12 in a school in South Africa?). The same Organic Chemistry achievement test was administered to both the control group and the experimental group at same time. This was possible because the test was written on a Friday, a day reserved for weekly tests by the school. Teachers from the other departments assisted with the invigilation, which ensured that the test was written under strict examination conditions. The question papers were also collected, alongside the answer sheets, as a precaution to ensure that the question paper would not leak to learners that were absent on that particular day, if any.

The test was developed by the teachers and the researcher and validated as described in the research instruments section of this study. One question of the achievement test consisted of multiple-choice questions. The learners were provided with question papers and blank answer sheets by the invigilators as described under research instruments section. The rest of the structure of the paper is clearly spelt out in the section on research instruments. The test was then marked by the researcher. This was followed by the recording of the marks obtained by the learners. A sample of twenty marked scripts (constituting 10%) were reviewed by the teacher that had run the pilot test. This ensured that the marking was consistent and that the marks were added as well as captured correctly. Before the scripts could be sent to the reviewer,

the names of the learners were removed and only numbers were used to identify each of the learners. The recorded marks were then analysed with a view to address research questions 1 and 3. The administration of the achievement test was followed by the administration of the learning engagement questionnaire by the teachers that were invigilating the test.

4.5.3.4 Administration of Learning Engagement Questionnaire

Data collected using the learning engagement questionnaire was used to address research questions 1, 3 and 5 which are outlined in Chapter 1 of this study with the main focus being on research question in which quantitative data on the learning engagement sub-constructs were collected. Research Question 1 reads as follows:

Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in learning engagement in Organic Chemistry at Grade 12 in a school in South Africa?

The same Organic Chemistry learning engagement survey questionnaire (OCLESQ) was administered to both the control and experimental groups just after the participants had finished writing the Knowledge of Organic Chemistry test (KOOCT), which was a post-instruction test. This learning engagement survey questionnaire was therefore administered once to each of the two groups as explained earlier in the research design section of this methodology. Since the learner engagement survey questionnaire was designed to provide numerical data using a 5-point Likert system (where strongly agree=5, agree=4, neutral/sometimes=3, disagree=2, and strongly disagree=1), the learner engagement score from each group could be calculated.

This learning engagement survey questionnaire contained 24 items (12 of which were based on the cognitive engagement while the other 12 were based on emotional engagement (the latter was a combination of affective engagement and participation behavioural engagement). This essentially split learning engagement into three sub-constructs). The decision to split the learning engagement construct into the two sub-constructs (cognitive engagement and emotional engagement) was informed by literature consulted (see for example Fredericks et al., 2004; Skinner & Pitzer, 2012; Reschly & Christenson, 2012), in which the participation component of behavioural engagement had to be accommodate in the form of participation behavioural engagement.

As pointed out previously in this study, an emotional engagement scale usually consists of two sub-constructs of learning engagement, which in this study were identified as affective engagement and participation behavioural engagement. For clarity purposes, a decision not to identify the participation behavioural engagement as behavioural engagement has noted and explained, which include the significant overlaps that behavioural engagement has with cognitive engagement, which would have complicated the measurement process. This was also deemed necessary for the purposes of addressing the third research question, which is based on the sub-constructs of learning engagement, which are cognitive engagement and affective engagement.

A copy of the learning engagement survey question is available in the appendix section of this study. The learning engagement data from the experimental group (the one that was taught using blended teaching) was compared with that from the control group. The descriptive and inferential statistics were calculated. The data from the learning engagement surveys were also used in the moderation analysis (research Question 3) and to answer the first research question. Research Question 3 was as follows:
To what extent is the relationship between blended teaching (or traditional face-to-face teaching) moderated by each of the learning engagement sub-constructs in the teaching of Organic Chemistry to South Africa Grade 12 Physical Sciences learners?

The main focus of this question was to establish the extent to which learning engagement sub-constructs were priming the relationship between the independent variable and the dependent. This study required that this important part of the study be undertaken, given that there was a possibility of three different variables given that Shimizu (2022) identified learning engagement as a moderator, which points towards the existence of three types of variables. The independent variable was therefore the teaching method (blended teaching or traditional face-to-face), while the dependent variable was academic achievement, whereas learning engagement becomes the moderating variable (Shimizu, 2022). The analysis of learning engagement data was followed by semi-structured interviews based on learning engagement for triangulation purposes.

4.5.3.5 Interviews: Learning Engagement

The qualitative data collected using the interviews were used to address research Question 4:

How does comparative analysis of post instruction interview data demonstrate that, the learning engagement sub-constructs of the experimental group (blended teaching group) are more positive compared to the control group (traditional method group)?

An interview schedule was developed based on Sahni's (2019) study and partly on Ouitmet and Smallwood's (2005) CLASSE learning engagement instrument. The developed interview guide consisted of questions that had been used by other researchers, which meant that the items were field-tested and dependent on the learner participants' responses in the Organic Chemistry Survey questionnaire. These interview guides (for teachers and for learners) were validated by same validation team that validated learning engagement questionnaire and the achievement test as shown in the reports in Appendix L. However, these questions were further refined after the preliminary data analysis of the quantitative data as shown in **Error! Reference source not found.**. These semi-structured interviews of the twelve selected learners (six from the experimental group and another six from the control group), affording the researcher the opportunity to probe some of the responses from the Organic Chemistry learning engagement questionnaire and to get more information relating to the nature of blend that could be more suitable to the South African context (research Question 5).

All the interviewees were interviewed individually via Zoom. The online interviews had to be considered to limit possible exposure to COVID-19 as indicated in the ethics section of this research report. The teachers for the two selected groups provided their laptops, while the researchers provided the internet services. These Physical Sciences teachers also ensured that only the learner that was being interviewed was in the room so that the learners would be free to share their experiences with the interviewer. This strategy was also employed to prevent learners from repeating what they heard other interviewees saying which improved the reliability of their responses. For convenience purposes, such as minimising transportation costs in addition to making more efficient use of time, these interviews were conducted at the school premises in June and July of 2021. All the interviews were audio-taped after seeking permission of the interviewees as shown in the assent forms and the consent forms that are in the Appendix section of this study. Audiotaping ensured that the interview data quoted in the research report are a true reflection of the interviewees' responses.

All the interview data were transcribed orthographically in which everything that was said was included including hesitations, laughter, repetitions, and false starts to ensure trustworthiness

of the interview data and coded using the deductive approach. The codes were then grouped into themes that were similar to the themes obtained from the quantitative data. To ensure validity and reliability of the interview data the interviewees were given an opportunity to go over the interview summary as acknowledgement of what transpired. Both the interviews for the selected learners and those for the teachers were designed to last for approximately seventy minutes, as with what was done by Sahni (2019). All the interviews were conducted by the researcher.

4.6 Ethical Considerations

Permission to conduct research was sought from the Mpumalanga Department of Education, and from the selected school. Copies of the permission letters are available in the appendix section of this research report. Consent forms were sent via email for signing by the Mpumalanga Regional Office person responsible for research. Letter to request for permission to carry out research was sent to the principal of the selected school via email to minimise contact. The permission letters were also sent via email. Information on what the research was all about and what was expected from the school, as well as the role of the researcher, was explained in application letters. The letters to request for permission had to be emailed to minimise physical contact which was in line with the COVID-19 guidelines. The researcher promised to keep all data collected in a safe in a password protected file in an electronic. After the data collection was done, the online learning platform was handed over to the school as a token of appreciation. The principal then approached the Physical Sciences teachers and explained shared the research details with them.

Following the above, participant information sheets and letters requesting the Physical Sciences teachers to participate in addition to explaining what was expected from them and the role of the researcher during the data collection process were emailed to each of them. However, confidentiality could not be guaranteed due to the use of interviews, but the researcher promised to use pseudonyms in the research report to protect the participants' identities. It was also explained to the Physical Sciences teachers that they were free to decline participating in the study and to withdraw from it at any time without having to face any consequences. It was explained to the teachers that they would also be interviewed and that the interviews were going to be audiotaped. These Physical Sciences teachers also informed that

they were not going to receive any form of remuneration in exchange for participation and that participation was voluntary. The teachers were then given consent forms to sign, and these were emailed back to the researcher. The second group of participants were the Grade 12 Physical Sciences learners.

Most of these learners did not have email addresses as a result the participant information sheets and the letters inviting them to participate in the study and those for their parents were emailed to the HOD for Physical Sciences. This member of staff then explained to the learners what the research was all about and handed the printed participant information sheets, the letters, and the consent as well as assent forms to the learners. The letter explained the learners' rights such as voluntary participation and being able to withdraw from the study at any time without giving reasons and without facing any harmful consequences. The learners were also assured that there was no harm associated with the study and that systems were going to be put in place to protect their personal information and the information that they may share with the researcher.

The learners were also informed that they would be requested to write a test on Organic Chemistry and to complete the questionnaire on learning engagement. The learners were assured that the results of the test were going to be used for research purposes only and that their marks were not going to be shared with their teachers. This served to reduce the anxiety associated with writing tests. It was further explained that confidentiality regarding their participation was going to be limited due to the participation in interviews. However, their confidentiality was guaranteed in the research report using pseudonyms and protecting any information that could potentially reveal their identities. The learners were further assured that the interview recordings were only going to heard by the researcher and her supervisors only. The learners were also invited to participate in an interview on learning engagement if they were chosen. The interviews were conducted online via Zoom, which was in keeping with the need to reduce the risk of chances of any possible spread of the COVID-19 infection. Additionally, the prospective learner participants were made aware that the interviews were going to be audiotaped and their permission to do so was sought.

After reading and thinking about the participation they were requested to complete the assent forms in which they indicated whether or not they would like to participate. Similarly, the parents of the learners below the age of 18 were also given letters requesting their permission to allow their child/children to participate in the study. They were also given the same

assurances that were given to the learners and given an opportunity read and get more information about the study. The parents who were willing to let their children participate in the study then signed the consent forms. All the signed consent and assent forms that were submitted to the HOD for Physical Sciences were quarantined for a week before being couriered to the researcher. Additionally, each of the participants a chance to read a section of the research report that pertains to them only, if they chose to, as proposed by Borg, Gall, and Gall (2007). This served to ensure that those sections were acknowledged as true representations of what transpired. The participants were promised that the data collected would be destroyed once the qualification is obtained. Copies of the participant information sheets, letters to the then prospective participants, consent forms and the assent forms are available in the appendix section of this study. Furthermore, the ethical considerations played an important role in the way that the data were analysed. This involved the removing the participants names and in some replace them with student numbers while the interviewees were also given pseudonyms as already mentioned. Chapter 4 which follows dealt with the analysis of the data collected and the processes that were undertaken to validate the learning engagement scales.

CHAPTER FIVE: DATA ANALYSIS AND RESEARCH FINDINGS

5.1 Introduction

As indicated previously, this study utilised a mixed-method approach in which the sequential explanatory design, or more specifically, the QUAN-qual design (Warfa, 2017), a notation which shows that the quantitative data were collected first in addition to giving an indication that it had a slightly greater weighting compared to the qualitative data. The assigning of the weighting was mainly driven by the research purpose, which sought to determine the effectiveness of blended teaching on learning engagement and academic achievement. To achieve this, a comparison was drawn between Group1 (which was taught using blended teaching) and Group 2, which was taught using tradition-face-to face teaching. These two groups of participants were drawn from a Grade 12 learner population in one school that was located in a previously disadvantaged community. As a result, the school used as the research site was an underprivileged one where traditional face-to-face teaching approaches are prevalent coupled with the limited resources to incorporate technology in the teaching methods. Research that is largely inconsistent has shown that traditional face-to-face teaching methods are associated with reduced learning engagement and poorer academic achievement (Fredericks, et al., 2004; Fischer, et al., 2018).

Owing to this inconsistency, combined with the conditional nature of blended teaching, this study demanded that the quantitative data be collected first, as an exploratory, measure specifically focusing on determining the effectiveness of blended teaching on learning engagement and academic achievement. Moreover, as pointed out by Bond et al. (2020), research studies from Africa that focus on learning engagement in blended settings are limited in number, which points towards a possible change in the research results available as contextual factors come into play.

This emphasises the need to determine whether blended teaching is effective in developing learning engagement academic achievement focusing on Organic Chemistry and the South African context, particularly an underprivileged school. The research design utilised made it mandatory that the quantitative data analysis be undertaken first. As such, in this chapter, the quantitative research findings are reported first followed by the qualitative study findings,

which were mainly designed to provide the further explanations and also for triangulation purposes.

Research questions 1 and 2 were quantitative in nature, since they sought to draw a comparison of both groups. Similarly, due to its very nature of focusing on variables and the relationship among them, research Question 3 was addressed quantitatively only. Research Question 4 then focused on collecting qualitative data, which was specifically on learning engagement and were used to further highlight the group differences, triangulate learning engagement data collected using research Question 1, and provide explanations why the two groups were different. Research Question 4 sought to gather and analyse qualitative data on learning engagement with a view to triangulation, provide explanations for quantitative data. Research Question 5 was more of an opportunity to apply the knowledge gained in the study, which typically meant it drew from both the quantitative data (Research questions 1, 2 and 3) as well from qualitative data (Research Question 5).

In this chapter, both the quantitative and qualitative data sets were analysed. Research findings were presented in process. SPSS was used to analyse the data while thematic analysis was predominant qualitative data (interview data from 12 learners and two Physical Sciences teachers) analytical too combined with elements of content analysis and comparative analysis. Quantitative data were collected using an Organic Chemistry learning engagement survey questionnaire in the focusing on the three sub-constructs of learning engagement (cognitive, affective engagement and participatory behavioural engagement) from both the experimental (Group 1) and control group (Group 2). The data were subjected to rigorous statistical analysis in which the descriptive and inferential statistics were used resulting in the research findings which were subsequently presented. Essentially what this meant was that if the group, which taught using blended teaching fared better in academic learning engagement (research question 1). This data were compared and used to address research Question 1.

Similarly, quantitative data in the form of achievement scores were collected using the Knowledge of Organic Chemistry test in the form of were also collected from the two groups. The quantitative data were subjected to rigorous statistical analysis, which included descriptive and inferential statistics with a view to draw a comparison between the teaching methods represented by the two groups and academic achievement (research Question 2) then that would mean the effectiveness of blended teaching would be determined. However, if traditional face-to-face group (Group 2) fared better than Group 1 then it would be concluded that blended

teaching was ineffectiveness in fostering learning engagement and promoting academic achievement.

This quantitative data analysis did not end there, as it also zoomed in on the learning engagement as a third variable in the relationship between blended teaching (or traditional face-to-face teaching) as the dependent variable versus academic achievement as the independent variable. It was hypothesised that learning engagement was a moderating variable, which essentially makes its sub-constructs moderating variables as well. The data analysis undertaken in this chapter in the form of moderated regression analysis sought to determine the extent to which each of the three sub-constructs of learning engagement moderated the relationship in question. This statistical analysis was used to determine the findings for research Question 3.

Prior to the statistical analysis aimed at addressing the questions alluded to in this introductory section of the data analysis, the emotional engagement scales and the cognitive scales were rechecked for validity and reliability since the pilot test had been conducted at a different school. Approaching the data analysis this way was informed by the fact that even though the items used in the learning engagement scales were field-tested, the conditions in which they were applied differed. For example, such conditions included the difference in population of respondents (Knekta et al., 2019). Additionally, the information on validation and reliability of the scales from which the items were derived was not easily available. Leaving out this important step of data analysis would have led to an increased number of limitations for this study. The quantitative findings were then explained using the qualitative data, which is in keeping with the sequential explanatory design utilised in collecting the data.

Qualitatively, thematic analysis of the interview data was used to determine the patterns (or themes) mainly because of its flexibility (Braun & Clarke, 2012; Pearse, 2019). Codes were derived from the literature before being grouped into predetermined themes. Approaching the data analysis this way meant the deductive approach in which the codes and the themes are imposed on the data had to be utilised (Braun & Clarke, 2012). The stages of the qualitative data analysis utilised included familiarising with the interview data (Braun & Clarke, 2012), development of the code book and the subsequent revisions of the codes (Pearse, 2019), application of the codes and revision of the themes (Braun & Clarke, 2012) to reflect the continuum of each type of learning engagement, tabulation of the codes and the number of interviews (content analysis) that said something which indicates each of the codes. This way

the quality and the number of times each code and theme appeared were determined. The data from Group 1 and Group 2 were placed in different columns of the tables followed by juxta positioning and comparative analysis to determine the quality and prevalence of each version of the theme in the case of learning engagement where each type of learning engagement was split into positive, negative, and mixed versions. Having said this, the research findings that were used to address the first research question were presented.

5.2 Effectiveness of Blended Teaching on Learning Engagement (Quantitatively)

Research Question 1: Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in developing learning engagement in Organic Chemistry for South Africa Grade 12 Physical Sciences learners?

To address the research Question 1 stated above, the validity and reliability of the learning engagement scales were determined.

5.2.1 Validity and reliability of learning engagement scales

The instrument (OCLESQ) used to collect data on learning engagement (Cognitive engagement and emotional engagement) consisted of a total of twenty-four items. Of these twenty-four items, the first twelve items were desired to emotional engagement or affective engagement which included three items on participation behavioural engagement, while the rest of the items measured cognitive engagement as explained in the Chapter on methodology. These twelve items for each of the learning engagement sub-constructs (EE and CE) potentially gave rise to many observable variables. Taking this into consideration, it became imperative that the dimensionality of the scales be determined. EFA was used to determine the number of factors as indicated by Knekta et al. (2019).

The first step to be followed when conducting EFA included the ‘cleaning’ of data involved checking for missing data, the potential existence of any type of redundancy among variables and establishing sampling adequacy using the Kaiser-Meyer-Olkin (KMO) and Bartlett test (Osborne, 2015). However, in this study, there were no missing data to check for the other

issues mentioned. Furthermore, it also became apparent that factor reduction methods be employed to the numerous factors that were implied in the questionnaire. To achieve this, principal component analysis and principal axis factoring were used as the factor extraction methods. The selection of the most suitable extraction method was dependent on multivariate normality of the data (Costello & Osborne, 2005). This was followed by rotation in a case where the scale was found not to be unidimensional. In this study, the emotional engagement scale was multidimensional as it consisted of two factors, namely: Affective engagement and Participation behavioural engagement. This factor loadings from this particular scale had to be rotated.

According to Osborne (2015), rotation improves the clarity of factor loadings, which can potentially result in the alteration of eigenvalues. Similarly, principal components can also be rotated. Two types of rotations are identifiable which are orthogonal and oblique. The selection of the most appropriate rotation, where needed, is dependent on whether the data are correlated or not (Knekta et al., 2019). Given that educational data usually correlated and in the absence of a hypothesis that suggests otherwise (Knekta et al., 2019; Osborne, 2015), it was decided that Oblimin with Kaiser normalisation be used, which happens to be an oblique type.

Normalisation prior to rotation is recommended for several reasons, which include efficient use of storage space, to ensure redundant data is eliminated, and reduction of data that was inconsistent (Osborne, 2015). The results of this EFA were then interpreted using the Kaiser criterion, in which all factors with eigenvalues that are more than one was considered as indicated by Costello and Osborne (2005). However, doing it this way does not always yield satisfactory results, (Costello & Osborne, 2005) which gave rise to a situation that demands further factor extraction methods, such as the scree test, and Horn's parallel analysis. Having developed an understanding of how the EFA was conducted, there is a need to examine the data set collected using the cognitive engagement scale used in this study.

5.2.2 Cognitive engagement scale

5.2.2.1 Validity and factor reduction

An exploratory factor analysis (EFA) was performed on the cognitive engagement scale. The KMO value of 0.864 was acceptable, and Bartlett's test of sphericity was significant ($p>0.001$).

The Kaiser criterion suggested that three factors could be extracted, explaining a total of 56.6% of variance in the data. The scree plot suggested a strong first factor, while Horn's parallel analysis suggested that one factor could be extracted.

5.2.2.1.1 Kaiser-Meyer-Olkin and Bartlett Test

This KMO and Bartlett's test is designed to measure adequacy of the sampling technique in which it determines whether all the correlations of variables are zero (Budaev, 2010). This is important because it gives an indication of the sample size. However, the KMO is not extremely sensitive, which requires that Bartlett's be performed. As Budaev (2010) asserts, the Bartlett's test, which is dependent on Chi-squared approximation and the assumption of multivariate normality, draws a comparison of correlations observed and partial correlations of variables (Budaev, 2010). Bartlett's test can therefore be considered as having a relatively higher power, but it can result in the rejection of the null hypothesis. This meant both tests (KMO and Bartlett's test) had to be performed. The results are summarised in Table 5.1 that follows:

Table 5.1: Results of KMO and Bartlett's Test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.864
Bartlett's Test of Sphericity	Approx. Chi-Square	721.563
	df	66
	Sig.	<.001

Using a significance level of 5%

5.2.2.1.2 Interpretation

A KMO between 0 and 1 but closer to 1 is acceptable (Budaev, 2010). KMO was therefore value of 0.864 (see, Table 5.1) was acceptable. Similarly, a p-value of lower than 0.01 for the Bartlett's reported in Table 5.1 is considered acceptable since it is lower than 0.05. The implications are that the sample size can be considered adequate and the existence of significant a correlation exists in the data set. Furthermore, this meant the data could proceed for further factor analysis (exploratory factor analysis). The step that followed involved analysing the total variance, which shows the number of factors that are extracted based on eigenvalues as shown in Table 5.2.

5.2.2.1.3 Total Variance Explained

Table 5.2:Total Variance Explained

Component	Initial Eigenvalues	Extraction Sums of Squared Loadings

	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %
1	4.660	38.833	38.833	4.660	38.833	38.833
2	1.112	9.268	48.101	1.112	9.268	48.101
3	1.020	8.499	56.600	1.020	8.499	56.600
4	.885	7.371	63.971			
5	.778	6.485	70.456			
6	.716	5.963	76.419			
7	.626	5.219	81.638			
8	.594	4.951	86.589			
9	.507	4.221	90.810			
10	.383	3.194	94.004			
11	.368	3.070	97.074			
12	.351	2.926	100.000			

Extraction Method: Principal Component Analysis.

5.2.2.1.4 Interpretation

Based on the eigenvalues shown in Table 5.2, three factors (components) can be extracted. These factors (components) have eigenvalues greater than one (Costello & Osborne, 2005). However, the information that is most important lies in the three columns on the extreme right of the Table 5.2 on 'Total Variance Explained'. From the information in these three columns, it can be deduced that three factors (components) were extracted the data set. This means that the 12 original variables/items can be reduced to three fundamental factors, which were cognitive engagement, affective engagement, and participatory behavioural engagement.

These three factors explain 56.6% of the variance that exists in the data. The first factor (component) which was cognitive engagement explains 38.833 %, the second, affective engagement explains 9.268% while the third, participatory behavioural engagement explains 8.499% as shown in Table 2. Based on the variance that each of these three factors explain, the first factor is more robust than the other two. However, further tests were conducted to avoid overextraction or under extraction of factors that could have impacted the results negatively. Research has shown that there exist several factor retention tests such as Velicer's MAP criteria, Horn's parallel analysis and the scree test (Costello & Osborne, 2005). A scree test which is used most frequently was performed.

5.2.2.1.5 The Scree Test

The scree test is performed by plotting a graph of eigenvalues of factors (or principal components) as shown in Figure 5.1 to assist in deciding on how many factors to retain. To obtain the number of factors to keep, the curve (graph was examined). The first step was to find the break point and count the number of plotted points, which are above this bend in curve (Costello & Osborne, 2005). It was further emphasised that the point lies directly at the bend is not supposed to be considered (Costello & Osborne, 2005).

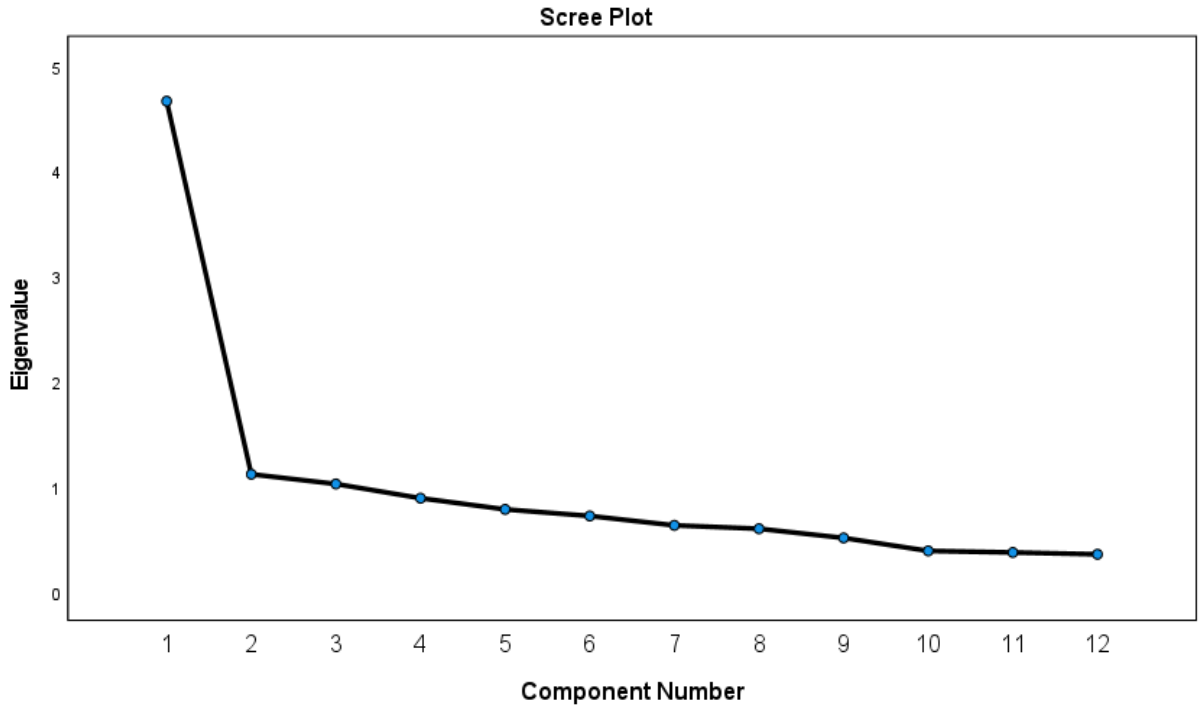


Figure 5.1:Scree Plot for Cognitive Engagement Scale

5.2.2.1.6 Interpretation

The scree test clearly shows that only one factor, which in this case was cognitive engagement should be chosen since the graph shows only one point above the bend.

5.2.2.1.7 Concluding exploratory factor analysis

After conducting a three-factor solution, which proved unlikely, and a two-factor solution (cognitive engagement and affective engagement), which showed no meaningful loadings on the second factor (affective engagement), it was concluded that the exploratory factor analysis was potentially pointing towards the existence of a single factor. However, research has cautioned against making decisions that are substantive based on EFA and encouraged the

utilisation of CFA and other methods that focus on the modelling of variables that are latent (Costello & Osborne, 2005). A decision to use confirmatory factor analysis (CFA) was done. CFA was then performed with a view to confirm whether only one factor needs to be retained.

5.2.2.1.8 Confirmatory Factor Analysis

After one round of modification, an acceptable model fit was obtained. Table 5.3 which follows shows the model fit indices which were obtained.

Table 5.3: Model Fit Indices

Index	Value	Guideline
Chi square / df	1.89	<3
RMSEA	0.06	<0.05 good; between 0.05 and 0.08 acceptable
TLI	0.933	> 0.90
CFI	0.913	> 0.90
SRMR	0.05	<0.05 good; between 0.05 and 0.08 acceptable

5.2.2.1.9 Interpretation of Goodness-of-fit Indicators

A comparison of the value and guideline columns shows that the goodness-of-fit indicators were all within the acceptable ranges, making it plausible that the CFA model illustrated in the section that follows. It can be argued that these indicators show that there is a greater chance that the model specified correctly represents the data.

5.2.2.2 CFA model for cognitive engagement Scale

The CFA model is illustrated in Figure 5.2 which follows.

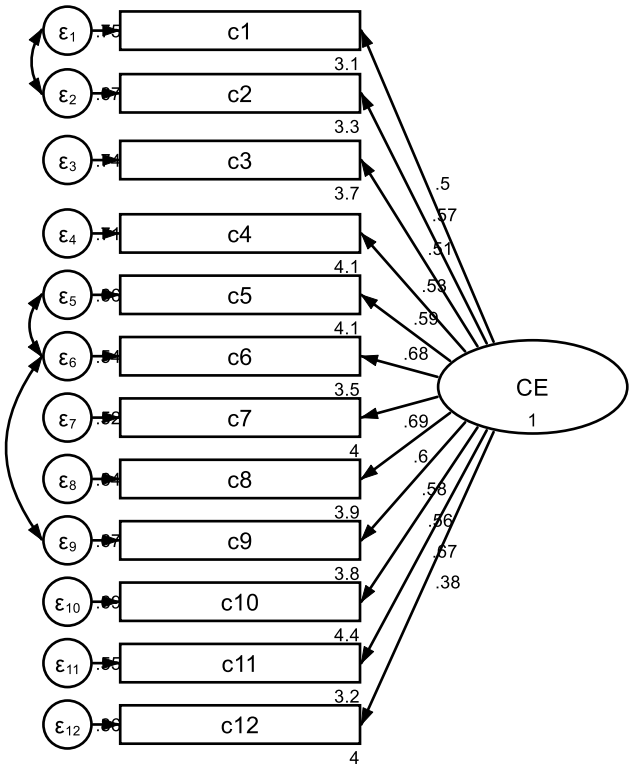


Figure 5.2: CFA Model of Cognitive Engagement

A decision to retain only one factor was confirmed. This was followed Cronbach's alpha test to test for reliability of the cognitive engagement scale.

5.2.3 Reliability

The Cronbach's Alpha coefficient for the scale was 0.854, while the composite reliability calculated based on the CFA coefficient was also 0.854 as shown Table 5.4**.**

Table 5.4: Reliability Statistics for the Cognitive Engagement Scale

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.854	.854	12

5.2.4 Conclusion on Validity and Reliability

Based on the factor analysis and the Cronbach's test, the cognitive engagement scale can therefore be described as both valid and reliable. However, there is a need to ascertain the validity and reliability of the emotional engagement scale (which is a combination of affective engagement and participatory behavioural engagement) to be able to draw conclusions on the effectiveness of blended teaching on learning engagement and academic achievement.

5.2.5 Emotional engagement scale

5.2.5.1 Validity and Factor Reduction

An exploratory factor analysis (EFA) was performed on the cognitive engagement scale. The aim was to determine the structure of the factors in the data. To achieve this, a similar approach to factor analysis as previously discussed was adopted.

5.2.5.1.1 KMO and Bartlett Test

Table 5.5: KMO and Bartlett's Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.855
Bartlett's Test of Sphericity	Approx. Chi-Square	643.277
	df	66
	Sig.	<.001

The hypotheses are as follows:

H_0: Data is appropriate for further analysis.

H_1: Data is not appropriate for further analysis.

Rejection criterion: KMO < 0.5

Using a significance level of 5%

5.2.5.1.2 KMO and Bartlett's Test Interpretation

The KMO (Kaiser-Meyer-Olkin) value of 0,855 was acceptable, and Bartlett's test of sphericity was significant (p>0.001) as shown in Table 5.5.

5.2.5.1.3 Total Variance Explained

Table 5.6: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.283	35.694	35.694	4.283	35.694	35.694
2	1.318	10.981	46.675	1.318	10.981	46.675
3	1.066	8.887	55.562	1.066	8.887	55.562
4	.955	7.959	63.521			
5	.777	6.478	69.999			
6	.697	5.805	75.804			
7	.597	4.971	80.775			
8	.559	4.654	85.429			
9	.492	4.097	89.526			
10	.465	3.878	93.404			
11	.452	3.769	97.173			
12	.339	2.827	100.000			

Extraction Method: Principal Component Analysis.

5.2.5.1.4 Total Variance Interpretation

The information that is most important lies in the three columns on the extreme right of the Table 5.2 on 'Total Variance Explained'. From the information in these three columns, it can be deduced that three factors (components) were extracted from the data set. This means that the 12 original variables (implied in the questionnaire items) can be reduced to three fundamental factors. These three factors explain 55.562% of the variance that exists in the data. The first factor (component), Affective engagement explains 35.694%; the second one, Participation behavioural engagement explains 10.981%; while the third, which is appears to be more cognitive, explains 8.887% as shown in Table 5.6. Based on the variance that each of these three factors explain, the first factor is more robust than the other two. However, there is

a need to conduct further tests to avoid overextraction of factors. To achieve this, a scree test was performed.

5.2.5.1.5 The Scree Test

The eigenvalues obtained because of principal component analysis (PCA) were used to perform the Scree test (illustrated in Figure 5.3), which was aimed at gathering further evidence to assist determining the number of factors to retain.

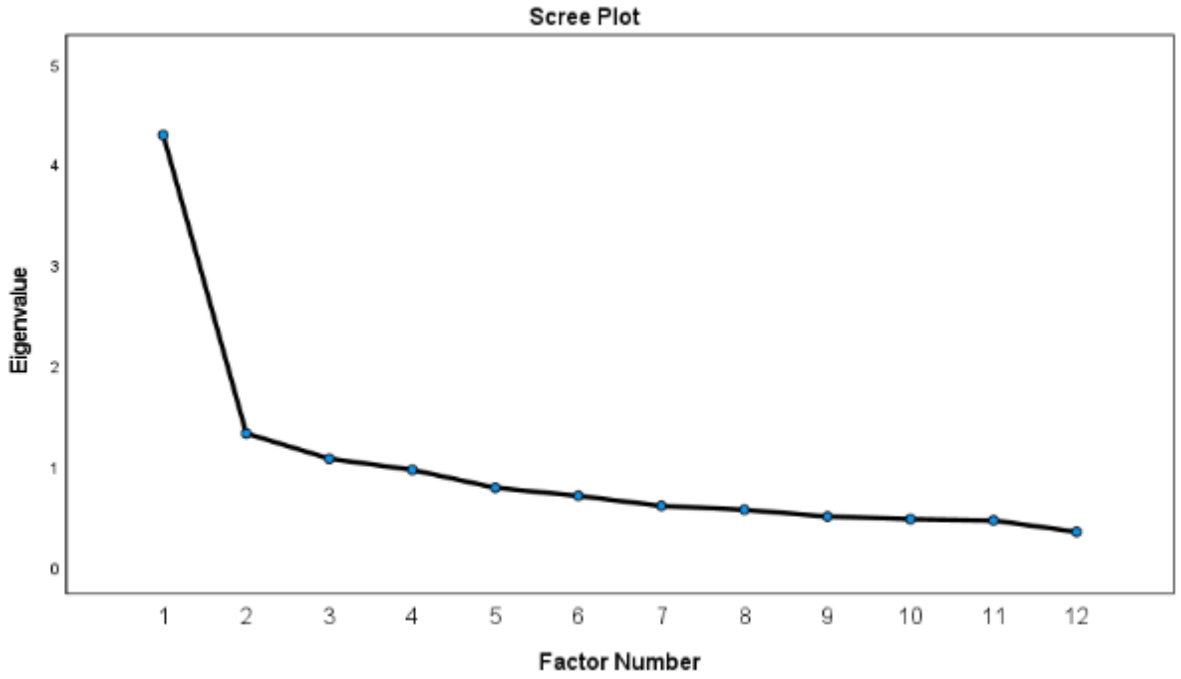


Figure 5.3: Scree Plot for the Emotional Engagement Scale

5.2.5.1.6 Interpretation of the Scree Test

An examination of the scree plot appears to point towards one factor (affective engagement) that could be retained since only one factor lies above the bend in the graph. The scree plot suggested a strong first factor. Given that the results on how many factors could be retained were not particularly conclusive another method was utilised.

5.2.5.1.7 Horn's Parallel Analysis

Horn's parallel analysis suggested that two factors could be extracted. This led to the examination of the pattern matrix.

Examination of Pattern Matrices

Table 5.7: Pattern Matrix with three Possible Factors

Pattern Matrix[a]				
	Factor			
	1	2	3	
e1 1. I like Organic Chemistry content very much.	0.884			Affective engagement
e2 2. I enjoyed most of the school based Organic Chemistry activities very much.	0.712			
e4 4. I did not find working on the Organic Chemistry work frustrating.	0.466			
e11 11. I felt like I belong to the Organic Chemistry class.	0.428			
e3 3. I enjoyed all the Organic Chemistry activities which I had to do away from the school premises.	0.365			
e5 5. I did not feel anxious about learning Organic Chemistry.	0.364			
e9 9. I could answer most of the questions that the teacher asked during the Organic Chemistry lessons for more than three times per lesson.				
e8 8. I worked with classmates on Organic Chemistry activities many times (more than three times a day) away from school premises.		0.830		Participation behavioural engagement
e7 7. I shared ideas with a classmate on an Organic Chemistry assignment or homework many times (more than three times a day).		0.609		
e6 6. I worked many times with a classmate on an Organic Chemistry project or practical or assignments.		0.481		
e10 10. I had many opportunities to ask for help from the teacher during the Organic Chemistry in-class lessons.			0.774	Cognitive
e12 12. I have been concentrating a lot during most of my Organic Chemistry lessons.			0.414	
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalisation.				

5.2.5.1.8 Interpretation of Pattern Matrix with three Possible Factors

As indicated in Table 5.7, three factors (affective engagement, participatory behavioural engagement, and cognitive engagement) could be retained. However, the third factor, which appeared to be more of cognitive than emotional engagement was indicated by only two items which made this factor less stable (Costello & Osborne, 2005). Based on this, a two-factor solution which focused on affective engagement and participation behavioural engagement was explored instead as shown in the pattern matrix illustrated in Table 5.8 that follows.

Table 5.8: Pattern Matrix with The Two Factors

Pattern Matrix[a]			
	Factor		
	1	2	
e1 1. I like Organic Chemistry content very much.	0.744		Affective engagement
e11 11. I felt like I belong to the Organic Chemistry class.	0.674		
e2 2. I enjoyed most of the school based Organic Chemistry activities very much.	0.603		
e4 4. I did not find working on the Organic Chemistry work frustrating.	0.550		
e10 10. I had many opportunities to ask for help from the teacher during the Organic Chemistry in-class lessons.	0.472		
e9 9. I could answer most of the questions that the teacher asked during the Organic Chemistry lessons for more than three times per lesson.	0.462		
e3 3. I enjoyed all the Organic Chemistry activities which I had to do away from the school premises.	0.443		
e5 5. I did not feel anxious about learning Organic Chemistry.	0.433		
e12 12. I have been concentrating a lot during most of my Organic Chemistry lessons.	0.422		
e8 8. I worked with classmates on Organic Chemistry activities many times (more than three times a day) away from school premises.		0.818	Participation behavioural engagement
e7 7. I shared ideas with a classmate on an Organic Chemistry assignment or homework many times (more than three times a day).		0.601	
e6 6. I worked many times with a classmate on Organic Chemistry project or practical or assignments.		0.470	
Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalisation.			

5.2.5.1.9 Interpretation Pattern Matrix with The Two Factors

A two-factor solution still showed that the factor related to participation behavioural engagement came out clearly, while the other items combined into one factor, which is 'Affective engagement'. It was therefore decided to retain two factors for this instrument as

Affective engagement and Participation behavioural engagement as shown in the pattern matrix in Table 5.8.

5.2.5.1.10 Conclusion on Factor Structure based Exploration Factor Analysis

The Exploratory factor analysis was therefore used as input to consider other factor solutions. A three-factor solution led to the clear identification of three factors, namely Affective engagement (7 items), Participation behavioural engagement (three items) and two items which seem to refer more to cognitive engagement (concentrating and asking questions) than (these had been included because Yazzie-Mintz and McCormick (2012) referred to them as emotional engagement) as shown in Table 5.7. This was followed up by a confirmatory factor analysis (CFA).

5.2.5.2 Confirmatory Factor Analysis

A single factor solution was explored in a confirmatory factor analysis focusing on affective engagement only.

5.2.5.2.1 Results

A satisfactory fit could not be obtained, despite several rounds of modification. It is therefore concluded that emotional engagement, as measured in this study, is a multidimensional construct. A two-factor model which included affective engagement and participation behavioural engagement provided an acceptable fit after only one round of modifications. The model fit indices are outlined in Table 5.9.

Table 5.9: Goodness-of-fit Indicators

Index	Value	Guideline
Chi square / df	1.531882	<3
RMSEA	0.052	<0.05 good; between 0.05 and 0.08 acceptable
TLI	0.941	> 0.90
CFI	0.955	> 0.90
SRMR	0,051	<0.05 good; between 0.05 and 0.08 acceptable

5.2.5.2.2 Interpretation of the Goodness-of-fit Indicators

It can be concluded from the Goodness-of-fit table of indicators that all the values are within the acceptable ranges when the values are compared with the guidelines outlined the third

column. Based on this, the model specified fits the data. This meant that CFA model illustrated in Figure 5.4 confirmed the notion that the two factors (Affective engagement and Participatory behavioural engagement) needed to be retained.

5.2.5.2.3 CFA Model for Emotional Engagement

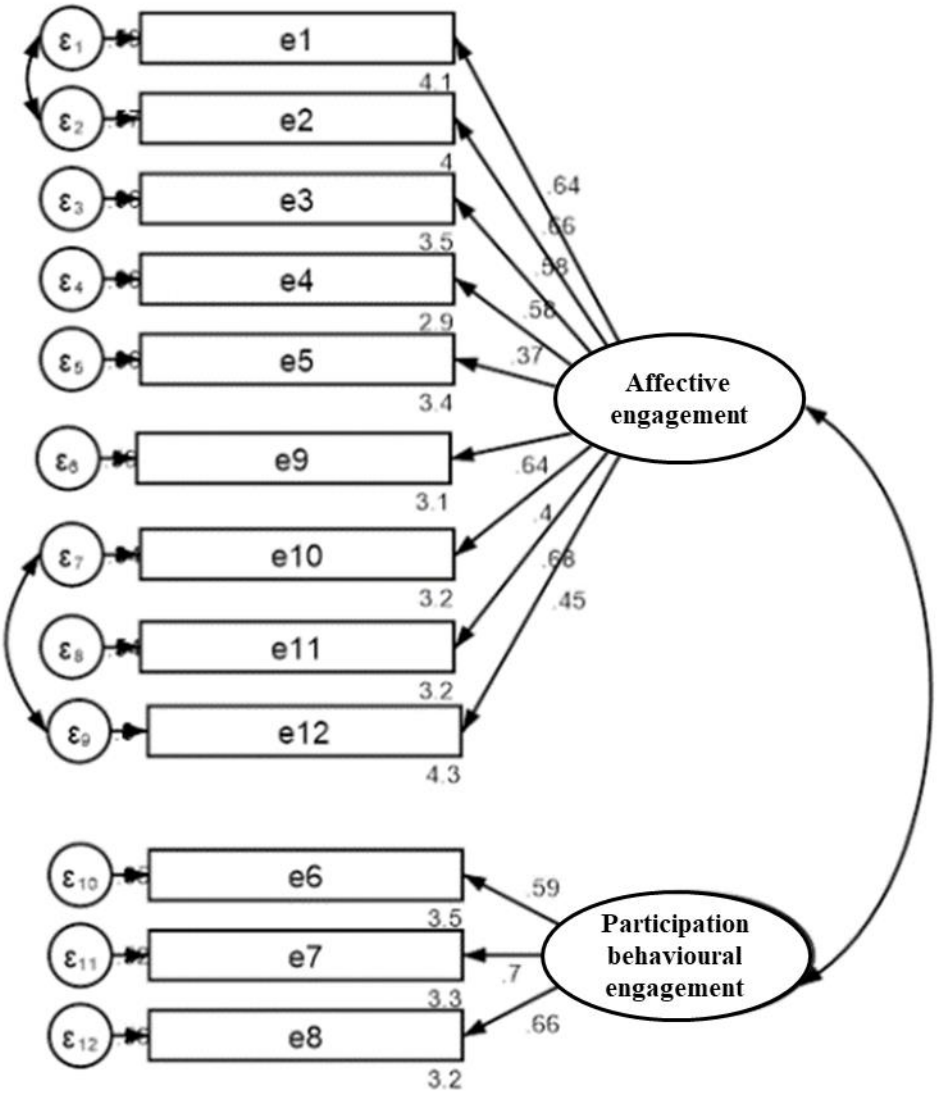


Figure 5.4: CFA Model for Emotional Engagement

5.2.5.3 Reliability

The Cronbach's Alpha coefficient for the affective engagement scale was 0.794 as shown in Table 5.10, and that for the participation behavioural engagement scale was 0.697 as illustrated in Table 5.11. Both Cronbach's Alpha coefficients were found to be within acceptable limits (Taber, 2018).

Table 5.10: Reliability Statistics for the Affective engagement Sub-scale

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.794	.794	9

Table 5.11: Reliability Statistics of the Participation Behavioural Engagement Sub-scale

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	No. of Items
.697	.698	3

It can be deduced from the results of validity and reliability tests that the two factors of the emotional engagement (affective engagement and participation behavioural engagement) scale can be described as reliable and valid.

5.2.5.3.1 Concluding Remarks

The importance of ascertaining the validity and reliability of measurement instruments used collect data in research cannot be overemphasised, since it has an impact on the actual data collected. Given the rigorous validation results of the tests done in this section of the study, it can be concluded that the cognitive engagement and emotional engagement/affective engagement and participation behavioural engagement, scales used in this study can be described as both valid and reliable. In addition to measuring the reliability and validity of the three sub-constructs of learning engagement identified (Cognitive engagement, Affective engagement, and Participation Behavioural engagement), must also meet the distributional requirements for moderated regression analysis and the t-tests. As a result, descriptive statistics

were determined, followed by tests for normality and then inferential statistics in a bid to determine the effectiveness of blended teaching on learning engagement.

5.2.6 Groups 1 and 2 Descriptive statistics of Learning Engagement Sub-constructs

The descriptive statistics for Groups 1 (which was taught using the blended teaching method) and 2 (taught using traditional face-to-face) focusing on the learning sub-constructs (cognitive engagement, affective engagement and participation behavioural engagement) can be found in Table 5.12, Table 5.13 and Table 5.14.

Table 5.12: Groups 1 and 2 Descriptive Statistics on Cognitive Engagement

Cognitive engagement	**Descriptive Statistic**	**Group 1**	**Group 2**
	N	100	100
	Mean	3.6318	3.4400
	Standard deviation	0.61933	0.54511
	Minimum	2	2.18
	Maximum	5	5.00
	Kurtosis	-0.495	0.593
	Standard Error of Kurtosis	0.478	0.478
	Skewness	-0.001	0.348
	Standard Error of Skewness	0.241	0.241

Table 5.13: Group1and 2 Descriptive Statistics on Affective engagement

Affective engagement	**Descriptive Statistic**	**Group 1**	**Group 2**
	N	100	100
	Mean	3.4722	3.1789

	Standard deviation	0.61740	0.54864
	Minimum	1.78	1.89
	Maximum	5	4.78
	Kurtosis	-0.025	0.489
	Standard Error of Kurtosis	0.478	0.478
	Skewness	0.146	0.129
	Standard Error of Skewness	0.241	0.241

Table 5.14: Groups 1and 2 Descriptive Statistics on Participation behavioural engagement

Participation behavioural engagement	**Descriptive Statistic**	**Group 1**	**Group 2**
	N	100	100
	Mean	3.2733	3.3400
	Standard deviation	0.79896	0.74758
	Minimum	1	1.67
	Maximum	5	5.00
	Kurtosis	-0.192	-0.357
	Standard Error of Kurtosis	0.478	0.478
	Skewness	-0.048	0.134
	Standard Error of Skewness	0.241	0.241

5.2.6.1 Interpretation

Descriptive statistics illustrated in the Table 5.12 above show that the means of cognitive engagement and affective engagement (Table 5.13) were relatively higher for Group 1, which happened to be the experimental group that was taught using blended teaching. However, those for participation behavioural engagement (Table 5.14) for Group 1 were marginally lower than that of Group 2. Based on this preliminary data analysis, it could be argued that the overall learning engagement for Group 1 was higher, since two learning engagement sub-constructs were relatively higher. Moreover, the participation behavioural engagement, which was marginally higher in Group 2 compared to Group 1, might not have been able to swing the overall learning engagement in the opposite direction, in which overall learning engagement would be higher in Group 2. However, in order to draw substantive conclusions on the comparison of the two groups in question, there is a need to go further and determine whether

the means of the three sub-constructs of learning engagement differed significantly or not. To achieve this, t-tests had to be performed. Performing t-tests required that the tests for normality be conducted first. The section that follows sought to determine the multivariate normality of the three sub-constructs of learning engagement.

5.2.7 Multivariate Normality Tests for Groups 1 and 2

5.2.7.1 Kolmogorov-Smirnov Test

To determine the multivariate normality of the sub-constructs of learning engagement, the Kolmogorov-Smirnov tests was performed first followed by the z test. The use of this test was motivated by the sample size.

Table 5.15: Kolmogorov-Smirnov Test for Groups 1 and 2

	Group 1			**Group 2**		
	Test statistic	df	p-value	Test statistic	df	p-value
Cognitive engagement	.078	100	.144	.079	100	.123
Affective engagement	.071	100	.200*	.079	100	.132
Participation behavioural engagement	.110	100	.005	.104	100	.010

5.2.7.2 Interpretation

As shown in Table 5.15 the p-value =0.144 > 0.05 for Group 1 cognitive engagement, therefore the H_0 was not rejected. Hence, cognitive engagement is normally distributed. Similarly, for Group 1 affective engagement, the p-value =0.200 > 0.05 therefore the H_0 was not rejected. Hence, affective engagement is normally distributed. However, for Group 1 Participation behavioural engagement, the p-value =0.005 <0.05 therefore there is sufficient evidence to reject the H_0. Hence, participation behavioural engagement is not normally distributed.

A similar trend with regards to the multivariate normality tests for the sub-constructs of learning engagement was observed in Group 2. For Group 2 p-value =0.123 > 0.05 therefore the H_0 was not rejected. Hence, Cognitive engagement for Group 2 is normally distributed. Similarly, just like in Group 1, the Group 2 Affective engagement p-value =0.132 > 0.05 therefore the H_0 was not rejected. Hence, Affective engagement for Group 2 is normally

distributed. However, for Group 2 Participation behavioural engagement the p-value =0.010 <0.05 therefore there is sufficient evidence to reject the H_0. Hence, Participation behavioural engagement for Group 2 is also not normally distributed.

Furthermore, since the Kolmogorov-Smirnov test has a low sensitivity to the tail alternatives of hypothesised distributions (Mason & Schuenemyer, 1983). However, the absolute value of the z-scores for the skewness and kurtosis can be used to test for normality as well. Following this, there was a need to perform a Z test, which was more preferable given that the sample was greater than or equal to 30 (Mishra, et al., 2019).

5.2.7.3 The Z-test for Sub-constructs of Learning Engagement

The z scores for skewness and kurtosis are shown in Table 5.16 which follows.

Table 5.16: Group 1 Z values of Skewness and Kurtosis

	$\lvert$Z- value of Skewness$\rvert = \left\lvert \frac{skewness}{standard\ error\ of\ skewness} \right\rvert$	$\lvert$Z-value of Kurtosis$\rvert = \left\lvert \frac{Kurtosis}{standard\ error\ of\ kurtosis} \right\rvert$
Cognitive engagement	0.0041	1.0356
Affective engagement	0.1037	0.0523
Participation behavioural engagement	0.1992	0.4017

Table 5.17: Group 2 Z Scores for Skewness and Kurtosis

	$\lvert$Z- value of Skewness $\rvert = \left\lvert \frac{skewness}{standard\ error\ of\ skewness} \right\rvert$	$\lvert$Z-value of Kurtosis $\rvert = \left\lvert \frac{Kurtosis}{standard\ error\ of\ kurtosis} \right\rvert$
Cognitive engagement	1.4440	1.0356
Affective engagement	0.5353	0.0523
Participation behavioural engagement	0.5560	0.4017

5.2.7.4 Interpretation

Both the z-values of the skewness and Kurtosis are within ±3.29. Therefore, the variables are accepted as being normally distributed.

5.2.8 Detection of Outliers

As Laio et al. (2016) point out, outliers are a common occurrence in educational research data sets. However, these outliers need to be detected and treated since they have an impact on statistical conclusions (Liao,et al., 2016). Many ways of detecting these outliers are available. However, box plots were used to detect outliers mainly due to their simplicity. In this section the outliers for learning engagement sub-constructs were detected and treated accordingly.

5.2.8.1 Cognitive Engagement

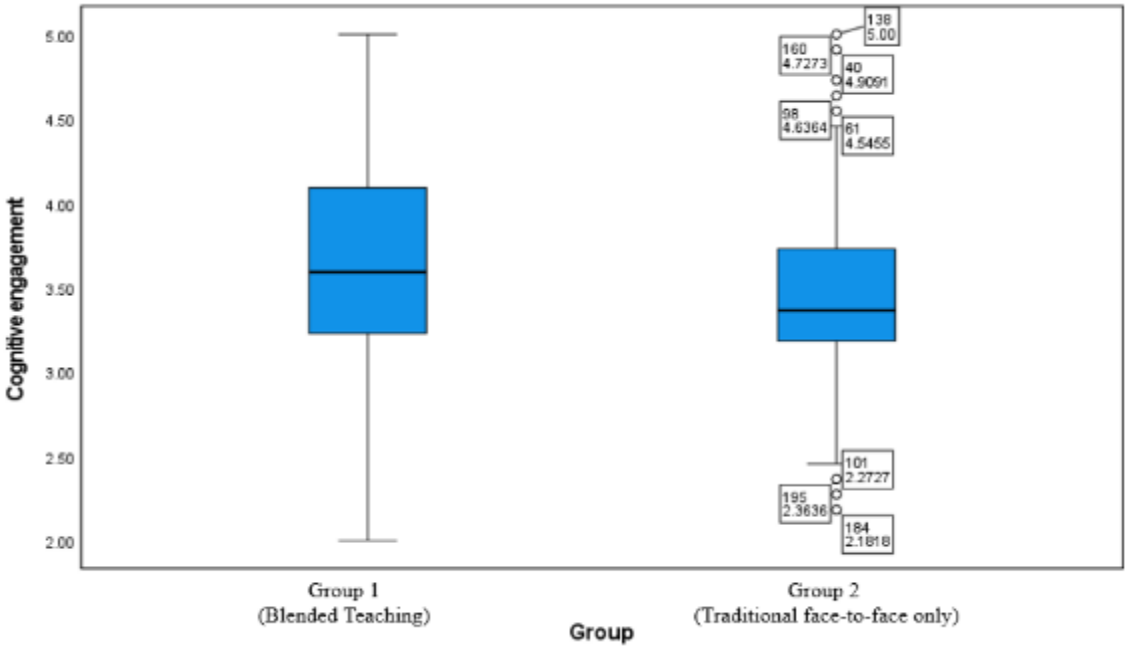


Figure 5.5: Box Plots of Cognitive Engagement

5.2.8.2 Affective Engagement

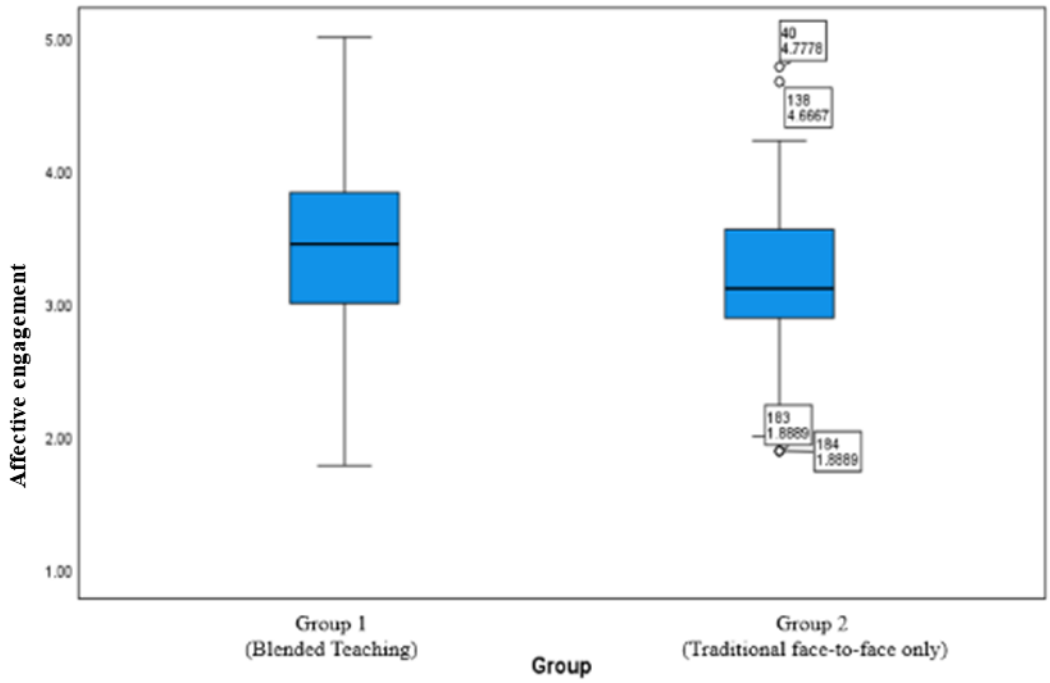


Figure 5.6: Box Plots of Affective Engagement

5.2.8.3 Participation Behavioural Engagement

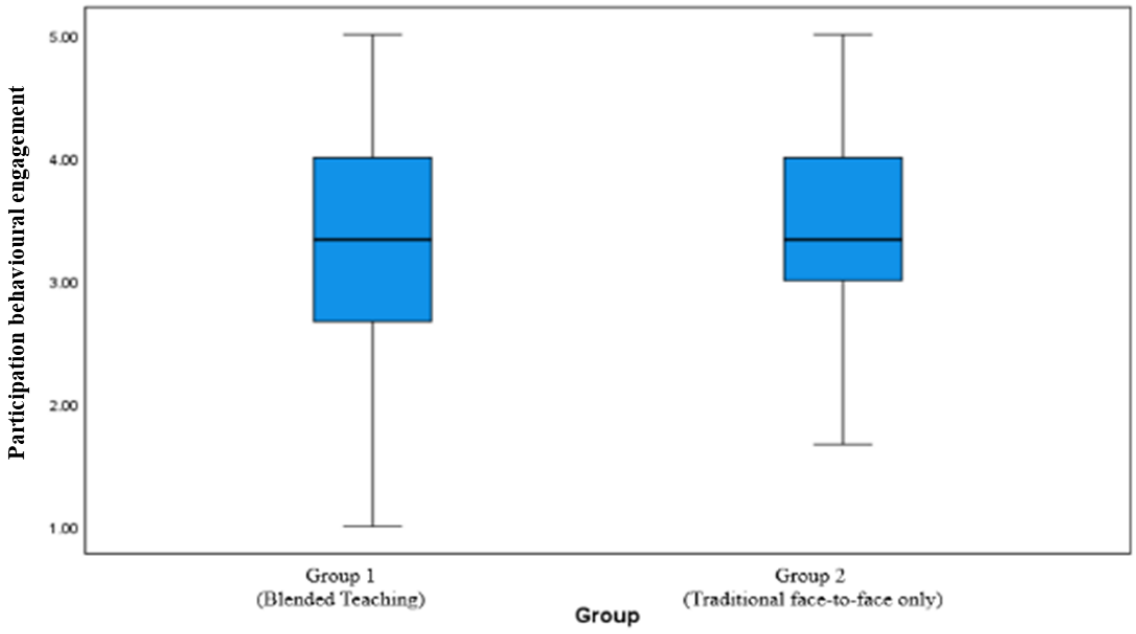


Figure 5.7: Box Plots on Participation Behavioural Engagement

As depicted Figure 5.5, 5 outliers at the top and three outliers at the bottom of the distribution could be identified for Group 2 (Traditional face-to-face Group). Furthermore, as illustrated in Figure 5.6, 2 outliers at the top and two outliers at the bottom of the distribution could be identified for Group 2 (Traditional Face-to-face Group). On the other hand, the Participation behavioural engagement (as shown in Figure 5.7) box plots show no significant outliers for either group. As noted earlier in the introductory section, outliers require some form of treatment which could involve excluding them totally or accommodating them. In this study, a decision was made to accommodate the outliers for reasons that will be advanced in the 5.2.9 section that follows.

5.2.9 Accommodation of Outliers

Research has identified several outlier accommodation methods (Liao et al., 2016; Mishra et al., 2019; Blaine, 2018.). A decision was made to use Winsorization. The influence of outliers was addressed through 10% Winsorization. Winsorization refers to the process by which outliers are set to a specific percentile of the dataset depending on the dataset's distribution (ZACH, 2021; Mishra, et al., 2019; Blaine, 2018.). The decision to use Winsorization instead of removing them (outliers) completely was motivated by several reasons, which include the need to retain the data, to prevent the reduction of sample size, the decision to use parametric methods, and a failure to explain the existence of the outliers (Liao et al., 2016). While the decision to Winsorize was deemed most appropriate, it is understood that it came with its own disadvantages.

Some of these emanate from the idea that Winsorizing reduces the undesirable effects of outliers without eliminating them totally (Liao et al., 2016). Considering that this study utilised t-tests, which happen to be parametric in nature, Winsorizing is arguably the most effective solution to deal with outliers (see, for example, Laio et al., 2016; Blaine, 2018). The results of these t-tests for the sub-constructs of learning engagement are presented with a view to provide more substantive evidence of the effectiveness of blended teaching in fostering learning engagement in this particular South African context, which has been identified as comprising a least advantaged school in whose situation was further exacerbated by COVID-19 which landed on the South African shores in 2020.

5.2.10 Determine the Effectiveness of Blended Teaching on Learning Engagement Using T-tests

Now that the learning engagement sub-constructs met the distributional requirements, the means for Group 1 – Blended teaching and Group 2 – Traditional face-to-face teaching were compared with a view to address the first research question more comprehensively. A two-sided test was performed to determine whether means of academic achievement, cognitive engagement, affective engagement, and participation behavioural engagement, differ significantly between the two groups. Should the means differ significantly, an additional one-sided test is conducted to determine which mean is greater.

The hypothesises for the one-sided and two-sided tests are stated below.

Two-sided test hypothesises:

H_0: Group 1's Mean of variable = Group 2's Mean of variable

H_1: Group 1's Mean of variable ≠ Group 2's Mean of variable.

One-sided test hypothesises:

H_0: Group 1's Mean of variable < Group 2's Mean of variable.

H_1: Group 1's Mean of variable > Group 2's Mean of variable.

Using a significance level of 5%

Following this, the cognitive engagement means for the two groups were compared in section 5.2.10.1.

5.2.10.1 Cognitive engagement

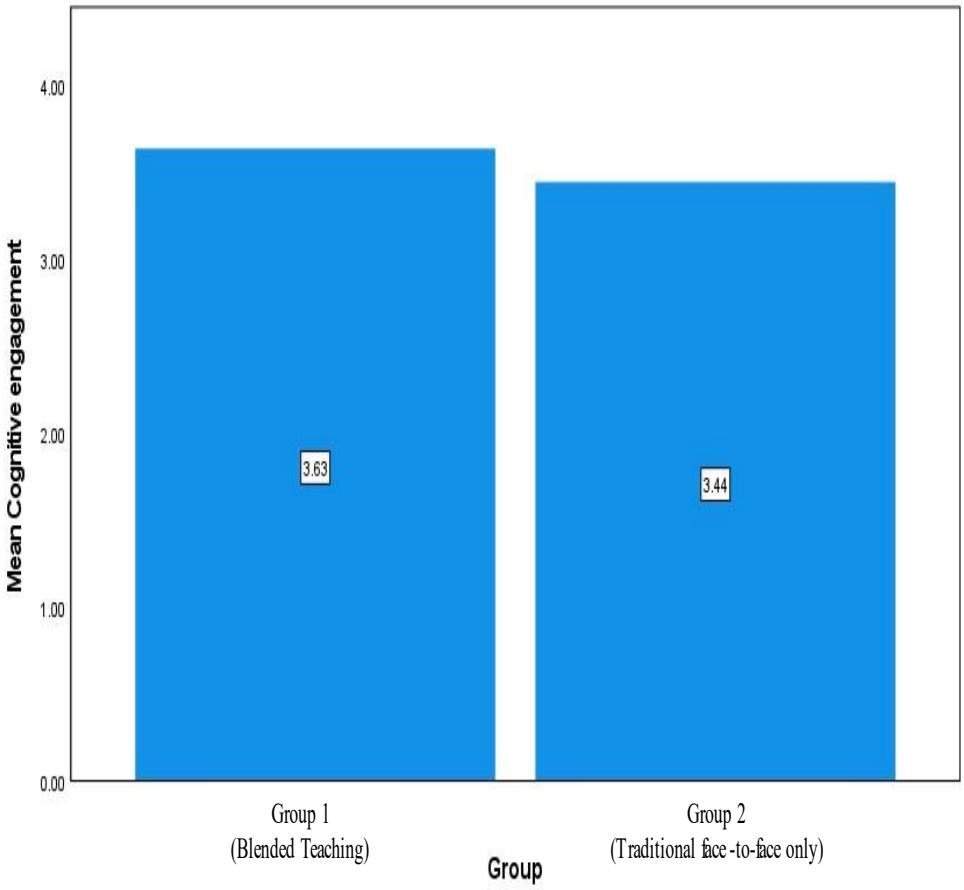


Figure 5.8: Bar Graph comparing Groups 1 and 2 Means of Cognitive Engagement

It is evident from Figure 5.8 above, that the average cognitive engagement for Group 1 is higher than that for Group 2.

Table 5.18: T-test Comparing the Means of Cognitive Engagement

		Levene's Test for Equality of Variances		t-test for Equality of Means			
						Significance	
		F	Sig.	t	df	One-Sided p	Two-Sided p
Cognitive engagement	Equal variances assumed	4.806	0.030	2.325	198	0.011	0.021
	Equal variances not assumed			2.325	194.859	0.011	0.021

5.2.10.2 Interpretations

The two-sided p-value=0.021 as shown in Table 5.18 and p-value<0.05. Therefore, there is sufficient basis to reject the equality hypothesis of the two means. Hence, the average cognitive engagement of the learners taught using the blended teaching method differs significantly from the average cognitive engagement of the students taught using the face-to-face method. The one-sided p-value =0.011 (Table 5.18) in which p-value<0.05, therefore, it was decided that there was sufficient evidence to reject the H_0. Hence, the average cognitive engagement of learners taught using the blended teaching method (Group 1) is higher than that of the learners taught using the traditional face-to-face method (Group 2) only. Furthermore, it is noteworthy that results of moderated regression analysis (presented and analysed in section 5.6) also show that cognitive engagement had significant moderating effects.

Following this, the means of affective engagement and participation behavioural engagement were also compared, and conclusions drawn in the section 5.2.10.3 below.

5.2.10.3 Affective Engagement

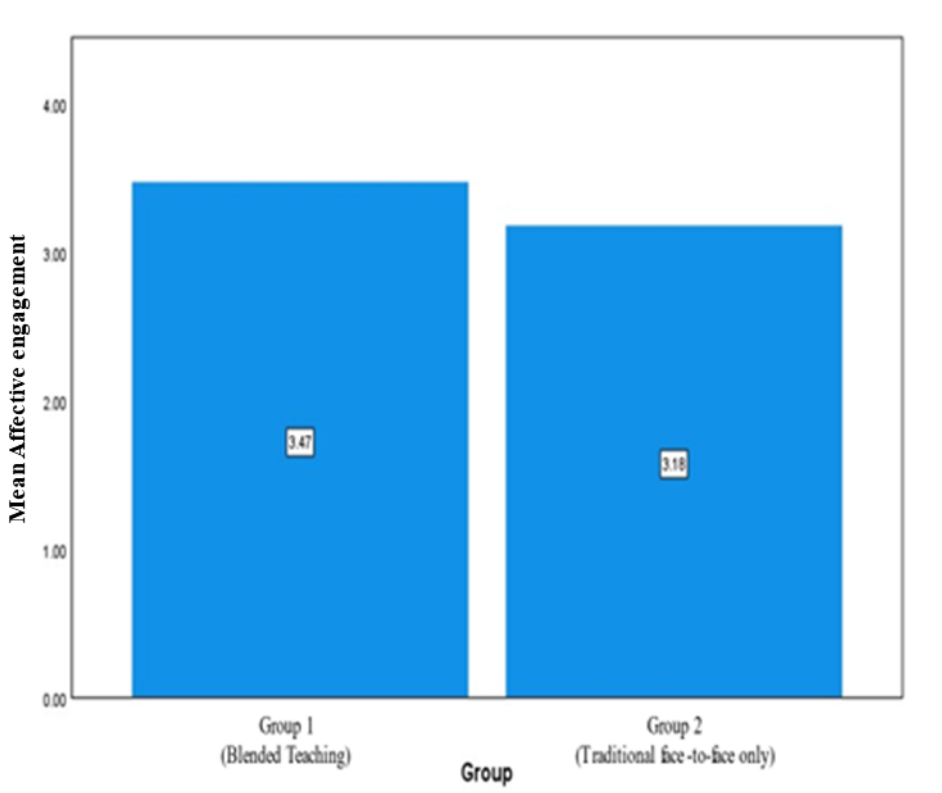


Figure 5.9: Bar Graph Comparing Affective Engagement Means of Groups1 and 2

It is evident from Figure 5.9 above, that the average affective engagement for Group 1 is higher than that for Group 2.

Table 5.19: T-tests Comparing the Means of Affective Engagement

		Levene's Test for Equality of Variances		t-test for Equality of Means			
						Significance	
		F	Sig.	t	df	One-Sided p	Two-Sided p
Affective Engagement	Equal variances assumed	1.861	0.174	3.551	198	0.000	0.000
	Equal variances not assumed			3.551	195.302	0.000	0.000

The two-sided p-value=0 as shown in Table 5.19 and the p-value<0.05. Therefore, there was sufficient to reject the equality hypothesis of the two means. Hence, the average affective

engagement of the learners taught using the blended teaching method differs significantly from the average affective engagement of the students taught using the face-to-face method.

Based on the one-sided p-value=0.00, in which p-value<0.05, it was decided that there was sufficient evidence to reject the H_0. Hence, the average affective engagement of the learners taught using the blended teaching method is higher than that of learners taught using the traditional face-to-face method. Interestingly, the results of moderated regression analysis (section 5.6) also showed that affective engagement has significant moderating effects. Following this, the results of the T-tests on affective engagement, the means of participation behavioural engagement for Groups 1 and 2 were also compared and interpretations drawn in the section 5.2.10.4 that follows.

5.2.10.4 Participation Behavioural Engagement

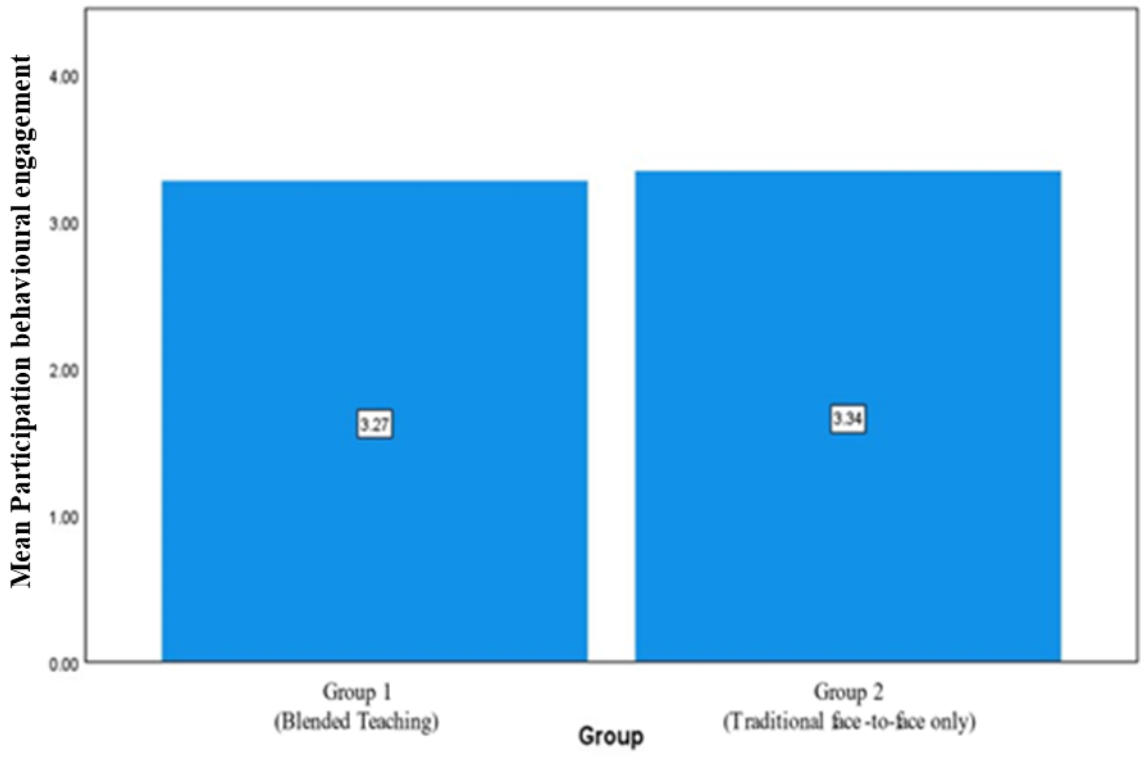


Figure 5.10: Bar Graph Comparing Participation Behavioural Engagement means of Groups 1 and 2

It is evident from Figure 5.10 above, that average participation behavioural engagement for Group 1 is close to that of Group 2.

Table 5.20: T-test Comparing the Means of Participation Behavioural Engagement

		Levene's Test for Equality of Variances		t-test for Equality of Means			
						Significance	
		F	Sig.	t	df	One-Sided p	Two-Sided p
Participation behavioural engagement	Equal variances assumed	0.503	0.479	-0.609	198	0.272	0.543
	Equal variances not assumed			-0.609	197.132	0.272	0.543

5.2.10.5 Interpretations

Based on the two-sided p-value =0.543 as shown in Table 5.20, in which the p-value>0.05 therefore, the H_0 was not rejected. It can also be deduced that the average Participation behavioural engagement (as part of emotional engagement) of the learners taught using the blended teaching method does not differ significantly from the average participation behavioural engagement of the learners taught using the traditional face-to-face method.

Interestingly, even though the two means for both groups are close to one another, the mean participation behavioural engagement for Group 2 is marginally higher, which is a departure from the existing trend where the means for Group 1 have been higher in all the other tests conducted in this study. It can be concluded that the learners from Group 2 were working together slightly more than those in Group 1, but not enough to result in a substantial difference. This could be owing to the idea that participation behavioural engagement did not have significant moderating effects in the relationship that was being studied. The qualitative data discussed hereafter, provides plausible explanations for this anomaly. This required that the findings that would lead to the addressing of research question 4 be presented.

5.3 Effectiveness of Blended Teaching on Learning Engagement (Qualitatively)

The effectiveness of blended teaching on learning engagement was addressed qualitatively using research Question 4, outlined below.

How does comparative analysis of post instruction interview data demonstrate that, the learning engagement sub-constructs of the experimental group (blended teaching group) are more positive compared to the control group (traditional method group)?

Addressing the above research Question was motivated by the need to find out if the interview data of Group 1 were more positive than that of Group 2 (research objective number 4) with a view of forging any possible corroboration between the quantitative data on learning engagement. This was in addition to providing explanations of the quantitative data. The qualitative data were collected using semi-structured interviews in which the questions were formulated were based on the preliminary analysis of the quantitative data. This was after the interview data had been transcribed by the researcher. Transcription of interviews was conducted in such a way that ensured that all the exact words that were said were recorded which included the pauses, stuttering, incomplete words, repeated words, and laughter that is "orthographically" (Braun & Clarke, 2012). Conducting the transcription this way was recommended by Braun and Clarke (2012). Furthermore, it is hoped that transcribing the interviews this way would foster trustworthiness and accuracy of what exactly transpired during the interviews thereby improving validity and reliability of the qualitative data. It was decided that "deductive thematic analysis" was ideal because of the 'sequential explanatory design' utilised (Pearse, 2019). Deductive qualitative data analysis is driven by theory (Pearse, 2019). Qualitative data from each of the two groups (Group 1 and Group 2) were subjected to thematic analysis followed by a comparison of the two groups.

5.3.1 Thematic Analysis

Thematic analysis entails rigorously examining data with a view of unravelling the patterns (or themes) that may exist in the data set (Braun & Clarke, 2012; Pearse, 2019). In this study, thematic analysis was used mainly because of the flexibility it offers as an analytic tool. It is important to note that there exist different types of thematic analysis. Notably, this study is concerned with the inductive, in which the themes and codes are dictated by the content of the data itself, while deductive is the exact opposite. Without delving into the details of every type of thematic analysis, it is important to highlight that deductive and inductive thematic methods of analysing qualitative data analysis are subsets of thematic analysis (Braun & Clarke, 2012).

According to Pearse (2019) and Braun and Clarke (2012), the deductive method of analysing qualitative data is based on the literature reviewed, and that which was subsequently used in

mapping the conceptual framework for this study which is described in Chapter Four. Moreover, this type of thematic data analysis was deemed more suitable for case studies, which were explanatory in nature and particularly useful as far as contributing to the relevant existing knowledge is concerned (Pearse, 2019). However, as Braun and Clarke (2012) assert, an exclusive use of deductive thematic analysis is considered impossible. This idea is supported by Bryne (2022). Considering this, elements of inductive approach to thematic analysis were employed to make sense of the data. While acknowledging this assertion by Braun and Clarke (2012), it is important to note that in this study deductive thematic analysis was the predominant analytical method utilised. This proceeded in a series of stages discussed in the section that follows.

5.3.2 Stages of thematic analysis

The qualitative data were subjected to various stages of thematic analysis. However, before explaining what each of these stages entails, it is evident from literature that different numbers of these stages exist. For example, Braun and Clarke (2012) and Bryne (2022) identify six stages of thematic analysis, while Pearse (2019) identifies seven stages. On the one hand, the six stages include familiarising with the qualitative data (Stage 1), generation of codes (Stage 2), identification of possible themes (Stage 3), Interrogating themes (Stage 4), Confirmation and naming of themes (Stage 5), and writing the report (Stage 6) (Braun & Clarke, 2012; Byrne, 2022).

On the other hand, formulation of a conceptual framework (Stage 1), identification of propositions (Stage 2), Developing a book with relevant codes to be used (Stage 3), Developing a question matrix (Stage 4), collection of data (Stage 5), analysis of qualitative data (Stage 6), writing of report (Stage 7). These two examples are a clear indication of the differences in categorisation of the events which are largely different. Notably, Pearse's (2019) stages were based on deductive qualitative data analysis while the other (Braun & Clarke, 2012) appears to be more of inductive than deductive. While the starting point in deductive thematic analysis is the conceptual framework, questions on whether the conceptual framework should be included in the thematic analysis cannot be avoided. Moreover, some of the stages included do not necessarily have anything to do with the data analysis per se.

The stages which involved the development of the conceptual framework, data collection and question matrix development were omitted as these had already been done. The interview used in this study were largely semi-structured in nature, which meant that they varied from one respondent to another. This made the question matrix difficult to compile. However, since these semi-structured interviews were designed to solicit more explanations for the responses in the OCLESQ, the pattern matrix, which was developed during the quantitative analysis of data, was used as a guide. In the process, the nature of the blend that could be suitable to the South African High school context utilised emerged. Similarly, as the interviewees provided explanations on learning engagement became evident.

In this study, four stages were used in the analysis of the qualitative data. The four stages are outlined in the sections that follow. Additionally, the qualitative data were also used to explain the varying significance in moderating effects of the three (3) learning engagement sub-constructs which are cognitive engagement, affective engagement, and participation behavioural engagement. The qualitative data also played a significant role in putting together the design features of the 'blend', which was proposed in response to the research Question 5. The first Stage which involved getting acquainted with the data is discussed in the section that follows.

5.3.3 Stage 1: Familiarising with the Qualitative Data

This Stage involved getting acquainted with the data by reading repeatedly (Braun & Clarke, 2012). Notes were made in a notebook during the reading process. This repeated reading provided an opportunity to develop a deeper understanding of the data, which involved asking questions that paved way to this in-depth understanding (Braun & Clarke, 2012). This process allowed the researcher to identify data that would be useful in addressing the research questions. Given that the deductive approach was mainly used, the data were identified using the conceptual framework and its related literature. This meant that the themes, subthemes, and the connections that exist between the themes and between subthemes were identified. In this study, the potential themes that were identified are cognitive engagement, affective engagement, participation behavioural engagement, nature of blend relevant to the South African context. These three factors were used to develop the codebook for learning engagement. This was deemed necessary because the responses of the two groups had to be

compared. The sixth theme was on the nature of the blend. This was followed by the development of a code book which is available in the appendix section.

5.3.4 Stage 2: Development of the code book

The following code book was developed from the potential themes that were obtained from the conceptual framework. The codebook developed consists of codes relating to cognitive engagement, affective engagement, participation behavioural engagement, and nature of blended learning. These codes were subjected to a series of revisions. An examination of these codes shows that the literature used to compile the codes was extended, as Pearse (2019) recommends. For example, literature on learning engagement and blended teaching reviewed did not explicitly highlight the negative impact of negative classroom interactions such as unhealthy competition on learning gains. The impact of this issue and other issues which were mostly related to the context are discussed in the section compares data collected from respondents that were drawn from the two groups.

These subthemes, which were derived from literature (see for example Fischer et al., 2018; Halverson & Graham, 2019; Manwaring et al., 2017; Reschly & Christenson, 2012) include in-depth learning, self-directed learning and self-regulation, interest, assessment, and perceptions based on learning goals or self-reflection. These subthemes can be viewed as facilitators of cognitive engagement in this study. However, it is important to note that there is no uniformity in terms of facilitators of cognitive engagement as far as literature is concerned as noted in the literature review section on the learning engagement construct. This confusion might exist because researchers do not agree on whether the indicators of learning engagement should be three (cognitive, emotional/affective, and behavioural), two (cognitive and emotional/affective), or four, as pointed out in the background to this study (Reschly & Christenson, 2012). To further deepen this lack of clarity, some researchers were not interested in splitting learning engagement into its sub-constructs and nor did they even acknowledge the idea that learning engagement is a multifaceted construct (Fredericks et al., 2004). Nevertheless, in this study, learning engagement is being presented in terms three constructs which are cognitive and affective engagement, and participation behavioural engagement. However, during measurement the affective engagement sub-construct was combined with the participation behavioural engagement and the measurement scale was labelled emotional engagement. Following deductive thematic analysis, the codes for the three learning

engagement constructs which are affective engagement, cognitive engagement and participation behavioural engagement were tabulated. The tables of these codes are available in the appendix section. Details of the codes can be found in Table T.1, Table T.2 and Table T.3.

5.3.5 Stage 3: Application of the Codes

These codes were applied to the data from the two groups and subjected to thematic analysis, content analysis, and comparative analysis. This led to a revision of the themes (Braun & Clarke, 2012) based on learning engagement to include the complementary themes (positive cognitive, mixed cognitive and negative cognitive engagement; positive affective, mixed affective and negative affective in addition to positive participation behavioural engagement, mixed participation behavioural and negative participation behavioural engagement) as illustrated in the conceptual framework.

5.3.6 Stage 4: Revision of the themes

Following this inclusion of the three themes relating to learning engagement became six: positive cognitive engagement, negative cognitive engagement, mixed cognitive engagement, positive affective engagement, negative affective engagement, mixed affective engagement, positive participation behavioural engagement, negative participation behavioural engagement, and mixed participation behavioural engagement. It was deemed necessary to do it this way to make comparisons between the two groups easier and more distinct. Moreover, Skinner and Pitzer (2012) also proposed that the different forms of learning engagement be investigated in terms of positive and negative to give a full picture of the range. As pointed out previously in this study, the intensity each form of learning engagement may vary due to varying contextual factors. It can be argued in this study, that continua of each form of learning engagement is incomplete when the mixed versions are left out.

While this study takes cognisance of the fact that the theory and literature used to compile this study does make mention of a maximum of three concepts as cognitive engagement, positive affective engagement, and negative affective engagement, this can be viewed as another extension. Following this decision, the tables showing each theme or concept, corresponding subthemes and code matches were compiled. Furthermore, for the sake of transparency the respondents were included in each table using **E-1** to **E-7** (for Group 1) and **C-1** to **C-7** (for

Group 2). This was also meant to ensure that the data were traceable to the correct interviewee in case there is a need to recheck issues that may arise. E-1 to E-6 were learner interviewees from the experimental group (Group 1), while E-7 was the teacher for the experimental group. Similarly, C-1 to C-6 represents the learner interviewees from the control group (Group 2) while C-7 becomes the teacher for the control group. These tables are available in the appendix.

These subthemes, which were derived from literature (see for example (Fischer et al., 2018; Halverson & Graham, 2019; Manwaring et al., 2017; Reschly & Christenson, 2012) include in-depth learning, self-directed learning and self-regulation, interest, assessment, and perceptions based on learning goals or self-reflection.

These subthemes represent the facilitators of cognitive engagement in this study. However, it is important to note that different there is no uniformity in terms of facilitators of cognitive engagement as far as literature is concerned. This confusion might be in existence because researchers do not agree on whether the indicators of learning engagement should be three (cognitive, emotional, and behavioural) or two (cognitive and emotional), as pointed out in the background to this study. To further deepen this lack of clarity, some researchers were not interested in splitting learning engagement into its sub-constructs, nor did they even acknowledge the idea that learning engagement is a multifaceted construct. Nevertheless, in this study, learning engagement is still being presented in terms of three sub-constructs, which are cognitive and affective engagement, and participation behavioural participation behavioural engagement, which were partly derived from literature and from the determination of the validity and reliability of the learning engagement.

Having reiterated this point, which was made in the introduction of this study, it becomes important to present the qualitative research findings on the sub-constructs of learning engagements, which are: (cognitive engagement positive, negative, and mixed), affective engagement (positive, negative, and mixed), and participation behavioural engagement (positive, negative, and mixed). The research data analysis for positive, negative and mixed cognitive engagement are discussed in the sections that follow and presented in tables. A similar analysis was carried out to determine the research finding affective engagement and participation behavioural engagement.

5.3.6.1 Qualitative Research Findings on Cognitive Engagement

5.3.6.1.1 Positive cognitive engagement

Group 1 respondents had positive cognitive engagement compared to Group 2 respondents (details of the findings can be found in Table U.1, available in the appendix). Content analysis was used to determine these research findings, and responses are included in this section transcribed verbatim. This entailed determining the frequency counts of the theme or subtheme. with a view to draw a comparison between the two groups (Group 1 versus Group 2). It was deemed necessary to draw a comparison between the two groups in a bid to determine the effectiveness of blended teaching on learning. It is self-evident from the data in the table that all the subthemes appear at higher frequency counts in Group 1, in which blended teaching was used than in Group 2, which was taught Organic Chemistry concepts using traditional face-to-face teaching. Based on this, it is a question as to whether blended teaching influenced higher level of cognitive (positive) engagement. However, this scenario changes when the negative version of cognitive engagement was considered. Content analysis of data showed that responses from more Group 2 interviewees compared to Group 1 depicted the version of cognitive engagement when the frequency counts were considered (details in Table U.2 available Appendix U).

Furthermore, more Group 2 responses than those from Group 1 could be classified as being mixed, which meant that exhibited traits of both positive and negative cognitive engagement (details in Table U.3 available in Appendix U). This category of findings was necessary in order to accommodate the various types of responses, while capturing the quality indicated by the continuum, where cognitive ranged from positive (ranked higher) to mixed (something in-between) to negative (ranked low or non-existent). In terms of quality of the cognitive engagement, it could be argued that the responses that were categorised as positive (in Group 1) demonstrated a higher level (quality) of cognitive engagement. Based on these research findings, it could be argued that overall cognitive engagement was higher in Group 1 than it was in Group 2, which is in line with the quantitative data for research Question 1. Based on this, it could be argued there is a chance that the qualitative findings could have corroborated quantitative findings in which the average cognitive engagement for Group 1 was significantly higher than that for Group 1. It is worth noting that the way the questionnaire was designed, which ranged from 1=strongly disagree to 5 (strongly agree), meant that higher average

cognitive engagement represented higher level of cognitive engagement, while also giving indication of the quality of the cognitive engagement.

A closer look at the facilitators/subthemes of cognitive engagement (positive) shows that responses from interviewees that were drawn from Group 2 only appeared in the assessment and interest categories. Interestingly, only a single respondent from Group 2 indicated that Organic Chemistry was interesting. This response can be labelled as an 'outlier' when Bazeley (2009) is considered. Even though this is an 'outlier' it confirms that though they were few, some learners in in Group 2 that found Organic Chemistry activities interesting. However, when this facilitator or subtheme of cognitive engagement is compared with Group 1, the evidently higher frequency shows that more learners in Group 1 found Organic Chemistry interesting.

A closer look at the interest facilitator appears to show that the interest was partly attributed to the use of the app as indicated by John, learner from Group 1 who had this to say:

> *Interviewer: You said that you found Organic Chem work interesting. What made it interesting?*
> John: *I found the app, the app interesting but some of my classmates complained about the data problem.*

Interestingly, no-one from Group 2 indicated that they found Organic Chemistry interesting. Interestingly, these findings on interest appear to confirm the notion that blended teaching was more effective in fostering learning engagement in terms of cognitive (positive) engagement compared to traditional face-to-face. Furthermore, the research findings show that more interviewees from Group1 which was taught using blended teaching exhibited higher levels of perseverance compared to Group 2 interviewees. Evidence of perseverance was well articulated by Mr. Zulu (Experimental Group-Group 1 teacher) as shown in the except that follows.

> *...learners were now willing to try those more challenging questions even the longer questions. In the quiz, they kept on trying when they were given three chances. This also happened when they were doing longer questions-they would try and explain something. They were no longer leaving blank spaces. They tried to put in something, and I think the online thing helped to realise that if they keep on trying, they can improve which was a very positive thing.*

Considering this statement, it becomes clear as to why Group 1 appears to have exhibited more positive cognitive engagement than Group 2, given that there was nothing that the respondents from Group 2 said that could point towards any form of perseverance as shown in the research findings. Most of these subthemes only started appearing under negative cognitive engagement. The third subtheme, which reflected some level of positive cognitive engagement, is the one that relates to assessment. Notably, even though Group 1 shows a higher frequency, it is important to highlight that positive perceptions on assessment could still be seen in Group 2. This could have been mainly driven by the after-school activities or homework. Interestingly, all the interviewees from Group 2 indicated that the homework was easier because of the opportunities to work with classmates after school. Similarly, Group 1 interviews indicated that they had opportunities to work with classmates during the face-to-face component, during which they initiated their own discussions and debated with one another. Considering this, it can be argued that these initiatives were evidence of self-directed learning and self-regulation.

Additionally, learners from Group 1 could have benefitted from the immediate feedback, which was made possible using technology as part of blended teaching. It can also be argued that positive cognitive engagement appears to have been influenced by assessment and perseverance in turn led to in-depth learning and general perceptions of Organic Chemistry as easy.

Similarly, perceptions that learning goals in which most of the interviewees were hoping to excel in Organic Chemistry and self-directed learning and self-regulation appear to have resulted in positive cognitive engagement. It is also noteworthy that learning material could have played a significant role in fostering cognitive engagement, which was generally positive. This is clear from the frequency of the positive comments about the learning material, which only came from Group 1, as reflected in the research findings above. As a way of concluding this discussion on positive cognitive engagement, it becomes necessary to briefly examine the excepts from the interviews which follow. Mary (pseudonym) from Group 2 had this to say:

I was getting better because of the activities I did away from school.

On the other hand, Zodwa from Group 1 had this to say about Organic Chemistry activities:

I could answer most of the questions.

Also, Organic Chemistry section improved my marks in paper 1.

It is clear from the interview excerpt that Zodwa rated all activities as important and found them helpful, but Mary specifically mentioned that she benefitted more from those activities she did after school. Additionally, Zodwa went on to emphasise that Organic Chemistry helped her get better marks in physical sciences paper (Chemistry component) 1. From these excerpts it becomes clear why Group 1 learners scored higher in terms positive cognitive engagement. However, at this point, it is important to examine one complementary form of cognitive engagement, which was generally negative in nature.

5.3.6.1.2 Negative Version of Cognitive Engagement

Contrary to the research findings on positive cognitive engagement, the subtheme relating to assessment as part of negative cognitive engagement appeared a significantly larger number of times under Group 2 compared to Group 1. This could be interpreted as showing that participants in Group 2 were finding assessment extremely difficult. However, the research findings on negative cognitive engagement, as illustrated in Table U.2 in the appendix appear to show that interviewees from both Groups 1 and 2 generally struggled with organic reactions and polymerisation. However, more interviewees from Group 2 seem to have struggled with these subtopics of Organic Chemistry than those from Group 1. Could this be pointing towards blended teaching being more efficacious in fostering learning engagement in terms of the cognitive engagement sub-construct?

In addition to the identified learning struggles, interviewees from Group 2 learners also appeared to have struggled with the interpretation of graphs on physical properties in conjunction with wide range of other learning struggles. These additional learning struggles experienced by Group 2 interviewees include performing poorly in homework activities, perceptions that the work was too little, finding homework too difficult, struggling to answer questions on practical work, generally finding Organic Chemistry difficult, and failing to answer questions. The interview excerpt that follows captured most of the Organic Chemistry subtopics that the Group 2 learners struggled with.

> Interviewer: *Since you didn't do any practical work, how did you fare in the questions based on practical work? Did you find them difficult or easy?*
> Rose: *I found them more difficult.*
> Interviewer: *What else did you find more difficult?*
> Rose: *About interpreting graphs.*
> Interviewer: *Graphs on what?*

Rose: *Graphs on temperature.*

Interviewer: *Graphs on physical properties.*

Rose: *Yes.*

As already mentioned, Rose was not the only Group 2 interviewee that that indicated that she experienced learning struggles of this magnitude. This is a complete opposite of what Group 1 interviewees mentioned under positive cognitive engagement. Furthermore, Group 2 interviewees did not only find school-based activities difficult, but they rated them as less helpful as well. When this category of negative cognitive engagement was compared between the two groups, it became apparent that a larger number of Group 2 interviewees expressed the experiences just mentioned on school-based activities. Given these findings, it could be argued they are pointing towards blended teaching being more effective in fostering learning engagement compared to Group 2 learners. Moreover, these experiences stood in sharp contrast to what was expressed by one Group 1 interviewee, who indicated that the school-based activities were not necessarily difficult per se but were less important. This is another case of only one 'outlier'. When asked to explain, Ntombi from Group 1 indicated that she preferred more difficult work, which could be signifying a higher level of cognitive engagement. The teacher Ms. Nkosi summed it up in noting that the Group 2 learners were not doing at all well in Organic Chemistry. The second most important subtheme after assessment could have been 'perceiving learning goal as not achievable', judging from frequency counts.

Once again, most of the Group 2 interviewees held this perception, which was in sharp contrast to Group 1, where not even a single interviewee mentioned that they perceived learning goals as unachievable. Conversely, none of the Group 1 interviewees indicated that they perceived the learning goals as unachievable. However, this does come as a surprise given the generally negative views of assessment that were expressed by Group 2 interviewees, as shown in Table U.2. Could this be a result of blended teaching being more effective in developing learning engagement, or could it be purely due to differences in the motivation levels? Interestingly, one of the interviewees from Group 2 indicated that he generally does better in the physics component, which shows that the learning struggles that informed this perception under discussion appear to be a general chemistry problem, and not specifically linked to Organic Chemistry.

This assertion was confirmed by the Group 2 teacher (control group teacher), who said the following:

> *So, in the past, it was really easier, but now with this generation, I'm really getting confused, because, honestly, right now, all of them are finding it very difficult, um, I don't know if it is the curriculum, how it is designed. I really don't know, but right now, chemistry is one of the feared subjects…*

It is clear from the excerpt above that this problem of learner struggles do not seem to be peculiar to Organic Chemistry alone, but to the Chemistry component in its entirety. Interestingly, this preoccupation with the examination is evident when Ntombi (from Group 1) who indicated that she did not find in-class activities helpful as shown in the excerpt that follows.

> *When we are in class we are given like simple activities, simple exercises and we don't gain much from those simple activities because when we get to the exam* (short for examination) *we don't find those questions as easy as what you did in class. There is no point in doing a simple task when you are not going to find it in the exam.*

It is evident from what Ntombi said that anything which does not help prepare for the examination is not worth doing. Ntombi added that when she initially struggled with Organic Chemistry, she resorted to memorisation as shown in the excerpt that follows.

> *I used different types of memorising the work.*

This idea of coping through memorisation could have been problematic as discussed later in Chapter 5 of this study. On the other hand, the teacher for the experimental group, Mr. Zulu also appears to be encouraging rote learning, in saying the following:

> *I think the reason is that the Organic reactions requires the learners to read more and to engage with the learning material because one needs to read and remember the conditions, reactants and remember the products.*

It is clear from what Mr. Zulu said that learning struggles associated with Organic reactions could have been resolved through memorisation. The idea that even the teachers are also encouraging rote learning was concerning as discussed later in Chapter 5 of this study. However, the problem highlighted here raises questions about the teaching methods being employed in the schools. Having looked at the subtheme relating to the perception of learning goal as achievable, there is a need to examine the third most important subtheme of self-directedness/self-regulation, based on the frequency.

As shown in Table U.2 which is in the appendix, a higher prevalence of a lack of self-directness/self-regulation among Group 2 interviewees is evident. Some of these Group 2 interviewees were not even doing their homework and were waiting for the teacher to read notes for them. This shows a lack of initiative from the learners. Interestingly, no interviewee from Group 1 exhibited any signs of this lack of self-directness and self-regulation. Based on this observation, it can be argued that most of the learners in Group 2 have not taken responsibility for their learning. The Group 2 teacher, Ms. Nkosi indicated commenting on time constraints, had this to say:

> *Interviewer: So, the time is really, really a problem?*
> *Ms Nkosi: Yes, if you have an hour you need to get in class, you need to check that they wrote yesterday's work, and then you find some didn't write that work.*

Even though this interview excerpt was on time constraints, it also shows that the learners are also not doing their work that is homework neither were they reading their notes. This is in sharp contrast to what was happening in Group as shown in Table U.1in the appendix. Furthermore, this problem of not reading notes also points towards reduced number of interactions with learning material. However, when interactions with the learning material is considered, a different picture seems to emerge, which would leave one wondering if this is a lack of self-directedness and or a teacher problem.

It appears that the teacher's skills to or lack thereof came under the spotlight when the learners' perceptions of some of the learning materials were considered. Some of the interviewees indicated that the notes from the teacher are difficult to understand, which leaves one wondering whether it was the teacher skills or simply the lack of language proficiency, which had been highlighted earlier during the situation analysis. Alternatively, it could have been a combination of all three factors-lack of self-directness/self-regulation, teacher skills, and a lack of language proficiency. Furthermore, a lack of perseverance was also noted in this this group, Group 2 when the teacher, Ms. Nkosi said the following:

> *Yes, so when they spend a lot of time, a solution needs to come there, and then, otherwise they don't appreciate it. And when still they are not finding a solution now, they give up. Then when you come back, and ask, did you find a solution? Now they say, "no, we didn't-there is no solution-actually, we left it." Yes, so*

the next day, they don't even want to go back there. So, you have to force them to go back. So, that's how it is.

It is clear from this interview excerpt that Group 2 learners lack perseverance and self-directedness/self-regulation, which stands in sharp contrast to what was happening in Group 1 where learners were no longer leaving blank spaces as indicated under positive cognitive engagement. It can be argued that Group 2 learners exhibited more of negative cognitive engagement traits than Group 1 learners. The conceptualisation of learning engagement as a moderator also appears to have been confirmed and more specifically the idea cognitive engagement has a significant moderating effect on the relationship between blended teaching and academic achievement appears more plausible (Research Question 3). However, before drawing any substantive conclusions, there is a need to discuss the mixed cognitive engagement theme. There were interview responses that could not fit perfectly into the two themes discussed. An analysis of these responses exhibited traits of both positive and negative cognitive engagement.

5.3.6.1.3 Mixed Version of Cognitive Engagement

It can be deduced from Table U.3 in Appendix U that the subthemes learning material and the one in which Organic Chemistry was difficult at times were the most important ones, judging from their high rate of frequency. Interestingly, more interviewees from Group 2 indicated that Organic Chemistry was difficult at times compared to Group 1. Some of these Group 2 respondents indicated that they struggled to understand organic reactions, polymerisation, naming, homologous series, and functional groups. This relatively long list of Organic Chemistry subtopics shows that these Group 2 learners struggled with a sizeable portion of the Organic Chemistry topic. Given this, it can be argued that these responses are tilting more towards negative cognitive engagement.

When compared with the responses from Group 1 interviewees, it becomes clear that Group 2 interviewees sometimes experienced more difficulties with Organic Chemistry in general, especially as far as the relative counts of frequencies of this subtheme are concerned. However, it is important to note that most interviewees from Group 1 indicated that they found Organic Chemistry easy, which explains why there would not be many of them that sometimes struggled to understand the Organic Chemistry concepts. This could partly be attributed to the increased interactions with the learning material, which has already been noted previously under positive cognitive engagement. Additionally, it appears more plausible that more Group 2 interviewees

expressed that they struggled to understand the notes and the teacher, Ms. Nkosi bemoaned that the learners were not studying and that they were not doing the homework.

Furthermore, Table U.3 in Appendix U shows an inconsistent interaction with learning material by some of the learners in both groups. However, only one interviewee from Group 1 indicated that she did not interact with all the learning material as shown in the interview excerpt that follows.

> Interviewer*: What did you find more helpful on the work that you had to after school in Organic Chemistry?*
> Ntombi: *The quizzes. I didn't watch the videos that much.*
> *Also, because I can't be writing notes all the time.*

This interview excerpt can be interpreted as depicting a mixed cognitive engagement, since the learner (Ntombi) indicated that she sometimes watched videos in addition to expressing that she does not like writing notes that much. The learner in question did mention that she found quizzes helpful. This is an indisputably clear case of mixed cognitive engagement. Interestingly, some of Ntombi's sentiments were echoed by the teacher, Mr. Zulu as shown in the excerpt that follows:

> *With the extra resources that I posted, I noticed that these learners were more into videos than the reading material. That's what I noticed with the learners that I started with in this programme. They preferred to watch videos than to read any another learning material.*

What the teacher said about some learners not reading notes resonates with Ntombi's dislike of note taking. However, the idea that Ntombi did not watch videos that much appears to be more of an outlier situation, since most of the interviewees from Group 1 mentioned that they watched videos. Notably, unlike Group 2 learners, Group 1 learners did not find the notes difficult to understand, even though some of them did not use them. Most importantly, this dislike of notes appears to be prevalent in this particular South African context in which this study was conducted which comprises Quintile level 1 schools. Furthermore, Mary from Group 2 indicated that an inconsistent interaction with the learning material when she said the following:

> *... because at times, you find that, uh, at night or later that night, I didn't study physics, but I did some other, other languages, so I would find it very hard for me to write the unexpected test if I didn't revise further about it the previous day.*

On the other hand, it is also clear that Mary (Group 2) was not revising her work consistently, and sometimes struggled to answer some of the questions. This points towards the assessment as third important subtheme of mixed cognitive engagement.

A comparison of the frequency of the subtheme relating to assessment appears to be uniform, however, in Group 1, some of the learners indicated that they found Organic Chemistry initially difficult, but this changed as the learning progressed. Conversely, in Group 2, this transition did not happen, since the learning struggles that were initially experienced persisted. Based on this, the expectation would be that some of the Group 2 learners' performance did not improve at all, resulting in low academic achievement. Furthermore, when the activities done in class and those which were part of homework were compared, most of the interviewees indicated that they found homework less challenging. On the one hand, some found the homework challenging, but were successful in working with classmates. These sentiments were shared by most of the interviewees from Group 2. On the other hand, only one learner, Zodwa from the Group 1 interviewees, indicated that in-class activities were difficult.

Once again, this appears to be more of an 'outlier'. However, in Group 2 teacher availability was questionable, given what the chaotic learning environment, which was a result of the teacher's inability manage the class effectively, which has already been pointed out under negative cognitive engagement. Considering what Zodwa noted, which is as follows, one it cannot be disputed that the there were learners found Organic Chemistry difficult.

> *When I understood a topic or chapter, I found it interesting because I could do every exercise. There were times when I didn't understand a thing that's when I didn't find easy. For example, when we were doing polymerisation, I found it difficult.*

From what Zodwa said, it cannot be disputed that this is a clear case of mixed cognitive engagement, especially based on the indication that these learning struggles were not persistent. Most importantly, this subtheme should not be looked at in isolation, given that Group 2 interviewees' responses, which were categorised as negative cognitive engagement were many compared to those from Group 1. Nonetheless, after a careful consideration of interview excerpt under discussion, it is interesting to note that this interviewee, Zodwa, implies that interest in Organic Chemistry was dependent on success in assessment activities. This requires that interest as a subtheme be discussed further.

Since Zodwa was struggling to understand at times, and sometimes left some of the questions unanswered, it becomes clear that interest was also mixed and so was perseverance.

> *…At times I did not understand the Organic Chemistry so I would struggle to answer the questions…*

Considering this, a pattern seems to emerge in which experiencing success led to more interest and perseverance. This trend was evident when negative cognitive engagement and positive cognitive engagement were discussed. While this pattern appears to emerge, it requires further research. Interestingly, most of these subthemes of all the three forms of cognitive engagement were also linked, directly or indirectly, to three forms of affective engagement, which are: positive affective engagement, negative affective engagement, and mixed affective engagement. All the three forms of affective engagement form a part of emotional engagement and can be described using the same subthemes. As pointed out previously in this chapter, it is important to look at whether each theme is positive, negative, or mixed to make it easier to compare the two groups which are Group 1 and Group 2, in addition to providing some of the quality of engagement. The results depicting these three themes will be discussed separately, while connections are being highlighted. For example, one learner (Zodwa) noted that she did not participate in the discussion forum, because she was afraid that her answer was wrong, which points towards issues related to affective engagement. This requires that data on affective engagement be analysed, starting with the positive version of this particular sub-construct of learning engagement.

5.3.6.2 Research Findings on Affective engagement

5.3.6.2.1 Effectiveness of Blended teaching in developing positive affective engagement

Table V.1 shows that more responses from Group 1 are positive compared to those from Group 2, which stands a sharp contrast to Table V.2 showing that more Group 2 responses are negative. The qualitative data analysis for this study shows that positive affective engagement can be described in terms of five subthemes, which are, enjoyment, confidence, opportunities to ask and answer questions, sense of belonging, anxiety, and frustration. The sub-themes anxiety and frustration, or rather a lack thereof, were the most infrequent. Furthermore, Table V.3 shows that mixed affective engagement for Group 1 had higher frequency counts than Group 2. These findings show that, in terms of quality of affective engagement and the frequency counts, the overall affective engagement was higher in Group 1 than it was in Group 2, which was in line with the quantitative research findings for Question 1, as presented. When

the frequency counts of these sub themes were considered, it became clear that enjoyment was the most important one followed by opportunities to ask and answer questions, confidence, and sense of belonging as shown in Table V.1. On the same note, a lack of enjoyment, lack of concentration in addition to anxiety had relatively high frequency counts in Group 2 compared to Group 1, as illustrated in Table V.2. Additionally, it could be argued that the relatively high frequency counts of mixed affective engagement (as shown in Table V.3) in Group 1 could be deduced as showing that for Group 1, most of the responses were either positive or mixed, which could have resulted in a higher overall affective engagement. Based on this it could be argued that this points toward affective engagement as being a significant moderator in the relationship between blended teaching (or traditional face to face teaching) method and academic achievement as illustrated by the results of moderation regression analysis that are presented in section 5.6.To illustrate how Group 1 responses were more positive than those of Group 2 the effectiveness of blended teaching on each of the facilitators of learning engagement is determined staring with learner enjoyment and an evaluation of opportunities the created to ask and answer questions.

When these Group 1 interviewees were asked to give reasons why they enjoyed Organic Chemistry, it became clear that most of them enjoyed the timely feedback and playing the flashcard game. This could be confirmed by what one of the interviewees, John said which is as follows:

> *"I would recommend it. I think it is a good way of learning, because for me, it tells my mistakes when I am attempting questions, so that I would be learning from my mistakes."*

On this basis, it becomes plausible that the introduction of technology played a significant role in bringing about this enjoyment. However, at this point, it would be premature to say with certainty that the teaching method (blended teaching) was responsible for the enjoyment of most Group 1 interviewees, at least before all the themes have been examined and the qualitative data has been fully integrated with the quantitative data. Conversely, only a single learner interviewee from Group 2 indicated that she asked and answered questions during the lesson. Furthermore, given what Lethiwe noted, which follows, it is not surprising that all of them expressed that they asked and answered questions during the lesson.

> *When I had questions, I asked the teacher in class.*
>
> *We were given a lot of opportunities to ask questions during the lesson.*

It is self-evident from what Lethiwe noted that the teacher was available to assist the learners and that many opportunities to ask questions were created. Based on the idea that most of the Group 1 learners appear to have been utilising these many opportunities to ask the teacher questions, it could be argued that utilising these opportunities could be linked to confidence and a sense of belonging.

As shown in Table V.1 in Appendix V, confidence in Organic Chemistry figured strongly, given its high frequency count. Furthermore, when the two groups are compared in terms of confidence, it can be seen that slightly more interviewees from Group 1 than Group 2 indicated they were confident. Even though the difference appears to be marginal, it is important to note that Group 1 learners appeared to have been faring better in this respect. For example, it became more plausible that feelings of confidence were boosted among Group 1 learners that were being taught using blended learning, when an excerpt of the interview with Lindiwe from Group 1 is considered.

> *Interviewer: If you were asked about Organic Chemistry, would you say Organic Chemistry activities boosted your confidence?*
>
> *Lindiwe: Yes, definitely yes!*

It is clear that Lindiwe meant what she said based on the emphasis. However, when this was compared with what Rose from Group 2 had to say when asked the same question a sharp contrast in the level of confidence emerges, as shown by the interview excerpt that follows:

> *Interviewer: Let's talk about these activities that you were doing in class since you said that they were challenging. Would you say that these questions boosted your confidence, or they had a negative effect on your confidence?*
>
> *Rose: I think they boosted my confidence.*

Rose's response lacked emphasis, which can be interpreted as uncertainty. Given this and coupled with the idea that the frequency of the feeling of being confident, indeed had a higher magnitude in Group 1 compared to Group 2. Interestingly, confidence appeared to have been boosted by many opportunities to practice as mentioned by some of the interviewees particularly from Group 1. The opportunities to practice increased because some the activities were graded using the LMS used in blended teaching. However, the same could not be said about Group 2 learners, who had to wait for their work to be graded by the teacher or by other learners during the lesson. This grading of work in real time could also have afforded learners from Group 1 an opportunity to learn from their mistakes within a short space of time, which

had a positive effect on cognition. Closely related to feelings of confidence is the sense of belonging, which was identified as another sub-theme of positive affective engagement.

It was only interviewees from Group 1 that expressed that they felt like they belonged to their class. For example, Zodwa, from Group 1, who was taught using blended teaching had this to say during the interview:

> *Yes, I feel like I belong in my class.*
> *We share information, and we talk generally-we share information about Physical Sciences. We are open to each other. We are like a family.*

It could be argued that this is a clear case of feeling of belonging to the class particularly considering the view that classmates were like family members. Family members are expected to value one another, offer encouragement, and generally accept one another. Given this kind of learning environment, where learners feel loved and appreciated by other classmates, it is not surprising that exchange of information could take place as pointed out the interviewee. There are many factors that could have instilled the feelings of belonging among learners. Could this have been the teaching method or peers or classroom structure? Additionally, the impact of this sense of belonging on the learning engagement appears more likely considering the informative interview which highlighted many particularly important factors that provided evidence of learners that were interconnected, respected one another and the sharing of information. This meant that they were ready help each other. At this point, it becomes important to reiterate that these research findings will go a long way in addressing the first research question, which sought to determine the effectiveness of blended teaching in developing learning of which affective engagement is a sub-construct, while sense of belonging becomes a facilitator of affective engagement. Based on the research findings on sense of belonging it can also be postulated that when learners lack a sense of belonging, they may find navigating the classroom environment frustrating.

In this study, an absence of frustration is considered positive affective engagement. Interestingly, all interviewees experienced some form of frustration. This could be showing that overall affective engagement and overall learning engagement could have been adversely impacted upon by frustration. Similarly, in this study, a lack of anxiety counts as positive affective engagement. Interestingly, no interviewee from both groups indicated that they did not feel any form of anxiety with Organic Chemistry content. Could this be linked to the nature of the topic, or could there be other more plausible reasons? Only one learner from Group 1

expressed that he did not feel any kind of anxiety. Interestingly, when asked to explain this 'outlier' response, Ntombi from Group 1 clarified that she was referring to the use of blended teaching. Even though this had nothing to do with Organic Chemistry, this idea that blended teaching did cause any form of anxiety is equally important by showing that anxiety did not add to list of confounding variables that may have influenced the study. Nevertheless anxiety, and frustration are linked to negative affective engagement.

5.3.6.2.2 Negative Version of Affective engagement

The data analysis of the data collected through the semi-structured interviews shows that Group 2, which was taught using traditional face-to-face teaching, had more interviewees that expressed a lack of enjoyment compared to Group 1 interviewees. However, the sources of the lack of enjoyment were varied. These included a general dislike of the nature of Organic Chemistry such as having too many notes and being too abstract, a dislike of interactions with classmates and the teacher, and failure to derive enjoyment from school-based activities. A general dislike for reading was also cited as another source of a lack of enjoyment. Given the counts of frequency of the enjoyment subtheme (or rather a lack thereof), it becomes more plausible that more Group 2 than Group 1 participants did not enjoy Organic Chemistry, as shown in Table V.2. When the reasons for this failure to enjoy Organic Chemistry were examined, the difference between the two groups in terms of affective engagement widens, as shown in the selected interview excerpts that follow. For example, the Group 1 teacher, Mr. Zulu, had this to say:

> *With the extra resources that I posted, I noticed that these learners were more into videos than the reading material. That's what I noticed with the learners that I started with in this programme. They preferred to watch videos than to read any another learning material.*

On the other hand, Ms. Nkosi, the Group 2 teacher mentioned something similar.

> *…but for most students, our students, most of them are spoon-fed, like spoon, spoon, spoon-fed so, even if you can give the person notes, as long as you didn't come in class and read their notes, they won't read by themselves…You rather say everyone take out your notes, take out your markers and pencils, then you walk around and say, "study your notes" You just need to be there, then that way you can see them being busy writing in their books, otherwise they don't.*

The common denominator between the two groups is that they both do not read notes. However, it is not clear as to whether Group 2 learners do not enjoy reading the notes, or

whether it is clear case of laziness, or a lack of language proficiency. However, it appears that preference for easy work sounds more plausible, given that while competition was encouraged in Group 1, more fierce competition appears have been happening among Group 1 learners. Based on this, the expectation would have been that learning engagement should have been drastically reduced in Group 1 instead.

In addition, not using notes appears to have been motivated by an alternative for Group 1 learners, which they found more preferable or more enjoyable. What is worrisome is that Group 2 learners did not read notes when they did not have an alternative source of information. One would wonder how they were able to answer questions in the learning activities. At least the Group 1 learners were using videos, even though they still need to use both. While the Group 2 teacher appears to imply that the learners do not put any effort, it can be disputed whether this was the correct assessment, given that some of the interviewees from this group said that the teacher's notes were difficult to understand, as pointed out under cognitive engagement. However, the same could not be said about notes from the Group 1 teacher, since one of the interviewees from this group, Ntombi, explicitly mentioned that she does not like writing notes. This shows that Group 1 learners were writing the notes themselves as opposed to being given notes by the teacher.

Most importantly, another factor that could have played a significant role in the general apathy for notes and reading in general could have been the limited proficiency in English, which is associated with learners from both groups. This raises questions as to the efficacy of using a language that is not the learners' mother tongue. In saying this, it is important to point out that this study does not wish to delve into the polemic on mother tongue instruction since doing that sufficient justice would lie outside scope of this study. Furthermore, some Group 2 interviewees also mentioned that they disliked the interactions with the teacher and with other classmates. The analysis of the data on the 'participation behavioural engagement' theme shed some light on this. However, it is important to highlight the point made by Fredricks et al. (2004), in which they assert that the three sub-constructs of learning engagement that this study focuses on tend to overlap. Keeping with this idea of overlapping sub-constructs means that affective engagement focuses on the emotional aspects only, and in this section, it becomes the negative emotions. Considering the discussions undertaken here, Group 2 learners appear to have exhibited a higher magnitude of negative affective engagement. Another aspect of the

affective engagement theme that appear to set the two groups apart is the concentration (or rather a lack thereof).

An analysis of the results in Table V.2 presented in Chapter 4 clearly shows that most Group 2 learners lacked concentration, which this study recognises as an important component driving the learning process. It can be argued that Group 1 learners were concentrating most of the time compared to Group 2 learners, given the frequency counts of failure to concentrate, which are shown in the table just mentioned. Having established that most of Group 2 learners were not concentrating, this study went further to ascertain the reasons that could be used to explain the observed disparity in keeping with the predominantly sequential explanatory design utilised in collecting the data, which was subsequently analysed. Interestingly, one would wonder whether the classroom context had anything to do with this. Among Group 2 learners this manifested itself in the form of poor classroom management skills. As shown in the interview excerpt that follows a lack of discipline, which was prevalent in some of the classes that belonged to Group 2. For example, Mary said the following:

> *I find it hard to focus while at school, and there is a lot of noise disturbing me. so, I found it hard to do my school at school.*

Still on the same note, Slindile added by saying the following:

> *Slindile: I would have concentrated more.*
> *Interviewer: Some of the lessons were chaotic or was it most of them?*
> *Slindile: Most of them, most of them.*

However, the image painted here appears to change when Sihle's (Group 2) comments are considered. He said the following:

> *I can say I was concentrating in class and studying more at home.*

It can be deduced that a lack of discipline was experienced in only one class out five, which is not enough to extrapolate these findings to the rest of Group 2. However, it cannot be denied that classroom discipline figures strongly as a predictor of learning engagement. This ensured that Group 2 affective engagement in terms of concentration is tipped to the negative zone. Group 1 learners therefore scored higher in this respect. The third important factor associated with affective engagement is anxiety.

To develop an understanding of how the interviewees from the two focus groups exhibited some form of anxiety, there is a need to examine the research findings in Table V.2. Notably, the relatively high frequency counts of anxiety shown in the table of results was pushed by

Group 2 interviewees, and there was not even a single contribution from Group 1 interviewees. It could be argued that the excitement of using online learning could have counteracted this anxiety, or alternatively this could be attributable to the context. Given that Organic Chemistry is generally perceived as a difficult topic, as noted previously in this study, it is not surprising that Group 2 participants indicated that they felt anxious. The triggers of the anxiety were also varied. These triggers ranged from unannounced tests, and the inability to understand Organic Chemistry concepts, to being afraid of making mistakes. This fear of making mistakes can also be conceived as a lack of confidence which was associated mainly with Group 2 learners.

Confidence has been identified as an aspect of affective engagement. In this study, confidence fulfils the function of a facilitator. As a facilitator of affective engagement, a lack of confidence levels was found to be at par in both groups as shown in Table V.2 considering the frequency of this subtheme. However, when the excerpts from interviewees from both groups on confidence are juxtaposed disparity in the confidence levels or a lack thereof begins to emerge. For example, Slindile from Group 2 indicated the following:

> *Interviewer: If you were asked to say, come to the school next year and say you've done grade 12, can you teach this class for us. Would you be able to teach Organic Chemistry?*
> *Slindile: Yes, I will, if uh uh, uh, and I would help the school if I am getting better at Organic Chemistry, then I will help them.*
> *Interviewer: But as it is, will you be able to do it?*
> *Slindilie: Yes, I'll try to manage it.*
> *Interviewer: You will try to manage it, but you are not that confident.*
> *Slindile: Yes* (with a heavy sigh).

Painting this scenario assisted in developing an understanding of what was being asked. Before drawing the comparison between the two groups, it becomes imperative that a quotation from the Group 1 interviewee (Zodwa) be provided.

> *I kept thinking "what if my answer is wrong?"*

While the questions asked were phrased differently, in both instances, it is important that they both relate to a lack of confidence. It is also evident that Slindile's responses were riddled with a lot of hesitations and repetition of words, which raises questions as to whether the interviewee was considering being dishonest. On the other hand, Zodwa's response does not show any attempts to tell lies. Furthermore, Slindile implied that she was struggling with Organic

Chemistry, while Zodwa was unsure of an answer that she wanted to write at some point, which shows an ongoing lack of confidence. The argument being presented here is that being less confident about an answer at some point is not comparable to persistent feelings of being incapable of being proficient in Organic Chemistry. Based on this analysis, it can be concluded that Group 2 learners exhibited a marginally higher level of lack of confidence. A lack of confidence may also result in being unable to utilise opportunities created to ask and answer questions with a view to improve learning.

In this study, opportunities to ask and answer questions are presented as an aspect of classroom context, which influences affective engagement. Failure to create such opportunities may result in learners being unable to test their ideas and to clear misconceptions. This disparity between groups 1 and 2 is attributable to the teaching methods employed. Reasons for the absence of such opportunities were three-fold. One interviewee mentioned time constraints, while another one blamed the absence of chance opportunities to ask questions, and for another, it was an inability to understand Organic Chemistry. The interview excerpt that follows serves as evidence to show that indeed opportunities to ask and answer questions were lacking.

> *Interviewer: Okay, sometimes it does happen that you don't understand all the, the stuff but did you ask questions? Did you get a chance to ask questions?*
>
> *Rose: umm, I didn't get a chance to.*
>
> *Interviewer: So, there was not much time for you to ask questions, even though you had questions to ask?*
> *Rose: Yes.*
> *Interviewer: Ok. Did you get a chance to answer some of the questions?*
> *Rose. Sometimes, if it's something that I understand.*

Judging from what said in the interview excerpt it appears that for Group 2, opportunities to ask and answer questions were not available due to time constraints however, the same interviewee could only answer questions a few when she understood the work. It can be deduced from what the interviewee said that there were many situations in which she failed to understand the Organic Chemistry concepts. The fact that the interviewee was from Group 2, the reason based on time constraints could be a plausible one because there was no use of technology to assist with grading of homework and some of the time was lost when the teacher

was reading notes with the learners. There is also a chance that this interviewee was from the class where there was general ill-discipline, which meant that the teacher spent a considerable amount of time dealing with these disciplinary problems at the expense of teaching. However, the three ill-disciplined learners were advised to leave the school, after which the normalcy was restored in that particular class. In addition, a noisy class does not offer a learning environment that is conducive to learning. Considering the need to address physiological needs was rated as fundamental need it becomes difficult to expect learners to progress to higher levels such as safety, self-esteem, and self-actualisation. In summary, it appears that more opportunities to ask and answer questions were created in Group 1 compared to Group 2. Even so, there appears to be a relationship between opportunities to ask and answer questions and individual learner needs, such as a feeling of belonging given that both issues form a part of the classroom context as noted previously.

Based on this, an absence of these opportunities to ask and answer questions appears to be positively correlated with a diminished sense of belonging. Sense of belonging appears to be an important aspect of affective engagement, judging from its frequency count. Just like confidence, it also has the potential to assume different roles such as that of an indicator of learning engagement or a facilitator of affective engagement. Once again, this idea requires further testing, through more extensive research. Having said this, it becomes important to analyse data on sense of belonging (or a lack thereof) with this subtheme under the umbrella of facilitators of learning engagement. Interestingly, given that the frequency counts of a lack of sense of belonging appears to be on par, as far as the two groups are concerned. However, the reasons that were advanced for this diminished sense of belonging are not entirely the same. Moreover, the only one reason related to unhealthy competition could be identified in Group 1, but in Group 2 two reasons could be identified. These Group 2 reasons relate to outright exclusion or isolation, coupled with efforts to make life difficult for other learners and the preference of learners from other schools. The excerpts from the interviews clearly exemplify the diminished sense of belonging in each of the two groups. For example, John had this to say:

> *Interviewer: Would you say you feel like you belong to your class?*
> *John: Eish! I think there is a huge gap between my classmates and me. Sometimes they don't want me to help them.*
> *Interviewer: That's strange-why wouldn't they want to be helped by you?*

John: My classmates think more highly of themselves-they think they are better than everyone else. I think it's because of competition.

It can be deduced from what John said that he does not feel like he belongs to the class and holds this perception that he is vastly different from the other learners in his class. Secondly, the idea that his classmates are reluctant to receive help from him raises a lot of questions, but he thinks it is due to unhealthy competition, which led to other learners to become arrogant. While John's evaluation of the situation appears plausible given that another interviewee, Ntombi also echoed similar sentiments. These claims require further research. Ntombi had the following to say:

Ntombi: For me this does not help, because of this thing of arguments and not respecting each other.

Interviewer: Given what you have said, do you feel you are a part of the class?

Ntombi: For me, this does help, because of this thing of arguments and not respecting each other.

Interviewer: Given what you have said, do you feel you are a part of the class?

Ntombi: No, I am not part of the class. I don't feel I am welcome because in class there are so many people competing with me when I am not competing with them. There are so many people watching me without me realising until someone says it. It is very tense.

Interviewer: Would you feel more welcome if there wasn't too much competition?

Ntombi: Yes. Instead of helping people grow as a group, it actually set people apart. Competition is supposed to be healthy and help us realize our weak points, but you end up fighting instead.

This corroboration of the idea of unhealthy competition being responsible for the diminished sense of belong more plausible. It is clear from this interview excerpt that Ntombi emphasised the harmful effect of intense competition. When Group 2 was considered a shift in the reasons began to emerge, as shown in what Jabu had to say:

Jabu: They are forming a group that excludes me and they are stealing my books. I am suffering now. They want to see me suffering. They are stealing my notebook, but I don't care, I continue studying at home using my study guide.

Interviewer: So, they are kind of making life difficult for you by doing these things.

Jabu: They want to see me struggling.

It appears that there is a concerted effort to make this interviewee (Jabu) isolated, unloved in addition making him suffer. It is not clear as to whether this is only meant to isolate him given that the notes that were stolen were the main source of information. While this situation is clearly baffling, it cannot be denied that this interviewee (Jabu) does not have any sense of belonging to the class where the classmates are so unwelcoming to say the least. However, this isolation could not be corroborated by his peers, since Slindile from the same group (Group 2 mentioned that she prefers to work with learners from other schools as shown in the excerpt that follows:

> *Uh we can also work maybe with learners from other schools, and then we can work amongst ourselves only as learners, because I find it very easy for us interacting with other learners. since we understand each other very well than when there is a teacher*.

It could be argued that Slindile does not feel accepted by her own classmates and is now looking to connect with learners from other schools. In summary, both groups would benefit from reconfiguring the classroom context to ensure that all learners feel that they belong to the class with a view of improving learner engagement. Interestingly, Jabu from Group 2 raised another very important point, which best captures the Quintile 1 South African schools, when he stated the following:

> *I am feeling comfortable because if I consider doing another subject there is no one that can help me because I am not staying at home. Even if I am staying at home no one can else can help me because my older brothers did not finish school-they did not end up in matric. Will continue to take my Organic Chemistry because it helps me to forget about my struggling problems and when I get to school, I try to ask the teachers.*
>
> *The other problem that I am facing this year is that I lost my mother-in June. I am not staying at home but on weekends when I am not attending school, I am going home to check on my family… I am the fourth born at home. My first born of my mum left the school without a matric certificate and the second born also leaving the school without matric and the other one left school in grade 9. I'm the only one arriving in matric.*

This interviewee (Jabu) clearly does not appear to a have strong support system, and the whole family is looking up to him. What made his situation worse was that other learners were isolating him and making it difficult for him to concentrate. The idea of learners staying alone (away from home) was also confirmed by Ms. Nkosi, who was teaching Group 2 when she was

bemoaning the availability of few options of disciplining the learners. The same teacher also highlighted the learners are bored.

The sources of boredom identified by Ms. Nkosi can be described as relating to the prevailing contextual factors, which were a result of the impact of the third wave of the COVID-19 pandemic as shown in the excerpt that follows:

> *Yes, for now, yes, for now, I can say that they are a bit bored for now, because it's not that interesting… they are demotivated that I don't want to lie. I just wish at some point. Uh, the country focuses on them to say, let's focus on our education - can we motivate our kids. As much as we do a lot of planning and say they must study, they must do this, but if these kids are not motivated, we are not doing anything.*
>
> *And another problem this year, is because of covid, they're constantly getting sick. So, today this one is present tomorrow, the other one is absent. uh, this one is present to talking about, stop uh absenting yourself. no, they, they will come. but to remember there were others that were not present. Absenteeism is a problem. They will be just giving each other a chance to be absent. uh uh since then they even using it to their advantage.*
>
> *We are losing teachers. And uh for now, it's really s hectic, it's hectic. If I were to say very nice things, I would be lying to you. It's hectic.*

This general outlook was blamed for the boredom, which resulted in absenteeism. The teacher added that there is nothing positive being communicated of late, as all the learners see on television is death rates (due to COVID-19) and protests (July unrest of 2021) as well as the rolling electricity blackouts. Closer home, some teachers who were teaching at the school that was used as a research site also succumbed to COVID-19, which made the situation all the more dire. Considering the argument presented here, boredom as an aspect of affective engagement could have played a significant role in this study. However, there is a need to highlight the fact that absenteeism as a problem was experienced in both Group 1 and Group 2, which makes it impossible to use it to explain the disparity in the cumulative learning engagement and academic achievement. For example, Mr. Zulu had the follwing to say:

> *The offline App mitigated the problem - that one I totally agree with it. The thing is, if a learner is absent when you are refreshing, then the learner will not be able to access. The major problem was those learners who are frequently absent. I used to allow learners to refresh their content during the lesson but*

those who were absent during the lesson would then have to find time come and do so, but the problem was that such learners would not come to school, which was another challenge.

Even though boredom was not highlighted as a major problem in Group 1, it can be argued that absenteeism and failure to make effort to refresh the App by a few learners could as well have been a result of boredom. Moreover, the problems that were said to be internalised by Group 2 learners, which included the impact of the third wave of COVID-19, also affected the Group 1 learners. In summary, negative affective engagement appears have been higher among the Group 2 learners, judging from the results pertaining to the sub-themes or aspects of affective engagement. However, there were situations where participants exhibited more of the mixture of both positive and negative affective engagement (discussed in more detail hereafter).

5.3.6.2.3 Mixed affective engagement

Some of the data collected using semi-structured interviews could not be classified as either completely negative affective engagement, or positive affective engagement, giving rise to the third category of affective engagement, which in this study is being referred to as mixed emotional engagement. Interestingly, this category does not appear to have many facilitators as only two could be identified. Of these two sub-themes, frustration appears to exhibit more of the mixed affective engagement. Even more interestingly, Group 1 has the highest frequency of frustration that was more mixed, while nothing that resembles a mixture of both negative and positive affective engagement could be identified in Group 2 responses. At this point, it is important to highlight that evidence of a lack of frustration (positive affective engagement) could be identified in neither of the two groups. However, evidence of frustration (negative affective engagement) was only identified in Group 2. Given this, it can be concluded that Group 1 fared better in terms of frustration. The reason being that the existence of a mixture of both frustration and a lack of it is more plausible can be regarded as better than having learners that are on the negative extreme. One example is what Ntombi said:

At first learning Organic Chemistry was frustrating but as time went by, I got used to it. I used different types of memorising the work.

Similarly, Lindiwe also said something that resembles Ntombi's response as shown in the excerpt that follows:

Interviewer: You indicated in the questionnaire that Organic Chemistry was sometimes frustrating. Can you please explain a bit on that?

Lindiwe: At first, I found Organic Chemistry frustrating.

To be honest I wasn't enjoying the topic. It had a lot of work, and I would be lazy to study but as time went on, I found this topic was great and interesting.
Interviewer: Were you finding it difficult?
Lindiwe: I was taking it lightly.

There were many such responses in which the interviewees from Group 1 responded in a similar vein. It is evident from these responses that Organic Chemistry was initially frustrating, but the frustration eventually diminished or disappeared. Considering Lindiwe's response, it confirmed Fredricks et al.'s (2004) assertions that learners generally perceive schooling as a means to obtain favourable grades only and that most learners would like to achieve these favourable grades with minimal effort. There is a chance that this could have triggered the initial frustration, which then diminished or completely disappeared when they realised that they had to put in effort, although it is debatable as to whether memorisation is an effective form of learning. Memorisation is viewed as being at lower end of the spectrum when learning engagement quality is considered. As noted by Fredricks et al. (2004), cognitive engagement ranges from memorisation to in-depth learning. However, emotions such as frustration still play a crucial role in determining the extent to which a learner engages. Also included in affective engagement is anxiety.

Anxiety as a negative emotion does not always exist, as shown in this study, resulting in a mixed version, in which the learner report being anxious, and in other cases, where anxiety does not exist. In this study, both Group 1 and Group 2 showed evidence of this mixed version of anxiety. Interestingly, the frequency counts of this variable form of anxiety was the same in both groups 1 and 2. Similarly, the sources of this variable form of anxiety were also uniform across the two groups. For example, Zodwa (Group 1) said the following:

At first, I thought it was going to be hard, but as time went by, I saw that it was small things that were giving me problems… this triggered anxiety, but it didn't last long.

It can be deduced that anxiety was initially triggered by the perception that Organic Chemistry was difficult, but it then disappeared after realising that she was making minor mistakes. On the other hand, Mary (Group 2) had this to say:

When I'm going to do my school activities, and if I'm struggling to understand the question. And oh, I feel so, so unsettled.

Once again, the emphasis expressed here was on failure to understand the work on Organic Chemistry. It is important to note that the interviewee said, "if I am struggling", which shows

that the learning struggles were not ongoing, and anxiety was therefore felt periodically as well. In summary, most of the facilitators of affective engagement did not fall in this category (of mixed affective engagement) as most of them were generally positive in Group 1, and negative affective engagement in Group 2. As a result, it can be argued that Group1 learners generally exhibited marginally higher levels of affective engagement when compared to Group 2 learners. This could mean that blended teaching might have been able to foster slightly higher levels of emotional engagement. Based on what Mary stated about being afraid of making mistakes, questions on the classroom social climate cannot be avoided. It appears the classroom social climate is not being attended to as far as Group 2 is concerned. The conclusion was arrived at considering that blended learning environment would qualify to be called a complex learning environment, but affective engagement was found to be marginally better (more positive).

Based on this analysis, affective engagement was found to have significant moderating effects on the relationship between blended teaching and academic achievement. Furthermore, the association between affective engagement and cognitive engagement appears to be self-evident, considering what Fredricks and colleagues said about social context versus negative affective engagement. In addition to this, it can be concluded that affective engagement has an effect on achievement, which confirms the hypothesis related to the second research question in which blended teaching is expected to foster higher levels of learning engagement. Additionally, anxiety and other negative emotions may affect participation behavioural engagement (discussed hereafter in detail).

5.3.6.3 Findings on participation behavioural engagement

5.3.6.3.1 Positive participation behavioural engagement

Based on Table X.1, positive version of participation behavioural engagement frequency counts for Group 2 slightly surpassed that of Group 1, respondents which was clear opposite of the research findings on cognitive engagement and affective engagement. The mixed version of participation behavioural engagement showed a somewhat similar trend as shown in

	Group 1-Blended teaching (Experimental)		**Group 2-Traditional face-to-face t**	
Theme	**Sub theme**	**Code match and frequency**	**Sub themes**	**Code mat**

Mixed participation behavioural engagement	Sharing of ideas	1. Learners only wanted to contribute while they are in class but not online. **(E-7)**	Sharing ideas/information exchange	
	Debating			
	Groupwork/discussions	Few online discussions **(E-7)** In-class learner-learner interactions improved. **(E-7)** Interactions limited to during the lesson.	Groupwork/discussions	1. Sometir **)** 2. Few in lessons 3. Someti classmates noise 4. Teacher 5. Teacher
	Helped by others at times		Helped by others at times	

Table X.3. However, an analysis of the data illustrated in Table X.2 shows that the negative version of participation behavioural engagement was slightly more prevalent in Group 1 compared to Group 2 based on frequency counts of the theme. Based on this, the overall participation behavioural engagement could have demonstrated a marginally higher level in Group 2, which is line with the quantitative data already presented in this section of the study. The research findings will be used to address research Question 1 combined with research Question 4 in which research Question 4 was used to provide further explanations, which motivated the use of a predominantly sequential explanatory design.

It can be deduced from Table X.1 that Group 2 learners appear to have shared information related to Organic Chemistry more than Group 1 learners, judging from the relative frequencies of this particular subtheme or facilitator. This was an unexpected trend considering the previous trends in which Group 1 was mostly faring better compared to Group 2. However, it is important to highlight that interviewees from Group 2 did not explicitly mention that they shared ideas or exchanged information, but all of them mentioned that they worked with classmates particularly when they were doing homework. While this is so, the assumption that

they were sharing ideas or exchanging information is a plausible one. Considering that these Group 2 learners worked together after the lesson. An excerpt of the interview with Ryan (from Group 2), which follows clearly shows that learner interactions were restricted to after school time.

> Interviewer: *When you look at the way you were working with you during your lessons. Did you get a chance during the organic chemistry lessons to work with your classmates?*
>
> Interviewee: *Yes, we did, like after school.*

While this interview excerpt seems to show that the learner interactions in Group 2 mostly happened after the lesson, it is important to highlight that learner interactions were indeed happening. Interestingly, in Group 1 most of these learner-to-learner interactions were mostly happening during the lesson. For example, Zodwa from Group 1explicitly mentioned that she shared ideas with her classmates as shown in the excerpt that follows:

> *We share information, and we talk generally-we share information about Physical Sciences.*

Based on the excerpt, it is clear that the sharing of ideas also happened in Group 1, but just like in Group 2, but Mr. Zulu, the Group 1 teacher clarified Zodwa's statement by indicating that the learners worked together during the face-to-face lessons as shown in the interview excerpt that follows:

> *...the learner-learner interactions inside the classroom did improve, because these learners were coming from different backgrounds in terms of their understanding of the concepts that they developed on their own so, there was an improvement of the learning engagement inside the classroom.*

In summary, Group 2 learners worked together after the lesson while Group1 learners shared ideas during the lesson. Even so, positive participation behavioural engagement was evident as far as sharing of ideas is concerned. Furthermore, it can be concluded that participation behavioural engagement in terms of the sub theme sharing ideas was marginally higher in Group 2. However, questions as to whether these learner interactions were meaningful cannot be avoided ,which requires that the quality of participation behavioural engagement be ascertained. Moreover, when the Group 1 learners were not interacting they were engaging in independent work which reslted in the formation of concepts when they were working online. This assertion is based on the idea that the interviewee, Mr. Zulu indicated that there was sufficient evidence to show that they were working individually. Mary (Group 2) indicated that

the work done in class was more difficult, and that fewer interactions with peers made it worse as shown in the interview excerpt that follows.

> *Interviewer: So, would you say, the homework that you did away from school was more difficult than what you did in class? would you say that?*
> *Mary: yes, less difficult.*
> *Interviewer: It was less difficult but then when you got to class, you were doing more difficult work?*
> *Mary: Yes, it was more difficult work.*

To fully understand the point being advanced here, it is important not to forget that it has already been demonstrated that in-class learner interactions were few or non-existent in Group 2. While it has been proven beyond any reasonable doubt that learners in both groups exchanged information or shared ideas, it must be emphasised that this was not always a case of mutual benefit, as there were situations when learners received help from others.

As shown in Table X.1 of Chapter 4, learners being helped by peers appears to be at par in both groups, judging from the equal frequencies identified. However, it appears most Group 1 learners asked for help from other learners mostly during the lesson, as shown by what Peter (Group 1) said, which is as follows:

> *Some questions I struggled with them so, I got opportunities to ask the teacher and to ask my classmates during the lesson.*

It is not yet clear why this interviewee did not ask for help on the discussion forum (away from school) rather than wait for the face-to-face lesson scheduled for the day that followed. On the other hand, Slindile (Group 2) mentioned the following:

> *Yes, after school, and we usually have extra classes after school. And we sometimes help each other there.*

It is clear from what Slindile said that there were extra lessons happening and that the learners were helping each other there as well. Furthermore, it is also clear that any help from other learners could not have be secured during the normal in-class school activities in Group 2 either. Conversely, help from other learners could be secured during after school activities in Group 1. Closely related to working with classmates is the idea of working in groups.

The Group 2 teacher, Ms. Nkosi indicated that the learners form groups after school and that sometimes they work in groups when they have been given a difficult question to answer. The formation of the groups can be viewed as placing emphasis on the idea that construction of knowledge demand that learners work together (interact socially) collaboratively. However, amongst Group 2 learners there were instances when groupwork was done during the lesson even though the frequency was low based on the learners said. Conversely, Group 1 learners mostly did groupwork during the lesson. This points towards a marginal increase in the incidence of groupwork in Group 2. Mr. Zulu (Group 1 teacher) also confirmed that learners worked in groups during the lesson only. In summary, Group 1 seems to have fared slightly better in terms of groupwork although the perceived difference looks marginal. Furthermore, analysis of data shed some details on how learners worked with peers and more specially, the use of debates.

One of the Group 1 interviewees specifically mentioned she engaged in debates with her classmates. Conversely, none of the Group 2 interviewees specifically mentioned anything to do with debating issues related to Organic Chemistry. For example, Lindiwe (Group 1) had this to say:

> *…and debate about the questions and come up with the correct answers…*We shared *ideas, and stuff. We agreed and disagreed.*

There is no doubt that Group 1 learners engaged in debates given that the interviewee quoted here (Lindiwe). Lindiwe went further, and qualified what she meant when she mentioned they debated questions by indicating that they *'agreed and disagreed'*. However, this study argues that these debates need not be restricted to the blended learning settings, as they should be an important aspect of traditional face-to-face teaching setting too. This is much more likely because the learners engaged in debates after they had already attempted the work independently when they worked online. However, since these debates were only restricted to the traditional face-to-face component, it can also be argued that the frequency was lower when compared to Group 2 interactions, which happened after lessons during the learners' own spare time, where there were no restrictions of time and during the extra lessons, as well as occasionally during the normal lesson. In summary and for a change, Group 1 learners appear to have scored higher as far as debates are concerned. However, overall positive participation behavioural engagement appears to have been higher in Group 2 than in Group 1, based on the relative frequencies, although there is a need to analyse data on the negative version of participation behavioural engagement. Despite this, in terms of quality of the participation

behavioural engagement, Group 1 appears to have fared better than Group 2. When the quality aspect is considered, coupled with idea that Group 1 also fared better in groupwork or discussions, and in addition that the two groups were fairly equal in terms of sharing of ideas, it could be argued that Group 1 could have still fared better than Group 2. However, this positive behavioural engagement cannot be looked at in isolation, there is a need to examine the negative participation behavioural engagement.

5.3.6.3.2 Negative Version of Participation behavioural engagement

Of the four subthemes that were considered were the absence of groupwork, or discussions has the highest frequency. Interestingly, Group 1 accounts for most of the absence of groupwork/ discussions that were mentioned during the interviews. This does not come as a surprise, considering what some the Group 1 learners said about groupwork. For example, Ntombi mentioned the following:

> *I am not a group person. I don't go to a classmate when I have a problem. I prefer to work on my own… I don't see this group thing working for me.*

It is clear from what the interviewee (Ntombi) said that she does not see any value in groupwork nor wonder she prefers to work alone. Furthermore, she made it noticeably clear that she would never work with another classmate. However, it became apparent during the analysis of what this interviewee went on to say, which is as follows.

> *Interviewer: Are there any of your classmates that are working in groups?*
> *Ntombi: They are there, but there is no group that lasts-by the end of the week nobody from that group will be talking to each other.*

Given the excerpt of the interview with Ntombi, it became clear that groupwork was not entirely absent in Group 1, but that there happens to be learners in Group 1 that do not like to participate in groupwork. It can also be deduced that these groups kept changing, which is not per se deleterious, but does lead to the splitting or dismantling of groups. What also makes the situation dire is the idea that the rate at which these groups are dismantling, which is on a weekly basis. This raises questions such as: If these groups are dismantling at such a high rate, how long would it take a class of 18 to 22 learners before they have fought with each other thereby making it difficult to work together within a short space of time? This could have made learners such as Ntombi resort to working alone. Interestingly, there appears to be a direct link between the absence of a sense of belonging (negative affective engagement) and reluctance to work in groups.

Furthermore, what complicates Group 1 learner-to-learner interactions is that they were mostly happening during the lesson (face-to-face component of the blended learning cycle). In addition to what Ntombi reported, Peter (Group 1) also indicated that he prefers to work alone. In summary, Group 1 did not fare well in terms of groupwork, which provides an expectation that Group 2 would be expected to better in this respect and most likely in the overall participation behavioural engagement. One reason advanced by Peter and Ntombi was that of unhealthy competition, which has already been discussed in this study under negative affective engagement. However, several reasons advanced to explain can this grim picture painted here as far as participation behavioural engagement is concerned. When the issue of groupwork was raised with Group 2 teacher, some interesting points were mentioned. For example, Ms. Nkosi pointed out the following:

> *I am not sure about learner-to-learner interactions during organic chemistry. Aargh, argh, oh yes, what I see the most is more girls grouping themselves. yes, then another thing. Um, that I have noticed in organic chemistry, I have most girls participating, more than boys. Yes, most girls are participating in Organic Chemistry. More girls are interested in Chemistry than boys, then most boys are reluctant, and then you find these good ones, you know, the top learners in class are bored by Organic Chemistry. I don't know why.*

What the Group 2 teacher said implies that learner characteristics such as gender (or more specifically being female or male) and level of competency in the subject appeared to play a central role in determining whether learners engage in groupwork or not. Interestingly, since the learners that were coping better with Organic Chemistry were said to be reluctant to participate, it raises questions about the performance of the girls who were more active in class. The implication here is that the girls were struggling with Organic Chemistry. Furthermore, all the Group 2 girls that were interviewed stated that they were struggling with Organic Chemistry. One example was Slindile, who said the following.

> *Some of us are struggling. We did not get much time with her* (the teacher) *because of the situation* (COVID-19); *we did not get much time with her.*

What Slindile states here appears to indicate that girls were struggling more than the boys. In addition to this the COVID-19 could have made the teaching and learning of Organic Chemistry more difficult, particularly for the girls that would have benefitted from interactions with the teacher. However, this would raise the question as to why Ntombi, who is a female learner from Group 1, appears to show a direct opposite of what Ms. Nkosi said. Could this

difference be attributed to the differences in the teaching approaches employed? There is a fair chance that the use of blended teaching could have made the Organic Chemistry easier. If so, then blended teaching was effective during the deadly third wave of COVID-19. However, considering the learners' performance level in Organic Chemistry (as indicated during the interviews), it becomes more plausible that the struggling learners appear to value groupwork more. Despite this seeming corroboration, there is a need to carry out further research on the claims made here.

Having said this, it is important to highlight that this study does not mainly focus on classroom contextual factors. However, these contextual factors appeared to be at play when the 'sharing of ideas' and 'being helped by others', or rather a lack thereof, was considered.

Interestingly, based on Table X.2, Group 1 learners were less open to helping one another when a comparison between the two Groups was drawn, which focused on how many times this phenomenon could be identified. It is evident from Table X.1, which focused on positive participation behavioural engagement, that Group 2 learners openly indicated that they were receiving help from other learners, which made the work done after school less difficult. On the other hand, some Group 1 learners did not like this kind of help. Here it becomes important to critically analyse Peter's (Group 1) sentiments on helping other learners which follows:

> *Interviewer: Did you get many interactions with your classmates?*
> *Peter: Not that much. I think they are scared of asking me questions. I tried pushing them and they told me to leave them alone.*

It can be deduced that Peter wanted to offer help, but that the classmates that he was trying to help were pushing back. Peter explicitly indicated that he did interact with his classmates that much, because he felt that they were not at easy to ask him questions. The situation painted here is a complicated one in the sense that Peter appears to be unapproachable to his classmates while at the same time wanted to help them. On the same note, John raised the same points as Peter when he said the following:

> *…and I would like more interactions with other learners…The problem of learners in my class is that they do not want to be helped.*

This complicated situation shows that John wishes he had more interactions with his classmates, but this would have meant that he would have to help them, but the classmates were not open to getting this help. However, it is also evident that Peter and John did interact

with classmates, even though they would have liked these interactions to be more. On the other hand, Zodwa had the following to say,

> *My classmates do not like to assist others.*

On the same note, Ntombi indicated that she does not seek help from other learners and only prefers to ask the teacher questions. It could be argued that the situation at play here is that of learners that are too prideful to ask for help from their peers, which could have been a result of the perception that they know everything. This shows a classroom that is riddled with the desire to outperform everyone, while at once creating the false impression that they are managing and therefore they do not require any help from another learner. This reluctance to get help could have compromised their performance leaving a situation, where John and Peter feel their peers need help. The situation described here raises several questions. Group 1 was exposed to blended learning, which included online learning. The question may be asked, could this have resulted in the sense that they could do it on their own? Secondly, could it have been a situation of competition which has already been flagged as a potential explanation? Thirdly, could it have been a case of the learners in need of help being afraid of exposing themselves for fear of being labelled as less capable? Could it be case of the teacher failing to actively build a community of learners in which information is shared freely and helping one another? Furthermore, could this classroom situation be the result of bigger forces at play at global level operating at the grass roots level, in which schooling, starting with but not limited to grading, is riddled with unnecessary competition? (Westbury, 2000). The question just appears to be more plausible, given that Ms. Nkosi (Group 2 teacher) promotes the idea of learners competing when she said the following:

> *I keep them interested and engaged. So, I make it like a competition during class.*

Whatever the case, these Group 1 learners appear to have internalised the need the to compete at all costs. This is counterproductive, mainly because it impacts negatively on participation behavioural engagement. Based on this, the negative impact of competition on learning engagement appears to be more plausible. Another aspect of participation behavioural engagement, which figured strongly in Group 1 was the absence of the sharing of ideas.

As noted previously, more Group 1 learners were reluctant to share ideas with peers except during the times when they were debating answers. While on this note, it becomes important demonstrate why Group 1 learners exhibited a lack of the willingness to share ideas. In this

respect what Ntombi (Group1) in she stated the following claims shows a situation in which relations among peers have been strained due to competition.

> *I never got to share most of my ideas, because when you are in a class because it is difficult when you are in a class with too much competition-everybody will be looking down upon you. Nobody is taking you seriously because every time they are thinking they are better than everybody else. Everybody is making themselves feel better. I never had a chance to say something, write something on the board and explain it, never!*

It is clear from what this interviewee (Ntombi) noted that she wanted to share her ideas, but she was prevented from doing so by the classroom environment in which competition was intense. It could be argued that this interviewee did not get an opportunity to test her ideas from which the rest of the class could have potentially benefitted. Even if the ideas were incorrect the teacher could have corrected since he (Mr. Zulu) as indicated in the excerpt that follows:

> *I would then restructure what the learner said to make it more accurate.*

The sharing of ideas was meant, therefore, to provide learners with opportunities to improve accuracy of their information, which Ntombi could not do. Furthermore, it can be deduced that this situation was not a once-off event, but something that was ongoing, which emphasises its severity. However, considering positive version of participation behavioural engagement which has been discussed, it became clear that not all learners in Group 1 were experiencing this kind of hostility, which makes Ntombi's experiences more of an 'outlier' or exception. However, on this basis, the importance of a classroom context in which all learners feel free to participate and are respected by peers cannot be understated. While sharing of ideas was considered important, another aspect of participation behavioural engagement, viz. debating was clearly absent in Group 2.

In a bid to develop an understanding of what happened during the lesson in Group 2, there is a need to examine what Slindile noted, which is as follows:

> *We were only interacting with the teacher during school hours, and then they give us some time for us to practice alone, so that we can understand it.*

When Slindile's sentiments were analysed, a clear picture of what was happening during the lesson in Group 2 emerges. Slindile summed it all up when she clearly mentioned that she did not work with classmates during the lesson. Additionally, the situation described here is a clear case of a lecture method being employed, followed by individual work. Considering that only individual work was happening here, it can be concluded that no debating took place in Group

2. In summary, in terms of the absence of the sharing ideas, groupwork, and helping other learners, Group 2 scored marginally higher than Group 1, even though there is a possibility that Group 2 learners did not engage in debates based on Organic Chemistry. This shows that the negative version of participation behavioural engagement appears to have been slightly more prevalent in Group 1 compared to Group 2, which was more of an unexpected finding. Nevertheless, it is in line with the quantitative data analysis. Based on this, even though there is a need to critically analyse the mixed version of participation behavioural engagement, so far, traditional face-to-face teaching appears to be more effective in fostering learning engagement in terms of participation behavioural engagement.

The effectiveness of blended teaching in this regard remains in question, particularly as far as the first research question is concerned. The first research question sought to determine the effectiveness of blended teaching (compared to traditional face-to-face teaching) in fostering learning engagement. However, when the second research question is considered, it becomes difficult to state that traditional face-to-face teaching (compared to blended teaching) Thirdly, by engaging in debates Group 1 learners would be expected to have developed in-depth learning which is more effective. In short, the quality of participation behavioural engagement may have actually been higher in Group 1 than in Group 2. However, further research which pays particular attention to the quality of engagement by considering a wider range of the learning engagement continuum needs to be conducted in order to bring finality to issues such as the ones manifesting in this study. In keeping with the need to understand learning engagement as continuum, there is a need to critically examine responses that may not fit perfectly in the negative or positive aspects of participation behavioural engagement, which in this study is being referred to as mixed.

5.3.6.3.3 Mixed Version of Participation behavioural engagement

As shown in

	Group 1-Blended teaching (Experimental)		**Group 2-Traditional face-to-face t**	
Theme	**Sub theme**	**Code match and frequency**	**Sub themes**	**Code mat**

Mixed participation behavioural engagement	Sharing of ideas	1. Learners only wanted to contribute while they are in class but not online. **(E-7)**	Sharing ideas/information exchange	
	Debating			
	Groupwork/discussions	Few online discussions **(E-7)** In-class learner-learner interactions improved. **(E-7)** Interactions limited to during the lesson.	Groupwork/discussions	1. Sometir **)** 2. Few in lessons 3. Someti classmates noise 4. Teacher 5. Teacher
	Helped by others at times		Helped by others at times	

Table X.3, the subthemes, groupwork/discussions, and sharing of ideas were the most important aspects of the mixed version of the engagement with classmate based on their frequency. When the two groups are compared it shows that the groupwork/discussions sub-theme was more prevalent in Group 2 than in Group 1. This can be interpreted as showing that more Group 2 learners were working at times individually and in groups. For example, when asked whether she interact with the teacher or with other classmates after school, Mary (Group 2) said the following:

Uuumh, sometimes on my own, sometimes with my classmates.

Even though most of the Group 2 interviewees indicated that they worked with classmates afterschool, this excerpt shows that the participation behavioural engagement afterschool was not consistent for all the Group 2 learners. This paints a grim picture as far as participation behavioural engagement, considering that the chaotic classroom environment made it difficult for the Group 2 learners to do any meaningful groupwork, as pointed out earlier in this chapter. This classroom context was further exacerbated by the teaching approach adopted in which the teacher first explained concepts and then learners did individual work as pointed earlier in this chapter. Moreover, another interviewee, Jabu (Group 2) had the following to say:

Interviewer: So, after school do you have other learners that you work with?

Jabu: Sometimes because others are rushing to go home, while others say they are going for soccer training or to do something else.

This interview excerpt confirms the idea that some of the Group 2 learners did not work consistently with classmates all the time, even after school. As Jabu indicated, some of the learners were not available for groupwork, due to several reasons, which included playing soccer, or doing something else different. However, the Group 1 teacher, Mr. Zulu, indicated groupwork/discussions were mainly restricted to the face-to-face lessons. Mr. Zulu further emphasised that there were fewer online discussions among Group 1 learners. On this note, the following interview excerpt appears to paint a clear picture of how Group 1 learners approached their work.

Interviewer: You had to do activities away from the school premises. Did you work with friends on these activities?

Lindiwe: I had to do them alone and sometimes I wouldn't find answers.

The interviewee (Lindiwe), just like Jabu (Group 2) explicitly mentioned that there were times when she worked with classmates and there were times when she did not. This is undoubtedly a clear case of mixed participation behavioural engagement. The reasons given by Jabu appear to be related to the classroom context in which the lessons were disrupted. The teacher was also not available to facilitate the groupwork/discussions when she abandoned the learners on some occasions, due to what appears to be pointing towards poor classroom management skills on the part of the teacher. This finding appears to be consistent with the researcher by Fredricks et al. (2004), in which support from the teacher was identified as influencing all types of learning engagement. On this basis, it can be argued that teacher support was sometimes unavailable when the teacher abandoned the class due to the poorness of the classroom management skills, at least in some of the classes. Having discussed the groupwork sub-theme, there is a need to analyse findings relating to sharing of ideas.

It is clear from Table X.2 that few there were few instances when learners shared ideas online as shown by the Group 1 teacher, Mr, Zulu's statement, which is as follows.

...they would want to contribute something only in class, but not on the online learning platform.

It appears that the sharing of ideas was prevalent during the lesson compared to during online. This uneven sharing of ideas points towards mixed participation behavioural engagement. This could have due to an unfamiliar way of learning since the learners were using blended learning

for the first time. Alternatively, it could have been due to the idea that learners were not awarded any marks for participating in the discussion forum. While it appears as if there was nothing pointing towards the absence of the mixed version of participation behavioural engagement in terms of sharing ideas, it is must be noted that these Group 2 interviewees also contributed towards the negative participation behavioural engagement in several ways that have already been discussed. Given what was discussed here, it could be argued that, as far as mixed participation behavioural engagement is concerned, Group 1 scored higher based on frequency counts of the theme in question. Nevertheless, this difference between the two focus groups was also marginal. Whilst the responses of the interviewees were on learning largely on the three types of learning engagement and academic achievement.

5.4 Effectiveness of Blended Teaching on Academic Achievement

Research Question 2, which sought to address the effectiveness of blended teaching on academic achievement:

Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in fostering achievement in Organic Chemistry at Grade 12 in a school in South Africa?

As shown in the research Question stated above, the aim was to compare the effect of blended teaching with that of traditional face-to-face instruction on the achievement of Grade 12 learners studying the Organic Chemistry topic. This comparison was used to determine the effectiveness of blended teaching in fostering academic achievement. This meant that the average achievement of the two groups had to be compared and conclusions drawn based on the results thereof. In this section of the data analysis, Research Question 2 outlined above was addressed quantitatively only, using descriptive statistics followed by multivariate normality tests and detection of outliers (and their subsequent treatment) if any. Following this, inferential statistics in the form of t-tests were utilised since there were only two groups involved. This involved a comparison of the means to and t-tests to determine whether the means of academic for Groups 1 and 2 differed significantly or not. First and foremost, the descriptive statistics on academic achievement are presented.

5.4.1 Groups 1 and 2 Descriptive Statistics on Academic Achievement

Table 5.21 shows the descriptive statistics of Groups 1 and 2, which were illustrated in the same table side-by-side for easy comparison.

Table 5.21: Group1 Versus Group 2 Descriptive Statistics on Academic Achievement

y(KOOCT)	**Descriptive Statistic**	**Group 1**	**Group 2**
	N	100	100
	Mean	41.74	27.18
	Standard deviation	19.533	13.039
	Minimum	4	0
	Maximum	86	66
	Kurtosis	-0.471	-0.503
	Standard Error of Kurtosis	0.478	0.478
	Skewness	0.368	0.278
	Standard Error of Skewness	0.241	0.241

5.4.1.1 Interpretation

It can be deduced from Table 5.21 above that the mean academic achievement of Group1 is higher than that of Group 2. However, just like in the research Question 1, the t-tests still had to be conducted, in order to draw more substantive conclusions on the effectiveness of blended teaching on promoting academic achievement. Undertaking this statistical analysis required that the distributional requirements be determined. It should also be reiterated that undertaking the comparison of means for academic achievement played a key role in addressing the second question which sought to determine the effectiveness of blended teaching in fostering academic achievement. Having said this, the tests for normality of data on academic achievement for Groups 1 and 2 were undertaken in the section that follows.

5.4.2 Determining Multivariate Normality of Academic Achievement for Groups 1 and 2

5.4.2.1 Kolmogorov-Smirnov Test

The Kolmogorov-Smirnov test was undertaken first as it was more appropriate considering the sample size as indicated previously.

The hypothesis is as follows:

H_0: The data is normally distributed.

H_1: The data is not normally distributed.

Using a significance level of 5%

Table 5.22: Multivariate Normality Tests for Groups 1 and 2

	Kolmogorov-Smirnov		
	Test statistic	df	p-value
y(KOOCT) for Group 1	.076	100	.174
y(KOOCT) for Group 2	.089	100	.049

5.4.2.1.1 Interpretation

As shown in Table 5.22 for Group, the p-value =0.174 >0.05 therefore we do not reject H_0. Hence, y(KOOCT) is normally distributed. However, for Group 2 the p-value =0.049 <0.05 therefore there is sufficient evidence to reject H_0. Hence, y(KOOCT) is not normally distributed.

Furthermore, for the reasons stated in the previous section on learning engagement, the z scores for academic achievement were determined.

5.4.2.2 The Z-test scores for Academic Achievement for Groups1 and 2

The z scores for skewness and kurtosis are shown in Table 5.23 which follows.

Table 5.23: Z values of Skewness and Kurtosis

	$\lvert$Z-value of Skewness$\rvert = \left\lvert \frac{skewness}{standard\ error\ of\ skewness} \right\rvert$	$\lvert$Z-value of Kurtosis$\rvert = \left\lvert \frac{Kurtosis}{standard\ error\ of\ kurtosis} \right\rvert$
Group 1 y(KOOCT)	1.5270	0.9854
Group 2 y(KOOCT)	1.1535	0.9854

5.4.2.2.1 Interpretation

Both the z-values of the skewness and Kurtosis are within ±3.29. Therefore, the variables are accepted as being normally distributed.

5.5 Detection of Outliers

For the same reasons advanced previously regarding learning engagement, it became important that any outliers that may be in the data on academic achievement be detected. For the reasons advanced earlier box plots were used to detect any outliers in the data on academic achievement.

5.5.1 The box plots of the relevant variables

5.5.1.1 Academic Achievement

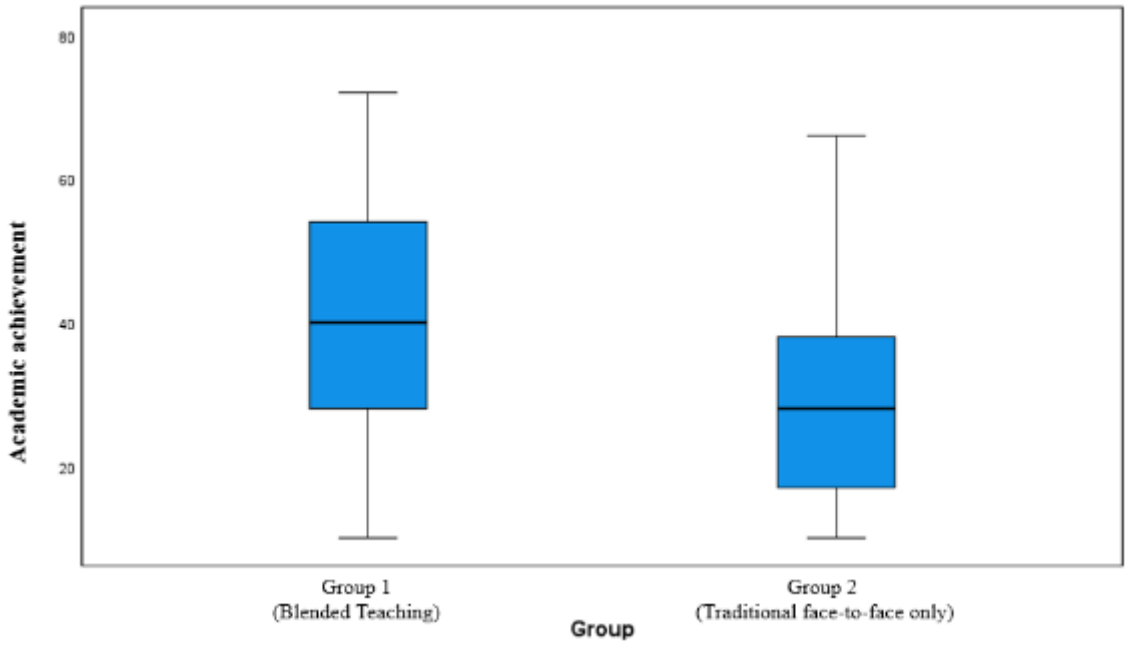


Figure 5.11: Box Plots of Academic Achievement

As shown in Figure 5.11 academic achievement score box plots showed no significant outliers for either group. As a result, no treatment of outliers was deemed necessary. Following this, the means for the academic achievement scores for the two groups were compared in section 5.5.1.2, which follows a bid to draw more comprehensive conclusions on the effectiveness of blended teaching on academic achievement.

5.5.1.2 Mean Academic achievement

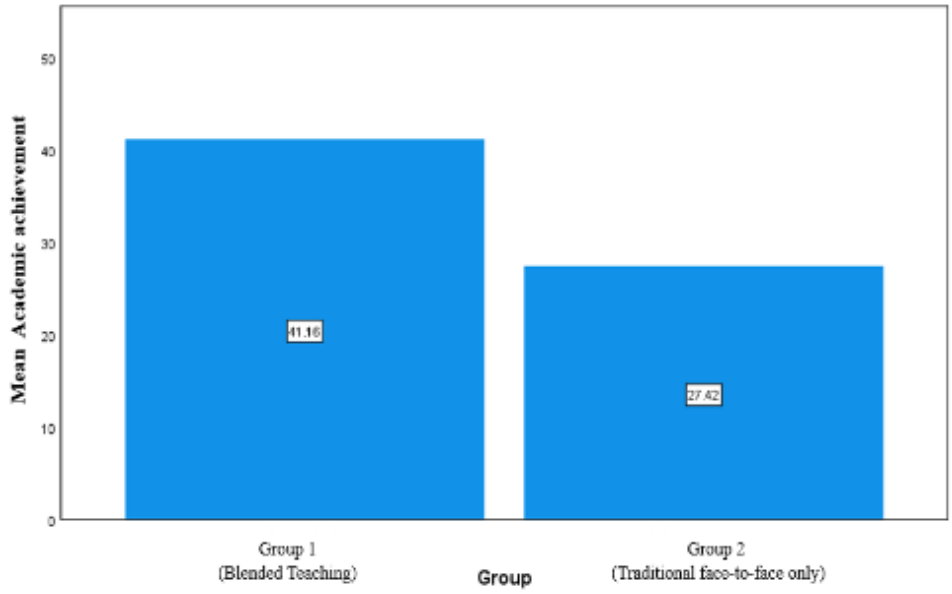


Figure 5.12: Bar Graph Comparing Academic Achievement Means of Groups 1 and 2

It is evident from Figure 5.12 above, that average Academic achievement for Group 1 is substantially higher than that for Group 2.

5.5.2 Determining effectiveness of blended teaching using T-tests

Table 5.24: T-test Comparing Means of Academic Achievement

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Significance One-Sided p	Significance Two-Sided p
Academic Achievement	Equal variances assumed	12.821	0.000	6.234	198	0.000	0.000
	Equal variances not assumed			6.234	177.429	0.000	0.000

5.5.2.1 Interpretation

The two-sided p-value=0 as shown in Table 5.24 and the p-value<0.05. This made it sufficient to reject the equality hypothesis of the two means. The average Academic achievement of the learners taught using the blended teaching method differs significantly from the average Academic achievement of the learners taught using the traditional face-to-face method. Furthermore, the one-sided p-value =0.00 and p-value<0.05. This value shows that there is sufficient evidence to reject the H_0 exists. Additionally, it can be deduced that the average Academic Achievement of Group 1 learners who were taught using the blended teaching method is higher than that of Group 2 learners, who were taught using the traditional face-to-face method. Most importantly, these t-test results were also used address the second Research Question on the effectiveness of blended teaching in improving academic achievement.

Based on the idea that blended teaching appears to have been effective in fostering learning engagement and at the same time promoting academic achievement, there appears to be a correlation between the two. However, questions on how blended teaching could have influenced academic achievement cannot be avoided. Given the possible correlation highlighted here it could be postulated that this could have happened due to higher levels of learning engagement experienced in Group. If this was the case, how did the learning engagement influence the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement? The need to examine the results of the moderated regression analysis cannot be over-emphasised.

5.6 Moderation Effects of the Learning Engagement Sub-constructs

Research Question 3: To what extent is the relationship between blended teaching (or traditional face-to-face teaching) moderated by each of the learning engagement sub-constructs in the teaching of Organic Chemistry to South Africa Grade 12 Physical Sciences learners?

This section sought to address Research Question 3 stated above using moderated regression analysis. The research findings are therefore presented. First and foremost, the correlations among the variables are examined as a requirement for moderated regression analysis.

5.6.1 Correlations

The Table 5.25 below illustrates the correlation matrix of the variables; Cognitive engagement, Affective engagement; Participation behavioural engagement; and Teaching Method (i.e., Group 1 – Blended Teaching and Group 2 – face to face Teaching).

Where Teaching Method = $\begin{cases} 0, & if\ Blended \\ 1, & if\ Traditional\ Face-to-face \end{cases}$

Furthermore, the following hypothesis test is conducted to determine the significance of a correlation.

H_0: the correlation = 0

H1: The correlations ≠ 0

Using significance level of 5%

Table 5.25: Correlation Matrix

		Academic Achievement	Cognitive engagement	Affective engagement	Participation behavioural engagement
Cognitive engagement	Pearson Correlation	.350**			
	Sig. (2-tailed)	0.000			
	N	200			
Affective engagement	Pearson Correlation	.365**	.784**		
	Sig. (2-tailed)	0.000	0.000		
	N+B14	200	200		
Participation behavioural engagement	Pearson Correlation	0.059	.482**	.477**	
	Sig. (2-tailed)	0.409	0.000	0.000	
	N	200	200	200	
Teaching method	Pearson Correlation	-.405**	-.163*	-.245**	0.043
	Sig. (2-tailed)	0.000	0.021	0.000	0.543
	N	200	200	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

It is evident from Table 5.25, that all the p-values for the correlations aside from the correlations between Academic Achievement and Participation behavioural engagement as well as the correlation between Teaching method and Participation behavioural engagement are less than 0.05. Hence, the correlations are significant, which shows that there is a presence of multicollinearity between the variables (Hayes, 2022). However, the correlation between Academic Achievement and Participation behavioural engagement and the correlation between Group membership and Participation behavioural engagement, with p-values =0.409 and 0.543 respectively >0.05 which makes these correlations

insignificant (Hayes, 2022). Notably, these correlations between Teaching method and Academic achievement, Cognitive engagement, and Affective engagement respectively, are all negative. This implies that there is a negative linear relationship between the traditional face-to-face teaching method and Academic achievement, Cognitive engagement, and Affective engagement respectively (Hayes, 2022). This further implies that Blended Teaching has a positive relationship with the above-mentioned variables thereby making Blended Teaching more effective (Hayes, 2022). The correlations discussed here were followed by moderation analysis to determine the significance of each of the three sub-constructs of learning engagement on the relationship between blended teaching (or traditional face-to-face teaching.

5.6.2 Moderating Effects of the learning Engagement Sub-constructs

This section of the data analysis aimed to determine whether there were any interaction effects that existed between any of the three sub-constructs of learning engagement and blended teaching (or traditional face-to-face teaching). This was in addition to determining whether these moderating effects (if any) were significant with a view to develop an in-depth understanding on how different learning engagement sub-constructs strengthened or weakened the relationship between blended teaching or traditional face-to-face teaching and academic achievement. Consequently, several moderations were conducted (Models 1 to 4). Model 1 had cognitive engagement only as the moderator, while Model 2 had two moderators, which were affective engagement and the second one being participation behavioural engagement. Model 3 tested for the significance of the moderating effect of affective engagement only. Furthermore, affective engagement and cognitive engagement were included in Model 4. The detailed results are illustrated in the tables included under each model. The interpretations are also discussed under each of these four models in order to develop an understanding of the significance of the moderating effects. While going through the table of results, it is important to take note of the fact that p denotes the p-values for the following hypothesis test for significance:

H_0: Coefficient or effect = 0
H_1: Coefficient or effect $\neq$ 0
Additionally, R squared values were used to provide an indication of the variation explained by each of the models. The results of Model 1, which had only cognitive engagement as the moderator, is discussed first.

5.6.2.1 Model 1

Outcome = Academic achievement, Predictor = Teaching Method (**X**) and Moderator = Cognitive Engagement (**W**) only.

Table 5.26: Model 1 Summary

R	R-sq	MSE	F	df1	df2	p
.5156	.2659	215.4826	23.6625	3.0000	196.0000	.0000

Table 5.27: Model 1 Parameter Estimates

	coeff	se	t	p	LLCI	ULCI
constant	-2.2596	8.7752	-.2575	.7971	-19.5655	15.0462
Academic achievement	16.5322	12.8779	1.2838	.2007	-8.8649	41.9293
Cognitive	11.9553	2.3821	5.0187	.0000	7.2574	16.6533
Int_1	-8.1334	3.6055	-2.2558	.0252	-15.2440	-1.0228

It is evident from Table 5.26, that there is a significant moderation as p-value=0.0252<0.05, therefore H_0 is rejected. As shown in Table 5.28, the R-squared = 0.2659; this implies that only 26.59% of the variation is explained by the model, which is adequate for 'real-world data' (since 0<R-squared<1), (Hayes, 2022). However, p-value=0.0000<0.05 as shown in Table 5.27, therefore there is sufficient evidence to reject H_0. Hence, Cognitive engagement is a significant moderator (Hayes, 2022). These results appear to mirror the trend that was observed during the t-tests and descriptive statistics and those from the qualitative data analysis which are presented in Appendices U.

```
Product terms key:
 Int_1      :            Teaching  Method  x
Cognitive engagement
```

Table 5.28: Model 1 Test(s) of highest order unconditional interaction(s)

	R2-chng	F	df1	df2	p
X*W	.0191	5.0887	1.0000	196.0000	.0252

```
----------
    Focal predict: Teaching method (X)

         Mod var: Cognitive engagement (W)
```

Table 5.29: Model 1 Conditional effects of the focal predictor at values of the moderator(s)

Conditional effects of the focal predictor at values of the moderator(s)

Cognitive engagement	Effect	se	t	p	LLCI	ULCI
3.0000	-7.8680	2.8272	-2.7830	.0059	-13.4437	-2.2924
3.4545	-11.5651	2.1189	-5.4582	.0000	-15.7437	-7.3864
4.0909	-16.7409	2.9341	-5.7055	.0000	-22.5274	-10.9543

Table 5.30: Model 1Moderator value(s) defining Johnson-Neyman significance region(s)

Moderator value(s) defining Johnson-Neyman significance region(s)

Value	% below	% above
2.8271	12.5000	87.5000

Conditional effect of focal predictor at values of the moderator:

Cognitive engagement	Effect	se	t	p	LLCI	ULCI
2.0000	.2654	5.8830	.0451	.9641	-11.3367	11.8675
2.1500	-.9546	5.3814	-.1774	.8594	-11.5676	9.6583
2.3000	-2.1747	4.8882	-.4449	.6569	-11.8149	7.4656
2.4500	-3.3947	4.4062	-.7704	.4420	-12.0843	5.2950
2.6000	-4.6147	3.9395	-1.1714	.2429	-12.3840	3.1546
2.7500	-5.8347	3.4942	-1.6698	.0966	-12.7258	1.0565
2.8271	-6.4619	3.2766	-1.9721	.0500	-12.9237	.0000
2.9000	-7.0547	3.0797	-2.2907	.0230	-13.1284	-.9810
3.0500	-8.2747	2.7101	-3.0533	.0026	-13.6195	-2.9300
3.2000	-9.4947	2.4062	-3.9460	.0001	-14.2401	-4.7494
3.3500	-10.7147	2.1954	-4.8806	.0000	-15.0443	-6.3851
3.5000	-11.9348	2.1059	-5.6674	.0000	-16.0878	-7.7817
3.6500	-13.1548	2.1528	-6.1105	.0000	-17.4004	-8.9091
3.8000	-14.3748	2.3280	-6.1748	.0000	-18.9659	-9.7837
3.9500	-15.5948	2.6057	-5.9850	.0000	-20.7335	-10.4561
4.1000	-16.8148	2.9571	-5.6863	.0000	-22.6466	-10.9830
4.2500	-18.0348	3.3592	-5.3688	.0000	-24.6596	-11.4100
4.4000	-19.2548	3.7959	-5.0725	.0000	-26.7409	-11.7687
4.5500	-20.4748	4.2566	-4.8101	.0000	-28.8695	-12.0801
4.7000	-21.6948	4.7343	-4.5825	.0000	-31.0316	-12.3581
4.8500	-22.9149	5.2243	-4.3862	.0000	-33.2180	-12.6117
5.0000	-24.1349	5.7235	-4.2168	.0000	-35.4224	-12.8473

It is evident from Table 5.30, p-values for a Cognitive engagement < 2.8271 is all >0.05, therefore for those values H_0 is not rejected (Hayes, 2022). Hence, for Cognitive engagement

< 2.8271, the relationship between Academic achievement and Teaching method is non-significant (Hayes, 2022). Table 5.30 further implies that the higher the Cognitive engagement, the stronger the relationship between Academic achievement and Teaching method (Hayes, 2022). Model 1 was then followed by Model 2, in which two moderators were tested as explained in the introductory paragraph on moderations.

5.6.2.2 Model 2

Outcome = Academic achievement, Predictor = Teaching Method (**X**) and Moderators= both Affective engagement (**W**) and Participation behavioural engagement (**Z**).

Table 5.31: Model 2 Summary

R	R-sq	MSE	F	df1	df2	p
.5083	.2583	219.9406	13.5152	5.0000	194.0000	.0000

Table 5.32: Model 2 Parameter Estimates

	coeff	se	t	p	LLCI	ULCI
constant	4.6001	8.8333	.5208	.6031	-12.8216	22.0219
Teaching_ Method	11.5352	12.6826	.9095	.3642	-13.4784	36.5488
Emotional commitment	10.6411	2.7553	3.8621	.0002	5.2069	16.0753
Int_1	-3.2398	4.2251	-.7668	.4441	-11.5728	5.0932
Engagement _with _classmates	-.1187	2.1292	-.0557	.9556	-4.3180	4.0806
Int_2	-3.5470	3.1716	-1.1184	.2648	-9.8023	2.7083

As shown in Table 5.31, the R-squared = 0.2583; this implies that only 25.83% of the variation is explained by the model, which is adequate for 'real-world data' (since 0<R-squared<1) (Hayes, 2022). It is noted that there has been a decrease in the R-square from the first model to the second model (Hayes, 2022). This implies that the use of Affective engagement and Participation behavioural engagement as moderators leads to a reduction in the variation being explained by the moderators (Hayes, 2022).

Furthermore, from Table 5.32, p-values = 0.4441 and 0.2648 >0.05, therefore the hypothesis of significant moderation is rejected. Therefore, Affective engagement and Participation behavioural engagement together are not significant. However, p-value=0.0002<0.05, therefore there is sufficient evidence to reject H_0. Based on these p-values, it can be concluded

that only Affective engagement is a significant moderator, whereas the p-value for the test for the significance of Participation behavioural engagement as a moderator is 0.9556<0.05, which implies it is not a significant moderator on its own. The results just presented appear to be in agreement with the quantitative results on t-tests and descriptive statistics as well as to a greater extent with the qualitative research findings.

```
Product terms key:
 Int_1      :            Teaching  Method  x
Affective engagement
 Int_2      :            Teaching  Method  x
Participation behavioural engagement
```

Table 5.33: Model 2 Test(s) of highest order unconditional interaction(s)

```
Test(s) of highest order unconditional interaction(s)
        R2-chng          F        df1        df2          p
X*W       .0022      .5880     1.0000   194.0000      .4441
X*Z       .0048     1.2507     1.0000   194.0000      .2648
BOTH      .0140     1.8287     2.0000   194.0000      .1634
```

It is evident from Table 5.33, that there is no significant interaction between teaching method and affective engagement, participation behavioural engagement since all three of the p-values> 0.05 (Hayes, 2022). These results prompted the need to determine how affective engagement would fare, as the only moderator in the model that is in Model 3.

5.6.2.3 Model 3

Outcome = Academic achievement, predictor = Teaching Method (**X**), Moderators = Affective engagement (**W**) only.

Table 5.34: Model 3 Summary

```
          R       R-sq        MSE          F        df1        df2          p
      .4990      .2490   220.4286    21.6656     3.0000   196.0000      .0000
```

Table 5.35: Model 3 Parameter Estimates

```
              coeff         se          t          p       LLCI       ULCI
constant     4.4687     8.5221      .5244      .6006   -12.3381    21.2755
Teaching
Method       7.8346    12.2303      .6406      .5225   -16.2852    31.9544
Emotional
Commitment  10.5671     2.4168     4.3723      .0000     5.8008    15.3334
```

Int_1	-5.8118	3.6384	-1.5973	.1118	-12.9872	1.3637

As shown in Table 5.34, the R-squared = 0.2490; this implies that only 24.90% of the variation is explained by the model, which is adequate for 'real-world data' (since 0<R-squared<1), (Hayes, 2022). It is further noted that there has been a decrease in the R-squared value from the second model to the third model (Hayes, 2022). This implies that the use of Affective engagement alone as a moderator leads to a reduction in the variation explained by moderators (Hayes, 2022).

Furthermore, as shown in Table 5.36 p-value = 0.1118 >0.05, therefore the hypothesis of significant moderation is not rejected (Hayes, 2022). Therefore, there is no significant moderation.

Product terms key:
Int_1 : Teaching Method x Affective engagement

Table 5.36: Model 3 Test(s) of highest order unconditional interaction(s)

Test(s) of highest order unconditional interaction(s):

	R2-chng	F	df1	df2	p
X*W	.0098	2.5515	1.0000	196.0000	.1118

It is evident from Table 5.36, that there is no significant interaction between teaching method and affective engagement since the p-value> 0.05 (Hayes, 2022). Considering the results obtained here and under Model 2, it was deemed necessary to determine what happens when affective engagement is in the model (Model 4) with cognitive engagement as the second moderator.

5.6.2.4 Model 4

Outcome = Academic achievement, predictor = Teaching Method (**X**), Moderators= both Affective engagement (**W**) and Cognitive Engagement (**Z**).

Table 5.37: Model 4 Summary

R	R-sq	MSE	F	df1	df2	p
.5206	.2710	216.1778	14.4258	5.0000	194.0000	.0000

Table 5.38: Model 4 Parameter Estimates

	coeff	se	t	p	LLCI	ULCI
constant	-3.1125	9.0074	-.3455	.7301	-20.8774	14.6525
Teaching _Method	14.3524	13.3430	1.0757	.2834	-11.9636	40.6684
Emotional _Commitment	1.8747	4.3305	.4329	.6656	-6.6661	10.4155
Int_1	2.2632	5.7650	.3926	.6951	-9.1069	13.6333
Cognitive engagement	10.3978	4.3170	2.4086	.0170	1.8835	18.9122
Int_2	-9.5181	5.7713	-1.6492	.1007	-20.9006	1.8643

R-squared = 0.2710, as shown in Table 5.37. This implies that only 27.10% of the variation is explained by the model, which is adequate for real-world data as indicated by Hayes (2022). Notably, the R-squared for Model 4 is the highest out of all the models. This can be interpreted as showing that using both Affective engagement and Cognitive engagement as moderators leads to an increase in the variation explained by the moderators (Hayes, 2022).

However, as shown Table 5.38, there are no significant moderations since the p-values for Affective engagement and Cognitive engagement are equal to 0.6951 and 0.1007 respectively, both p-values >0.05, therefore the hypothesis of significant moderation is not rejected (Hayes, 2022). Therefore, there is no significant moderation.

```
Product terms key:
 Int_1      :            Teaching  Method  x
Affective engagement
 Int_2      :            Teaching  Method  x
Cognitive engagement
```

Table 5.39:Model 4 Test(s) of highest order unconditional interaction(s)

```
Test(s) of highest order unconditional interaction(s):
        R2-chng          F        df1        df2          p
X*W       .0006      .1541     1.0000   194.0000      .6951
X*Z       .0102     2.7200     1.0000   194.0000      .1007
BOTH      .0178     2.3628     2.0000   194.0000      .0969
```

It is evident from Table 5.39, that there are no significant interactions between teaching method, Cognitive engagement, and Affective engagement since all three of the p-values> 0.05.

5.6.3 Concluding Remarks on the Moderating Effects of Learning Engagement Sub-constructs

These tests led to the conclusion that cognitive engagement and emotional engagement have significant moderating effects on the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement. However, it also became apparent that the significance of the moderating effect was dependent on the combinations of these three identified moderators, or a lack thereof. Interestingly, the combination of cognitive engagement and emotional engagement resulted in an insignificant moderating effect on the relationship between the predictor and outcome variables in question. However, a combination of affective engagement and participation behavioural engagement also showed that affective engagement exhibited more significant moderating effects.

This led to the conclusion that cognitive engagement and affective engagement as moderators had significant moderating effects on the predictor and outcome variables in this study. However, the condition was that affective engagement had to be combined with the factor of participation behavioural engagement. Interestingly, affective engagement and cognitive engagement could not result in the same effect. Even more interestingly, affective engagement on its own did not exhibit significant moderating effects on the relationship between the variables in question. Participation behavioural engagement did not result in significant moderating effects on the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement. This was the case when participation behavioural engagement was on its own, or when combined with the affective engagement factor. This led to the conclusion that participation behavioural engagement resulted in insignificant moderating effects.

Furthermore, affective engagement combined with participation behavioural engagement resulted in affective engagement, exhibiting significant moderating effects on the relationship in question. However, the moderating effects of affective engagement were deemed less than those of cognitive engagement. It could also be concluded that learning engagement has moderating effects in the relationship between blended teaching (traditional face-to-face teaching) and academic achievement. Given the summary drawn here, there is a need to develop an understanding as to why cognitive engagement and affective engagement were exhibited significant moderating effects, while participation behavioural engagement did not.

It is hoped that analysis of the qualitative data will provide these and further explanations. Furthermore, the qualitative data provides explanations on the differences between the two groups (Group 1 and Group 2), while highlighting the contextual factors and confirming the quantitative data.

5.7 Concluding remarks

Research findings on effectiveness of blended teaching on learning engagement show that blended teaching appears to have been effective in fostering cognitive engagement and affective engagement in Group 1 learners. These results were strengthened by the corroboration that between quantitative results and qualitative findings. Results on the effect of blended teaching on participation behavioural engagement are not straightforward as blended teaching appears to be more effective only when the quality aspect of participation behavioural engagement is considered. Aside from quality, the quantitative results on the effectiveness of blended teaching become debatable as Group 2 seems to have fared slightly better. Furthermore, the quantitative results on Research Question appear to show that blended teaching was more effective in promoting academic achievement. The results on moderation analysis also showed that cognitive engagement and affective engagement had more significant moderating effects on the relationship between blended (traditional face-to-face) teaching while participation behavioural engagement did not.

To reiterate, the aims of this study was to draw a comparison between the effectiveness of blended teaching and traditional face-to-face teaching 1) in developing learning engagement 2) in fostering academic achievement in South Africa Grade 12 physical sciences learners. To achieve this, Groups 1 and 2 were compared. Both the quantitative results and qualitative research findings showed appear to confirm that Group 1 was more efficacious in developing both learning engagement and academic achievement. This could have been owing to the significant moderating effects of two out of three learning engagement sub-constructs which are cognitive engagement and affective engagement while the participation behavioural engagement did not. The determination of the moderating effects of the three sub-constructs became a necessity to fulfil in order to fulfil the third objective. The fourth objective sought to determine whether interview data on learning engagement sub-constructs were more positive for Group1 (experimental group) than Group 2 which appears to have been fulfilled, at least more substantially as far as cognitive engagement and affective engagement are concerned.

CHAPTER SIX: DISCUSSION OF RESULTS

6.1 Introduction

This section of the study discusses the research results illustrated in Chapter 5, with a view to addressing all the research questions (research question 1, 2, 3, 4, and 5) that guided this study more comprehensively. Just to recap, the main purpose of this study was to determine the effectiveness of blended teaching (compared to traditional face-to-face teaching) in developing learning engagement and improving academic achievement in the contexts of Organic Chemistry, South Africa, and high school with a particular focus on one of the least advantaged schools of South Africa. To fulfil this study purpose, two research questions, 1 and 2, were formulated together with their corresponding hypotheses. Research Question1 read as follows:
Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in developing learning engagement in Organic Chemistry for South Africa Grade 12 Physical Sciences learners?
Hypothesis 1 was as follows:
Compared to learners taught using traditional face-to-face teaching methods, Grade 12 Physical Sciences learners taught using the blended teaching approach will score significantly higher in a post-instruction questionnaire on learning engagement during Organic Chemistry.
Research Question 2 was as follows:
Compared to traditional face-to-face teaching, how effective is the use of blended teaching approach in fostering achievement in Organic Chemistry at Grade 12 in a school in South Africa?
Hypothesis 2 was as follows:
Compared to learners taught using traditional face-to-face teaching methods, Grade 12 Physical Sciences learners taught using the blended teaching approach will score significantly higher in a post-instruction test on Achievement in Organic Chemistry.
Within this effort the relationship among the variables: blended teaching (or traditional face-to-face teaching), learning engagement, and academic achievement was determined, which sheds light on how exactly the learning engagement influenced academic achievement. This required that research Question 3 be addressed, which read as follows:
To what extent is the relationship between blended teaching (or traditional face-to-face teaching) moderated by each of the learning engagement sub-constructs in the teaching of Organic Chemistry to South Africa Grade 12 Physical Sciences learners?

The hypothesis for this question was as follows:

For South Africa Grade 12 Physical Sciences learners, each of the sub-constructs of learning engagement significantly strengthens the relationship between the use of blended teaching (or traditional teaching method) and academic achievement.

Hypothesis 3 read as follows:

For South Africa Grade 12 Physical Sciences learners, each of the sub-constructs of learning engagement significantly strengthens the relationship between the use of blended teaching (or traditional teaching method) and academic achievement.

Research Question 4 read as follows:

How does comparative analysis of post instruction interview data demonstrate that, the learning engagement sub-constructs of the experimental group (blended teaching group) are more positive compared to the control group (traditional method group)?

Hypothesis: There was no hypothesis formulated since this question collected qualitative data.

Research Question 5 read as follows:

What key design features of the nature of the blend that is effective in fostering learning engagement and academic achievement in the South African High schooling context (focusing on Quintile 1 schools)?

In this Chapter, research questions 1 and 4 were addressed together, with a view to discussing both quantitative results and qualitative research findings on learning engagement. This was deemed necessary in order to determine the effectiveness of blended teaching in developing learning engagement focusing on Grade 12 South Africa Physical Sciences learners that were studying the Organic Chemistry topic. This was followed by research Question 2. These three research questions were therefore used to determine the effectiveness of blended teaching on learning engagement and academic achievement on Organic Chemistry focusing on Grade 12 learners of South Africa. This means that the quantitative research phase and the qualitative research phase, which formed the two phases of this mixed methods in the sequential explanatory design, were predominantly used. It is worth noting that the effectiveness of blended teaching in this study was determined through drawing a comparison between Group 1, which was taught using blended teaching, with Group 2, which was taught using traditional face-to-face teaching approach to teach Organic Chemistry to Grade 12 learners at a South African school. Essentially, this meant that if the Group 1 fared well in terms of having higher levels of learning engagement and higher level of academic achievement compared to Group

2 then blended teaching was effective. On the other hand, if Group 1 learning engagement score and academic scores were on average lower that those Group 2, then blended teaching was not effective in fostering learning engagement and academic achievement. Based on this, the present study could be said to be correlational.

6.2 Effectiveness of Blended teaching on Learning Engagement and Academic Achievement

6.2.1 Effectiveness of Blended Teaching on Learning Engagement

Based on both the quantitative research results and the qualitative research findings it became clear that the overall learning engagement of Group 1 (taught using blended teaching) was relatively higher than that of Group 2 (which was taught using traditional face-to-face). In this study, the means were of two sub-constructs of learning engagement, namely: cognitive engagement and affective engagement were significantly higher in Group 1. Even though the mean participation behavioural engagement means for both Groups 1 and 2 were not significantly different from each other, it could be argued that the means of cognitive engagement and that of affective engagement elevated the overall learning engagement for Group 1. The argument being presented above is that if the average mean for participation behavioural engagement was significantly higher in Group 2 than in Group 1, then the claims being made here would have been invalid. On the same note, the moderated regression analysis results also show that cognitive and affective engagement sub-constructs had significant moderating effects on the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement whereas participation behavioural engagement did not.

Furthermore, the idea that the qualitative research findings derived from addressing research Question 4 appear to corroborate the claim being forwarded here in addition to providing explanations to quantitative data. What makes this more plausible is that a similar trend was evident in the qualitative research findings presented in Chapter 5 of this study. Group 1 appears to have fared better when cognitive engagement and affective engagement were considered and compared with that of Group 2 during the analysis of the qualitative data. However, the qualitative research findings for participation behavioural qualitative findings could be said to be in favour of Group 1 particularly with regards quality of engagement. Without considering quality, Group 2 would have fared slightly better in this type of

engagement, but it could still be argued that the difference was marginal, which ensured that the overall engagement determined qualitatively was which higher in Group 1. It could be argued that quality needs to take precedence over quantity as far qualitative research is concerned.

6.2.2 Effectiveness of Blended Teaching in developing Cognitive Engagement

6.2.2.1 Effectiveness of Blended Teaching in Promoting Interest and Finding Organic Chemistry Easy

The research findings also showed that most of the Group 1 interviewees found Organic Chemistry interesting, while none of the Group 2 interviewees did. This finding was in addition to Group 2 learners reporting that they found Organic Chemistry challenging, which was a complete opposite of the Group 1 perceptions. This observation is not far-fetched, considering that Manwaring et al. (2017) go on to suggest that most learners do not appreciate challenging work. Moreover, literature on disengagement also cited a lack of interest as a reason for disengagement (Yurtseven & Ocak, 2021). Based on this, there is a possibility that most Group 2 interviewees did not find Organic Chemistry interesting, because they were finding it difficult.

Given that in sequential explanatory design the qualitative data is mainly designed to provide explanations for the quantitative data, it becomes more plausible that Group 1 participants fared better in terms of cognitive engagement, and ultimately in terms of the overall learning engagement, because they found the work less challenging in addition to finding it interesting. Additionally, research findings on interest appear to be confirming the notion that blended teaching was more effective in fostering learning engagement in terms of cognitive (positive) engagement. By extension, this could also possibly confirm Hypothesis 1 related to the first research question, which states that blended teaching compared to traditional face-to-face teaching has the capability of developing learning engagement. However, basing this on only two facilitators would be premature. There is a need to look at more facilitators of cognitive engagement which were identified as subthemes during the analysis of data.

6.2.2.2 Effectiveness of Blended Teaching in Fostering Perseverance

It also became apparent through this study that Group 2 learners lacked perseverance as shown by the research findings, as they were not even completing their homework, nor were they reading their notes, which was a complete opposite of what was happening in Group 1.

Halverson, and Graham (2019) postulated that perseverance is likely to be higher in online settings, which to a great extent could have explained why Group 1 respondents scored better in this category of subtheme as well. Furthermore, Halverson and Graham (2019) indicated that perseverance manifests itself when learners do all their activities and revisit the work deemed to be more difficult. It is noteworthy, that Organic Chemistry was labelled as a difficult topic by a several researchers (see for example, Flynn 2015; Grove & Bretz, 2012; Tekane et al., 2020; Salame et al., 2019). Based on this, Group 1 learners could have scored higher on cognitive engagement due to perseverance.

6.2.2.3 Effectiveness of Blended Teaching in Promoting Self-directedness and Self-regulation

It could also be argued that Group 1 scored higher in terms of cognitive engagement due to self-directedness, which was non-existent in Group 2. Group 1 participants initiated some discussions in addition to doing the work assigned by the teacher, which could be considered as evidence of self-directedness. Self-directed in the sense that the task (discussions) was not initiated by the teacher and self-regulatory in cases where the teacher placed them in groups and planned the task (Saks & Leijen, 2014). Interestingly, this was also somewhat expected, since some of the Group 2 interviewees did not appear to be setting any learning goals, which is a sign of lack of self-regulation. This proves itself to be problematic given the importance of self-regulation emphasised in the literature that forms part of the theoretical framework which anchors this study (Mahn, 1999; Vygotsky & Cole, 1978).

Emphasis was also placed on the need to ensure provision of more frequent assessment feedback for assessment tasks (Vaughan, 2014). Similarly, as noted in the literature review, Seery and O'Connor (2015) indicated that Chemistry (Organic Chemistry included) learners need plenty of opportunities to test themselves and that blended teaching had the capability of providing these much needed opportunities. On this basis, it could be argued that Group 1 learners benefitted more in this regard. Additionally, learners from Group 1 could have benefitted from the immediate feedback, which was made possible due to the use of technology as part of blended teaching. Furthermore, the design of assessment activities and related feedback appears to determine the kind of learning that takes place (Vaughan, 2014). This observation appears to be in keeping with what Vaughan (2014) indicates. Vaughan (2014) made significant contributions on the conceptual framework used to analyse data in this study by forging links between learning engagement and assessment (Chapter 2).

6.2.2.4 Effectiveness of Blended Teaching in fostering In-depth Learning

Furthermore, in-depth learning instead of just memorisation was cited as one of the types that is likely to occur when there is groupwork and immediate feedback (Vaughan, 2014). Interestingly, the teachers for both groups appeared to be encouraging the learners to memorise some of the Organic Chemistry concepts, particularly the Organic reactions, which were problematic. However, most of the Group 1 interviewees did not seem to be relying on memorisation. It is a question as to whether this could have been the issue in Group 2. While on this point, it becomes important to highlight that Fredricks et al. (2004) ranked memorisation as the lowest quality of cognitive engagement when they indicated that cognitive engagement ranges from recalling concepts to in-depth learning.

Fischer et al. (2018) also indicated that blended teaching, more specifically, flipped learning promotes in-depth learning. Could the use of flipped learning fused with elements of active blended learning have elevated cognitive engagement in Group1 learners? At this point, it becomes plausible that blended teaching could have been effective in developing learning engagement in this study, however, more extensive studies need to be conducted in order to draw more substantive conclusions on this matter. At this point, it becomes important to briefly discuss the finding on affective engagement, which was also arguably a significant contributor towards the overall engagement as stated previous in this chapter.

6.2.3 Effectiveness of Blended Teaching in Promoting Affective engagement

6.2.3.1 Effectiveness of Blended Teaching on Enjoyment as a Facilitator of Affective engagement

Notably, most of the Group 1 compared to Group 2 interviewees expressed that they enjoyed Organic Chemistry, which is not entirely surprising, given that the responses of most of the interviewees in question also depicted positive affective engagement. While it can be argued that the enjoyment experienced by Group 1 interviewees could have been linked to the new teaching method, it is important note that these learners were finding Organic Chemistry less challenging. While the new teaching and learning method (blended teaching) could have triggered these positive perceptions, research tells us that an introduction of technology does not guarantee positive results unless it is done in way that addresses the learner needs effectively (Bonk & Graham, 2012; Garrison & Vaughan, 2008). However, when these Group 1 interviewees were asked to give reasons, it became clear that most of them enjoyed the timely

feedback and playing the flashcard game, as well as the many opportunities to practice in addition to the videos and the quizzes. Based on this, it becomes plausible that the introduction of technology played a significant role in bringing about this enjoyment.

6.2.3.2 Effectiveness of Blended Teaching in Creating Opportunities to Ask and Answer Questions

Group 1 did not fare highly in enjoyment only, as they also utilised the numerous opportunities to ask and answer questions during the lesson. Conversely, only a single learner interviewee from Group 2 indicated that she asked questions. Fewer opportunities to ask questions could have resulted in low academic achievement simply because the learners were not getting opportunities to clear their misconceptions. Research results show that most of the Group 1 learners appear to have been utilising these many opportunities to ask the teacher questions that were created. Additionally, it could also be argued that utilising these opportunities could be linked to confidence and a sense of belonging.

In this study, opportunities to ask and answer questions is being presented as an aspect of classroom context, which influences affective engagement. Failure to create such opportunities may result in learners being unable to test their ideas and to clear misconceptions. Clearing of misconceptions is an important exercise particularly given that as Vygotsky postulated, the learners come to school with already preconceived ideas (Vygotsky & Cole, 1978; Mahn, 1999). Some of these ideas are shaped by the home environment and culture (Vygotsky & Cole, 1978). As such, these learners can potentially come to school with inaccurate ideas of Organic Chemistry, which need to be corrected.

Opportunities for learners to test their ideas and correct any misconceptions that they may have are important in fostering academic achievement an absence of the opportunities to ask and answer questions particularly in Group 2 was evident. Group 1 qualitative findings did not show an obvious lack of the opportunities in question. This disparity between groups 1 and 2 is being attributed to the teaching methods employed. Reasons for the absence of such opportunities were two-fold. One interviewee mentioned time constraints, while the other one blamed the loss of chance opportunities inability to understand Organic Chemistry.

Additionally, a noisy class, which was associated with Group 2, does not offer a learning environment that is conducive to learning thereby depriving learners of opportunities to ask

and answer questions. This interpretation is consistent with Maslow's hierarchy of needs in which noise was identified as presenting a physiological need that needs to be addressed to ensure learners are motivated (Maslow, 1943). Considering the need to address physiological needs was rated as a fundamental need by virtue of being the first one, it becomes difficult to expect learners to progress to higher levels such as safety, self-esteem, and self-actualisation (Maslow, 1943). In summary, it appears that more opportunities to ask and answer questions were created in Group 1 compared to Group 2. Even so, there appears to be a relationship between opportunities to ask and answer questions, and individual learner needs such as a feeling of belonging, given that both issues form a part of the classroom context as noted previously in this section of the study.

6.2.3.3 Effectiveness of Blended Teaching in Fostering a Sense of Belonging

Moreover, the development of the sense of belonging has been underscored in the literature that was used to develop the conceptual framework, when Gilly Salmon's (2003) work was incorporated, coupled with the work on communities of inquiry. Additionally, these feelings of belonging were also rated as important by Maslow (1943). It should be emphasised that Maslow's hierarchy of needs, which includes the need to be accepted by others and to belong, has a significant bearing on motivation resulting in perseverance and preference for more challenging work (Fredericks et al., 2004). Once again, this highlights the interconnectedness that exists among the learning engagement sub-constructs, since perseverance has already been identified as a facilitator of cognitive engagement (Fredericks et al., 2004). When these kinds of feelings were examined, appears to be a strong determinant of the learning environment, which depicts the teacher and other classmates as playing a significant role (Fredericks et al., 2004). At this point, it becomes important to highlight that it was only interviewees from Group 1 that expressed that they felt like they belonged to their class.

Given this kind of learning environment, where learners feel loved and appreciated by other classmates, it is not surprising that exchange of information could take place as pointed out in Gilly Salmon's theory of e-moderation (Chew et al., 2008). Furthermore, feelings of being loved and accepted by peers and the teacher have been found to impact positively on learner engagement, particularly in terms of affective engagement and participation behavioural engagement (Fredericks et al., 2004). Additionally, the need to build communities of inquiry which forms a part of the conceptual framework anchoring this study has been emphasised and this hinges on the established of communities of learning (Chew et al., 2008).

Feelings of belonging have been identified as individual learner needs which form a part of contextual factors that play key role in developing intrinsic motivation (Fredericks et al., 2004). Additionally, teaching method was also identified as a contextual factor that has the potential to influence learner engagement (Skinner & Pitzer, 2012). It can be argued in this study that blended teaching could have had an effect of fostering affective engagement, which by extension means that it was effective in developing learning engagement. Based on the point raised in the previous paragraph, an absence of these opportunities to ask and answer questions appears to be positively correlated with a diminished sense of belonging. Sense of belonging appears to be an important aspect of affective engagement judging from the research findings under discussion particularly given that this was higher in Group 1, which could potentially point towards the idea that blended teaching could foster learning engagement. However, there were a few interviewees (less than half) from Group 1 that expressed that she did not feel like they belonged to their class.

6.2.3.3.1 Sense of Belonging Versus Competition

Moreover, only one reason for unhealthy competition could be identified in Group 1, but in Group 2, two reasons could be identified. These Group 2 reasons relate to outright exclusion or isolation, coupled with efforts to make life difficult for other learners and the preference of learners from other schools. Interestingly, learners refusing to accept even when they were clearly struggling was also linked to unhealthy competition, which was prevalent among Group 1 participants. This makes it difficult to postulate why some participants in this study did not feel like they belonged to the class. It became possible that unhealthy competition could be a plausible explanation when other researchers mentioned it. Mahatmya et al. (2012) assert that, as learners progress into adolescence, learning engagement diminishes due to the promotion of intense competition, and is blamed on the system of education.

Interestingly, Mahatmya et al. (2012) appear to agree with Fredricks et al. (2004), stating that learners at this stage of development (adolescence) generally prefer work that is easy. However, it appears that preference for easy work sounds more plausible given that while competition was encouraged in Group 2, more fierce competition appears have been among Group 1 learners. Based on this, the expectation would have been that learning engagement ought to have been drastically reduced in Group 1 instead. This makes the reasons for lack of sense of belonging unclear what was happening in both groups is considered. At this point, it is

necessary to highlight that this requires further research as the reasons for a lack of sense of belonging are either many or they vary with context. Group 2 participants also scored highly in negative affective engagement, such as anxiety, frustration, and boredom, which could have diminished the learning engagement.

6.2.3.4 Effectiveness of Blended Teaching in Averting Boredom

While on the issue of boredom, it is important to highlight that according to Halverson et al. (2019), boredom is "Weariness or restlessness due to lack of interest" (p.160).

One of the outcomes of boredom was cited as diminished effort or lack of desire to get involved which leads to diminished engagement. Halverson & Graham (2019) add that boredom has the ability to drain all kinds of energy from an individual. This includes the energy to perform cognitive tasks nor those that require emotions and ultimately resulting in lack of intrinsic motivation. On the basis of this, boredom has the potential to interfere with effective learning. In addition to this, Fredricks et al. (2016) assert that learners generally hold the perception that schoolwork is boring which becomes concerning when learners are described as being bored. Such learners were in Group 2 as indicated in the research findings.

Interestingly, boredom was also linked to absenteeism (Reschly & Christenson, 2012) and other off-task behaviours such as not completing homework. These issues were more prevalent in Group 2 which shows that the findings of this study in this respect appear to be consistent with literature. While boredom was linked to the prevailing contextual factors such COVID-19 pandemic and the rolling electricity blackouts, it is noteworthy that such issues were affecting all learners in both Groups. Given this, these reasons that were affecting everyone cannot be used to explain the disparity in the levels of boredom in which Group 2 scored higher. The point being forwarded here is that this could be better explained using the nature of traditional face-to-face teaching approaches have been associated with passive learning (Lehesvuori et al., 2018; De Beer, 2016).

It is noteworthy, that the general outlook alluded to could have resulted in subdued learning engagement in both groups particularly when the learners did not feel safe due to COVID-19. The situation could have gotten worse when some of the teachers the school that was research site also succumbed to COVID-19. These kinds of feelings are in keeping with Maslow's hierarchy of needs. It could be argued that nothing mattered when the learners felt that their lives were being threatened by the COVID-19 which was spreading rapidly at the time. This

could have resulted in absenteeism when the learners also got sick. Nevertheless, the absenteeism could also be viewed as a by-product of diminished learning engagement particularly in terms of affective engagement, particularly in Group 2.

Diminished learning engagement has been presented as a precursor of school dropout (Halverson & Graham, 2019; Fredericks, et al., 2004). Considering the argument presented here, boredom as an aspect of affective engagement could have played a significant role in this study. However, there is a need to highlight the fact that absenteeism as a problem was experienced in both Group 1 and Group 2, which makes it impossible to use it to explain the disparity in the cumulative learning engagement and academic achievement.

Even though boredom was not highlighted as a major problem in Group 1, it can be argued that absenteeism and failure to make effort to refresh the App by a few learners could also have resulted from boredom. Moreover, the problems that were said to be internalised by Group 2 learners, which included the impact of the third wave of COVID-19 also affected the Group 1 learners. In summary, negative affective engagement appears have been higher among the Group 1 learners, judging from the results pertaining to the subthemes or aspects of affective engagement. More importantly, it is worth noting that quantitative results also show that affective engagement was higher in Group 1 compared to Group 2. This corroboration could be supporting the claim that blended teaching was more effective in developing affective engagement. Furthermore, there is a need to look at participation behavioural engagement.

6.2.4 Effectiveness of Blended Teaching on Participation Behavioural engagement

When the participation behavioural engagement sub-construct considered a departure from the trend seen before, where blended teaching was more slightly more effective changed. This was because p-value=0.543, in which $p>0.005$. This showed that the Group 1 mean does not differ significantly from that of Group 2 even though that for Group 2 was marginally higher. Based on these results of quantitative analysis it was concluded that the overall learning engagement for Group 1 was higher than it was for Group 2. A similar trend could be observed when qualitative data analysis was considered. These unexpected results could have been due to Group 2 learners that working together after the lesson, while Group 1 learners shared ideas during the lesson. Even so, positive participation behavioural engagement was evident in

Group 2 research findings, which included sharing of ideas. Furthermore, it can be concluded that participation behavioural engagement in terms of the subtheme sharing ideas was marginally higher in Group 2.

These findings appear to be in keeping with research findings by Manwaring et al. (2017), who indicated that learner activities that were rated as being difficult led to temporary decline of affective engagement (which includes affective engagement since the scholars combined aspects of behavioural engagement with affective engagement). To fully appreciate what Manwaring et al. (2017) argue, it should be noted that learning engagement has been conceptualised as having two sub-constructs—cognitive engagement and emotional engagement, the latter which includes one participation between behavioural engagement and. Additionally, these difficult activities require active learner interactions with peers (Manwaring, et al., 2017).

6.2.4.1 Effectiveness of Blended Teaching on Peer Interactions

On the same note, Yurtseven and Ocak (2021) argue that a learning environment in which learners are free to express their ideas, participate in discussions, test their ideas, and take time to listen to each other's contributions fosters learning that is effective. This could be pointing towards the effectiveness of blended teaching in promoting learning engagement and academic achievement. The emphasis on learner interactions is rooted in Vygotsky's socio-cultural theory and in the *community of inquiry framework (COI)* (Chew et al., 2008), both of which were encompassed in the theoretical and conceptual frameworks that guide this study.

6.2.4.2 Effectiveness of Blended Teaching in encouraging Learners to seek Help from Classmates

Furthermore, it is also clear that any help from other learners could not be secured during the normal in-class school activities in Group 2 either. Conversely, help from other learners could be secured during after school activities in Group 1. Help from other learners is considered important to the learning process as indicated in Vygotsky' socio-cultural theory, in which the *Zone of Proximal Development or ZPD* figures strongly. The ZPD is centred around the notion that there exist concepts or learning tasks that some learners may not be able to effectively understand without the help of the teacher or better skilled learners or to be more specific what Vygotsky referred to as the 'knowledgeable others' (Mahn, 1999; Vygotsky & Cole, 1978). As indicated in the theoretical framework in which this study is anchored, these concepts and

learning tasks are located outside the learner's *ZPD* (Vygotsky & Cole, 1978; Mahn, 1999). Closely related to working with classmates is the idea of working in groups.

The research findings showed that sometimes Group 2 learners worked in groups when they have been given a difficult question to answer. The formation of the groups can be viewed as placing emphasis on the idea that construction of knowledge demand that learners work together (interact socially) collaboratively, which other scholars deem important (Mahn, 1999; Vygotsky & Cole, 1978). It could be argued that as the learners interact, they were also creating knowledge collectively which is sign of cognitive engagement. These interactions were done effectively have the potential of traversing all the three sub-constructs of learning engagement which this study focused on. This point just raised has an implication on the quality of the participation behavioural engagement when can potentially lead to more meaningful learning.

6.2.4.3 Effectiveness of Blended Teaching in Promoting Groupwork and Debates

Furthermore, the idea that in Group 2 learners there were instances when groupwork was done during the lesson even though the frequency was low based on the research findings, that were particularly a result of the analysis of the data provided by the interviewees. Conversely, Group 1 learners mostly did groupwork during the lesson. This points towards a marginal increase in the incidence of groupwork in Group 2, mainly because the Group 1 teacher confirmed that learners worked in groups during the lesson only. In summary, Group 2 seems to have fared better in terms of groupwork although the perceived difference looks marginal. One of the Group 1 interviewees specifically mentioned that she engaged in debates with her classmates. Conversely, none of the Group 2 interviewees specifically mentioned anything to do with debating issues related to Organic Chemistry.

According to Vaughan (2014), learning experiences that are active and foster collaboration among learners should the goal of blended learning design as this can encourage learners to take responsibility of their learning and to test their ideas through debates. Given this, the importance of debates among learners cannot be overemphasised. As indicated by Vygotsky and Cole (1978), learners come to school with some preformed ideas related to the subject matter to be learnt and that they have different zones of proximal development. This makes it necessary that learners engage in debates where they engage in a dialectic (Mahn, 1999).

6.2.5 Conclusion on the Effectiveness of Blended Teaching in developing learning engagement

Given the discussion undertaken, it appears that there is overwhelming evidence showing that blended teaching could have been effective in developing learning engagement based on the combined address of research questions 1 and 4. However, this study also investigated the effect of blended teaching on academic achievement. This requires that the research findings on academic achievement briefly discussed. The relationship between learning engagement and academic achievement has been well documented in literature, however this requires that the discussion of the results for research Question 2 still needs to be discussed, which will provide an indication of the effectiveness of blended teaching on academic achieved.

6.3 Effectiveness of blended teaching on academic achievement

The effectiveness of blended teaching at improving academic achievement was determined through comparison of the mean academic achievement of the two subgroups — experimental versus control in order to fulfil the second aim of the study. The descriptive statistics showed that the mean for Group 1 (41.74%) was higher than for Group 2 (27.18%). The t-tests provided more information on whether there means for Groups 1 and 2 were significantly different. This step was important to ensure that magnitude of the difference was determined if it was important or noticeable. These results show that blended teaching could have been effective in fostering academic achievement. There are several factors that could have contributed this. The first being the high levels of learning engagement, which have already been discussed (Fischer et al., 2018; Halverson & Graham, 2019; Maslow, 1943). Most importantly, based on this learning engagement, there is a chance that the learners were creating knowledge together during peer interactions (Vygotsky & Cole, 1978). This could also have been due to contextual factors, which included a classroom learning environment conducive to learning, since there were no disruptions reported in Group 1 (Fredericks et al., 2004).

The higher academic achievement could also have been due to the benefits of blended teaching, particularly the use of flipped learning, which by its very nature promotes learner centred approach believed to be associated with in-depth learning (Fischer et al., 2018). Additionally, the use of flipped learning could have made more time available for class discussions (O'Flaherty & Phillips, 2015). In this study, many opportunities for learners to assess

themselves and receive timeous feedback, which may well have resulted in higher academic achievement in Group 1 learners (Vaughan, 2014).

Considering the discussion on the effectiveness of blended teaching on learning engagement, it appears that there was a correlation between academic achievement and learning engagement which could be pointing towards the effectiveness of blended teaching on both learning engagement and academic achievement. This is in line with what other researchers have found (Fazal & Bryant, 2019; Fischer et al., 2018; Seery & O'Connor, 2015). Given that learning engagement is intricately linked to academic achievement, there is a need to develop an understanding of learning engagement as a moderator of learning, focusing particularly the significance of the moderating effects of the three sub-constructs that this study focuses on.

6.4 Moderator Effects of Learning Engagement Types

6.4.1 Discussion on Interaction Effects of Learning Engagement Sub-constructs

Research Question 3: To what extent is the relationship between blended teaching (or traditional face-to-face teaching) moderated by each of the learning engagement sub-constructs in the teaching of Organic Chemistry to South Africa Grade 12 Physical Sciences learners?

The research results showed that lower levels of the overall learning engagement associated with Group 2 could have potentially resulted in lower achievement in Group 2. Even though the participation behavioural engagement was higher among Group 2 learners as shown in the descriptive statistics (quantitative data analysis), it could be argued that the difference between the two groups was marginal as shown by the t-tests. As a result, participation behavioural engagement on its own could not strengthen the relationship between blended teaching (or traditional face-to-face teaching) and academic achievement.

Considering the fact that the independent variable's effect on the dependent variable varies with the moderator (Hayes & Rockwood, 2016), this meant that if the moderator effect is small then the independent variable's effect also becomes small. Nonetheless, the conclusion that blended teaching (or traditional face-to-face teaching) would have significant effects on academic achievement only under two conditions which are when the moderator variables are either cognitive engagement or affective engagement is to a large extent congruent with

qualitative data findings. Having said this, it is noteworthy that Question 3 is best addressed using statistical analysis in the form of MRA, since the third variable needs to be determined first before even trying to hypothesise what could be happening in any relationship among variables.

This study, therefore, takes exception to literature that refers to learning engagement or its sub-types as mediators or moderators, without undertaking this first necessary step of conducting the test. Additionally, the conditions under which the independent variable (blended teaching or traditional face-to-face teaching) exerts its effects on the dependent variable (academic achievement) can also be used to determine the nature of blend, which is effective in developing learning engagement and academic achievement (Research Question 5). However, this requires that research Question 4 be addressed first.

6.4.2 Conclusion

The discussion of the results show that blended teaching was more effective in fostering learning engagement and academic achievement which happens to mirror the quantitative results. As demonstrated in this data analysis chapter, both quantitative results on affective engagement and cognitive engagement appear to support the notion that blended teaching was more effective in developing learning engagement. However, the effectiveness of blended teaching in fostering participation behavioural engagement is not a straightforward one. In this case, the effectiveness of blended teaching in fostering participation behavioural engagement appears to be more evident when the quality of engagement is considered. Furthermore, cognitive engagement and affective engagement had more significant moderating effects while participation behavioural engagement did not. Even so, the overall learning engagement appears to be higher in Group 1, both qualitatively and quantitatively. Additionally, based on the idea that affective engagement and cognitive engagement played significant roles in moderating the relationship between blended teaching and academic achievement, it could be concluded that academic achievement there appears to be a positive correlation between learning engagement and academic achievement. This knowledge also became key in addressing research Question 5, which forms a part of Chapter 7. Chapter 7 is therefore being presented as being born out of an application of the knowledge gained from this study whose main focus was to determine the effectiveness of blended teaching on learning engagement and academic achievement.

CHAPTER SEVEN: NATURE OF BLEND THAT COULD BE SUITABLE FOR SOUTH AFRICAN CONTEXT

7.1 Introduction

Research Question 5: What key design features of the nature of the blend that could be effective in fostering learning engagement and academic achievement in the South African High schooling context (focusing on Quintile 1 schools)?

The interview data and partly on the quantitative data led to the design features of the nature of blend that is effective in fostering learning engagement and academic achievement, focusing on the South African high school context, and particularly Quintile level 1 schools. However, this study was not an extensive one, which means that the design features that are proposed here will need to be tested further. This should therefore be viewed as a significant starting point since this particular context of the South African education system is largely under researched in terms of blended teaching despite catering for the largest learner cohort. It is noteworthy that, considering the pivotal role played by contextual factors (Bryant and Fazal, 2019; Fredericks et al., 2004; Reschly & Christenson, 2012) who rejected a one size fits all approach when it comes to design features of blended teaching, analysis became necessary.

These contextual factors include characteristics of learners, support offered by the teacher, the structure of the classroom, variety of activities, family support and situations, such as home environment, peers and the school, South Africa Grade 12 Organic Chemistry, and economic conditions (Fredericks et al., 2004; Reschly & Christenson, 2012; Yurtseven & Ocak, 2021). Based on this, the recommendations provided by the learners and the teachers, and considering what appears to have been effective in developing learning engagement and academic achievement, determining the design features of a suitable blend became a possibility. In this analysis of data, the contextual factors will be discussed, first followed by the nature of blend that can potentially be effective in terms of promoting learning engagement and academic achievement.

7.1.1 Contextual Factors

As indicated previously, the school is situated in a less privileged community, which came with challenges that had to be overcome to ensure the effectiveness of the blend. The proposed blend needs to tap into how these challenges were addressed, while taking cognisance of the challenges that emerged, which were not necessarily catered for. When the context was considered, the economic challenge figured strongly. This manifested itself in terms of learners struggling to secure internet services at home, which made the online component difficult to implement. This challenge was overcome by providing internet services at the school and providing an offline application, which learners could access away from school. Given that this mitigatory procedure worked effectively, any blend for schools in this kind of predicament need to consider this. However, this came with its on challenges given that learners had to refresh their MOODLE smartphone app at school. This presented a certain challenge considering that learners were absent due to Covid-19 pandemic that was ravaging the country at the time of the study. However, these learners (those that could not get data to refresh the app at home) were given the work during the time they were at home to ensure that they do lag behind and these were few. The MOODLE app had to be appraised to determine what worked and what did not. In this respect, John (from Group 1) had this to say:

> *The app was very helpful. Some learners were struggling to refresh the app but I would try to have a little data to refresh.*

While access to internet services posed a challenge, it can be deduced from what John said that refreshing the App (application) did not require a lot of data, which made it possible for him to refresh it. When asked how often he used it his response was as follows:

> *I used it a lot.*

The fact that John used the app a lot shows that other learners could also do the same. However, those that could not secure the little data needed could still refresh the App at school. Additionally, being a 'no fee' type of school also came with its own challenges with regards to provision of internet services. Interestingly, after interviewing the teacher for Group 1, Mr. Zulu, it became clear that some of these learners were merely in a position to secure the little data required to refresh the app. This is what he had to say:

> *...but some of them will tell you that it was a lack of internet access, but they are always on WhatsApp so, it has to do with the tradition of learners reserving their data for recreational purposes and not for schoolwork. If it's schoolwork, then they want the school has to provide.*

This kind of attitude is something that appears to form a part of the context that needs to be considered when designing a blend for similar schools as shown in Table Y.1. The problem highlighted here is not necessarily that of inability to secure internet services per se, but rather, that of entitlement, in which the learners feel that it is not their responsibility to provide for their own educational supplies. This contextual issue being raised here was also mentioned by the control group (Group 2) teacher, Ms. Nkosi, when she said the following:

> *This afternoon actually I was with my girls yesterday. I ask them, what do you actually do when you get home, then others said, I go home and, and eat after eating… when the other one said, ma'am, she spends the whole entire weekend on Facebook, she is forever online. So, you can see that they love being online, but now they buy Facebook data, but they don't have data for schoolwork.*

It is clear from the point advanced here that this context is a lot more complicated than in other places. This contextual factor needs to be addressed for any blended learning to happen effectively. It became clear that any 'blend' that should be proposed needs to ensure that this issue is taken into consideration. In this study, this challenge was mitigated using an offline app and by ensuring the school provides internet services for learners that were either unable to secure such services or were unwilling to provide any form of funding for their education even though it was a small amount of money required. John went on to say that the use of the app made Organic Chemistry interesting as shown in the interview excerpt that follows:

> Interviewer: *You said that you found Organic Chem work interesting. What made it interesting?*
>
> John*: I found the app the app interesting but some of my classmates complained about the data problem, but they do not want to ask the teacher to refresh the app for them.*

Considering this, it becomes clear that the teaching approach (blended teaching) which was made possible through the use of an offline app had a positive effect on making Organic Chemistry interesting. Interestingly, Peter also echoed similar sentiments when he noted the following:

> *I used the notes and homework given on the App. I found the App very helpful. Most of the time, I practised those questions on that App. If I am bored, I just answered those questions again.*

It is clear from what Peter said that the app was effective in providing much-needed practice and also became a panacea for boredom. Given that learners generally find schooling boring

as pointed out in literature (see for example, Yurtseven & Ocak, 2021, Fredricks et al., 2004), this was a welcome development. Similarly, Ntombi (Group 2) said something related to interest when she said the following:

> *I really did. I liked this type of learning because I became more interested in whatever I was learning.*

Considering this, it can be deduced that a lack of interest was a major problem, which could be addressed by the nature of the blend that was utilised. The need to ensure that the blend ideal for the study context addresses the issues of boredom and a lack of interest cannot be overemphasised. To further make the learning interesting, the learners were introduced to gamification to play an educational game. Gamification has been identified as an important design feature of the blend in Table Y.1. Another challenge was that most of the learners stay alone (without parents), which makes the situation at school problematic. It could be argued that having parents that are indifferent to schooling, or that are not even available for one reason or another, can potentially result in disengagement (Yurtseven & Ocak, 2021). This situation of learners living alone is a reality in some of these Quintile level 1 schools located in South Africa, which requires that the proposed blend takes this into account. One way is to ensure that the blend appeals to the learners. To put this into context, there is a need to look at what Ms. Nkosi (Group 2 teacher) said, which is as follows:

> *Yes, yes, they do not attend the extra classes. I think the best way is that at school we have morning classes, but they don't show up in those morning classes. The classes where they show up. they are showing up only in those for teachers that they are scared of. There, they know that if you come late you will get into trouble. Yes, yes, that this one you can't just uh absent yourself in, in his class and her class, then they would show up, but if you are a person who is just communicating to them to say this is your future, if you don't come, then you are going to be affected then you do anything about it they don't come. If I say, "I'm going to call your parents", and then some learners talk to me and say "What about us? Maybe because we are staying alone, my parents are not here-we are renting rooms. so, what are you going to do? I'm all by myself. No parents are taking care of me. I'm taking care of myself." So, you can see that you can't even give them a letter.*

A grim picture has been painted here, which requires ingenuity when comes to formulating a blend that works effectively in such a context, where the learners do not answer to anyone while at home since they stay alone. This lack of family support presents a serious challenge.

One way would be to ensure that the learning activities are interesting so that the learners are drawn to participate. The lack of parental support was given as a reason for a lack of classroom discipline, which characterised the classroom structure at this school. This is in line with literature on disengagement such as Skinner and Pitzer (2012), who pointed out that parents influence learners' classroom engagement, finding schoolwork enjoyable, interesting and enthusiastic in addition to preferring challenging work and being committed. Additionally, the teacher's inability to manage the class comes with a lot of challenges be it in a blended setting or in traditional face-to-face teaching environments. No meaningful learning can be expected to occur under such conditions. This is the case particularly given that learning engagement was found to correlate with activities that are hands-on, minds-on project-based, relevant, and characterised by integration within the content area. Considering the kind of teaching method being used by the control group teacher, it would be difficult to ensure such activities, particularly those that are hands-on and project-based since learners in such settings are usually passive. Moreover, Chemistry content has been criticised for being fragmented (Seery & O'Connor, 2015). Prioritising interesting activities and eliminating boredom could assist in mitigating some of the problems highlighted in this study context. This could be achieved through varying the type of activities thereby ensuring that the activities cater for the variety of learning styles among learners as proposed by Fazal and Bryant (2019). The effective blend for this particular South African schooling context needs to incorporate many different types of activities. This was also pointed out by Mr. Zulu, the Group 1 teacher when he said the following:

> *That* (having more educational games) *would definitely help because we need to increase the variety of activities that we upload on the online platform. You will find that some learners will enjoy playing these games instead of reading. This will help big time because we will be able cater for the wide variety of learning styles that the learners have.*

Here the teacher was referring to the use of educational games as part of the blend. Having looked at some of the contextual factors, it becomes important to examine more ingredients of the blend that could be effective in developing learning engagement and promoting academic achievement in this rather unusual yet prevalent South African public schooling context. Mr. Zulu also indicated that most learners used all three attempts at quizzes in order to improve their marks. Once again, this idea of providing learners with more opportunities to attempt the quiz cannot be understated. Given this, the blend that is more suitable in the captured South African context has to consider this idea of providing learners with many opportunities to

attempt the quiz. Furthermore, the other problem associated with the South African context in which case study was undertaken was that most of the learners that were interviewed pointed out that they struggled with Organic reactions. This included interviewees from both groups. Organic reactions, being a function of practical work, raised questions over whether adequate practical work was being done. In this respect, both factors appear to be true, given what Rose (Group 2) said in the interview excerpt which follows:

> Rose: *There were no practicals - not even one.*
>
> Interviewer*: Why do think this was the case?*
>
> Rose: *I think it was more of the material to do use for practicals.*
>
> Interviewer: *Why do you think it was because of a lack of materials to do the practical work?*
>
> Rose: *We could make our own time if we had the resources.*
>
> Interviewer: *Do you think it can be managed during the lesson?*
>
> Rose: *No, I don't think so.*
>
> Interviewer: *Why? Is it because of the time or there were other challenges besides the resources for practical work?*
>
> Rose: *I think it was time.*

It can be deduced from what Rose notes above that there is a good chance that the practical work could not be done, due to a shortage of resources, as well as due to time constraints, particularly during the lesson. At this point, it becomes important to acknowledge that two things could possibly be true at the same time. It became clear that the time during the lesson was not enough when the learner explicitly mentioned that practical work could not be done during the lesson due to inadequate time. However, a shortage of resources is also a plausible reason, considering that this school is located in a disadvantaged community and relies on government funding. However, the time constraints could have been a function of several factors such as time was lost during school closures due to COVID-19 outbreaks at the school. Alternatively, it could have been due to time lost, when the teacher was attending to disciplinary problems, or it the situation could have been compounded by the fact that the bulk of the Grade 12 syllabus has to be completed before the preliminary examinations, which are usually written in August.

The last reason put forward has the effect of creating a fast-moving curriculum, which may result in some learners being left behind. Considering the issues raised here, it becomes imperative that teaching approaches such as blended teaching which provide learning

opportunities outside the normal lessons be put in place. The question is, what design features of the nature of the blend that is responsive to some of the contextual factors raised in this section of this study should be considered? The key is to ensure that learning engagement is developed while promoting academic achievement. Most importantly, it is equally important to ensure that the learning engagement developed is meaningful or effective to ensure that academic achievement is guaranteed. This reduced amount of practical work could have deprived learners of more opportunities to engage in hands-on activities, and more minds-on activities, which could have further bolstered academic achievement.

7.1.2 A Blend Responsive to Leaning engagement and Academic Achievement- what could work?

In this study, a fusion of active blended learning (ABL) and flipped classroom was used. This combination appears to have worked effectively considering that the Group 1 learners were relatively highly engaged and that they also had significantly higher academic achievement (as demonstrated by the descriptive statistics and the t-tests in Chapter 5 of this study) compared to Group 2 learners. Based on this, the argument is that the blend suitable for the South African high school described in the previous section needs to make use of a similar combination. This suggestion is based on the idea that flipped learning has been credited for fostering independent learning (O'Flaherty & Phillips, 2015). While ABL has been praised for ensuring that active learning occurs. Drawing lessons from this study, one way in which active learning was incorporated was by ensuring that learners did not watch videos and end there, as they were expected to do the quiz as well. On this note, it is important to take note of what Mr. Zulu, the Group 1 teacher said which is as follows:

> *When they attempted the quiz, it was another way of seeing if they have been able to construct the knowledge. I would say, blended learning is a game changer. Even in the classroom it changed everything for the better, so I would say it is good when it comes to active learning.*

Based on this positive comment, this study proposes that a blend suitable for the South African context discussed needs to incorporate active learning through the use of ABL. The learners also liked the combination as shown by what Lethiwe (from Group 1) had to say, which is as follows:

> *I used the videos a lot and then answer the questions*.

Given that it is always advisable to consider the opinions of those who are meant to benefit from what is being put forward or the affected, what Lethiwe said emphasises the importance of including quizzes and their corresponding videos with a view to promoting active learning. Intricately linked to the use of quizzes, it can also be argued that it is important to ensure that these quizzes are graded using technology or by the online learning platform to ensure that feedback is made available to the learners in real time. This point just raised was emphasised by Lethiwe (Group 1). She said the following:

> *I liked that you write, you write your questions and get feedback right afterwards. It was easier to know what you got wrong right after writing and to know where to focus more energy on while studying.*

Based on this, it could be argued that incorporating quizzes that are immediately graded is worth considering when formulating a blend that is suitable for the South African context in question. Interestingly, even learners from Group 2 also indicated that they would like more practice questions and to watch videos. For example, Mary (Group 2) had the following to say:

> *I would have liked to do more practice while I am also watching the videos.*
> *I would then replay the video so that I would understand more.*

Even though the Group 2 learners were given activities that were similar to those given to Group 1, Group 2 learners were lagging in terms of the number of activities that they had to complete due to the absence of technology. In Group 1, technology helped with speedy grading of the quizzes and also with provision of feedback. This makes it imperative that the quizzes be graded by using technology as indicated in Table Y.1. This is in keeping with what Seery and O'Connor (2015), who pointed out when they said that underscored the need to use technology by saying that learners need more opportunities to practice. Another important point raised by Mary was that using videos would be more beneficial when compared to listening to the teacher, since she would be able to rewind and replay the video many times until she understands everything being explained. This underscores the need to ensure the blend being proposed for this particular South African context that has already been described should include videos. This is particularly important in the sense that it has an effect of increasing levels of both affective engagement and cognitive engagement. Increasing these two aspects of learning engagement was quantitatively proved to be beneficial, given that they were found to have significant moderating effects on the relationship between blended teaching and academic achievement.

Additionally, quantitative data in the form of descriptive statistics (in which the Group 1 average academic achievement was 41.74% versus 27.18% for Group 2) and t-tests showed that cognitive engagement and affective engagement were higher in Group 1, which also happened to have higher academic achievement. The key is therefore to increase cognitive engagement and affective engagement and ensure that quality participation behavioural engagement happen. Quality participation behavioural engagement would result in in-depth learning instead of surface learning. It is noteworthy that Group 1 learners could have engaged in higher quality participation behavioural engagement because of debates and independent learning. The activities to be included in the blend being proposed here should therefore encourage in-depth and independent learning to guarantee its effectiveness. In addition to raising the quality of participation behavioural engagement, it also becomes imperative that teachers become more proactive in building a community of learners where sense of belonging, respect, tolerance, and acceptance as facilitators of affective engagement are promoted. This also involves not placing too much emphasis on competition, which led to fights among the learners and negatively impacted on participation behavioural engagement as noted previously in this study. Furthermore, it has been shown in this study that learners struggled with Organic Chemistry reactions and that the teachers from both groups were encouraging rote learning of the work on this subtopic of Organic Chemistry.

One of the reasons why Organic reactions appear to be a chronic problem is the absence or insufficient amount of practical work, which was largely due to time constraints and sometimes a shortage of resources. To mitigate this problem, simulations need to be included in the 'blend' that is being proposed for the schools similar to the one used in the case study as shown in Table Y.1. The nature of the blend being proposed would be incomplete without the incorporation of the simulations especially given that the NSC Examination reports have been identifying Organic reactions as an area that most learners struggle with (Department of Basic Education, 2019; Department of Basic Education, 2020; Department of Education, 2021). Incorporating simulations into the blend is important as this would potentially make the blend more effective in improving learning engagement and academic achievement given that nature of Organic Chemistry and the nature of the problems associated understanding this seemingly complex topic. It is therefore proposed that the coverage of the subtopic on Organic reactions the use of simulations would have edged Group 1 further. This suggestion is against the backdrop that the Group1 teacher indicated that the learners struggled with Organic reactions. This was in addition to the responses of the learner interviewees.

Having said this, these design features would not result in successful blending if policies were not put in place-policies in terms of subject policy (relating to Organic Chemistry) and school policies pertaining to curriculum particularly the incorporation of educational technology. Having these policies in place will go a long way towards mitigating some of the challenges that have been described in this study. For example, providing incentives for participating on the discussion forum would become possible. One example would be to incentivise through allocating a certain portion of the end of term marks to participation in the discussion forum. This proposition is based on the idea Yurtseven and Ocak (2021) pointed out that learners tend to disengage if the activity is not for marks, while Fredricks et al. (2004) mentioned that learners generally perceive school as a vehicle to obtain grades and that they usually would like to obtain these marks with little effort. Based on this, incentivising online discussions ought to be done in a way that has been fully thought through as incentivising participation on the discussion forum may result in learners just posting for the sake of obtaining marks which will lead to superficial discussions. The point here is that there is a need to promote in-depth discussions on the online platform as well particularly given the tendency of learners to try and obtain favourable grades with minimal effort.

Furthermore, there are many challenges that may be encountered during the curriculum policy design and its subsequent implementation. These problems may include inability to cater for learner needs, teachers that are reluctant to implement the changes that include incorporation of technology, budgetary constraints and learners that may be reluctant to start learning in different way. In this study, efforts were made to sell the blended learning idea to learners which reduced the level of resistance to change. Nonetheless it is important to note that this was possible because the experimental group (Group 1) teacher was open to teaching Organic Chemistry in a different with the hope of improving the learning engagement and academic achievement. Looking at the way the two groups emerged, which was a result of the decisions of the two teachers on whether to use technology-mediated teaching in the form of blended teaching or not, the postulation of teacher resistance as a major problem during the implementation phase is possibility.

Another curriculum policy issue highlighted in this study was the time constraints which leaves the allocation of time to cover the Grade 12 syllabus in need of revision. This ought to be undertaken at the macro level which may potentially result in further injection of funds as the

learners might have to spend an extra year in school. It is worth noting that one of the challenges associated with this study was under-funding of Quintile level 1 schools coupled with socio-economic status of the learners and their parents which making this problem difficult to solve. While policy changes are suggested it must be recognised that such changes are associated with numerous problems which require a less restrictive teaching environment in which the schools and teachers have more freedom to implement changes instead of being too prescriptive. In addition, Group 2 learners were not even doing the homework, as noted previously in this study and this study was conducted over a short period of time, where is not clear if the interest that was stimulated by the use of blended teaching can sustained over long period of time. By extension, the nature of blend discussed in this Chapter could be instrumental in mapping a blended teaching model for schools with limiting factors beyond the South African context given that the South African context utilised has limiting factors.

7.1.3 Development of a Blended Learning Model That could be used by Schools with limiting Factors

Considering the contextual factors discussed earlier in this chapter coupled with the design features of the blend that could be responsive to the South African context, it could be argued that the blended learning model ought to be one that takes cognisance of the limiting factors highlighted. Consequently, a hybrid-one which retains the traditional classroom but includes online learning (Christensen et al., 2013) is recommended. However, instead of adopting a strictly sustaining innovation (one that is directed at extant learners that are already utilising technology-mediated learning) this study proposes a model that combines elements of both sustaining and disruptive models. According to Christesen et. al. (2013), adopting the disruptive innovation entails doing away with the traditional face-face classroom totally with the aim of reaching out to those that are making use of technology already such as the learners in underprivileged schools. On this basis, a strictly disruptive innovation would fall short since the learner participants in this study were just like most of those schools with limiting factors, are most likely going to be using technology mediated learning such as blended learning for the first time. However, this could require further studies in which the effectiveness of different models is compared through a comparative study. Additionally, the idea of ensuring that policy changes (as a condition for a smooth implementation of a disruptive innovation) is a daunting task. However, policy on informal assessment (at school-level) could be implemented first in

which online participation is incentivised. Alternatively, encouraging learners to take turns to facilitate online discussions could be implemented with further exploration on effectiveness of strategies used. The further exploration could include sequential exploratory design.

Considering the above, a blended learning model in which limiting factors pose a serious challenge cannot be placed in either of the two innovations. For example, ensuring that there are no drastic changes to the physical infrastructure or number teachers is key given budgetary constraints already highlighted in this study. Having said this, the rest of the design features ought to resemble the ones for the nature of blend that could be suitable for the broader South African schooling system as illustrated in the Figure 7.1 below. Figure 7.1 is an illustration of the blended learning model that could be used by schools with limiting factors which also happens to be a potentially significant contribution of this study.

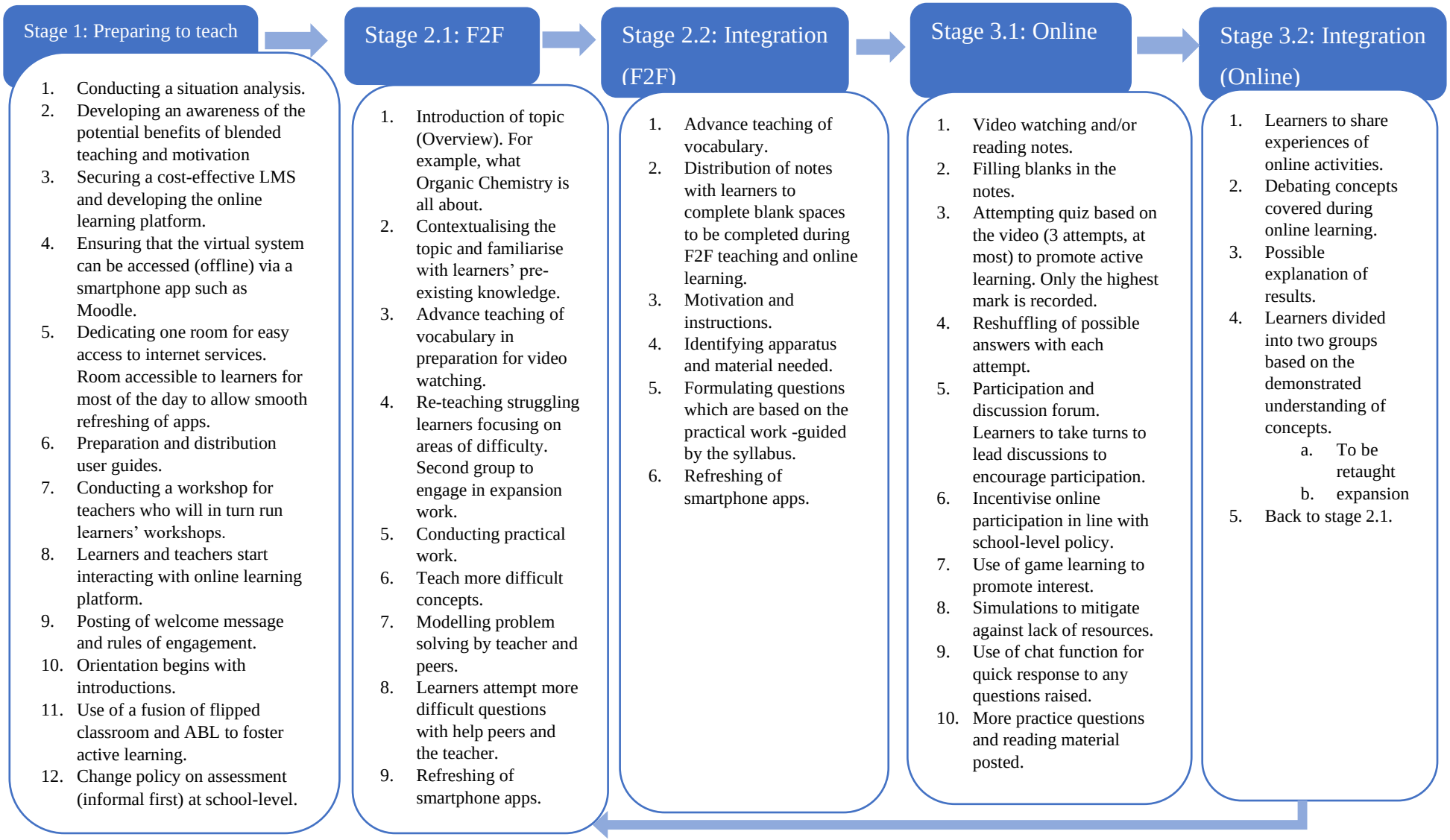


Figure 7.1: Blended Learning Model for Schools with limiting Factors

7.1.4 Conclusion

While this blend proposed here cannot be viewed as an antidote for learner disengagement and poor academic achievement in Organic Chemistry, it can be argued that there is a good chance that what was achieved in this study could be replicated under similar conditions. As a result, this study attempted to provide a blended learning model that could be used by schools with limiting factors in South Africa and globally. To reiterate, there is enough evidence to show that both quantitative results and qualitative findings appear to show that the blend used in this study was effective in fostering both learning enagement and academic achievement. For example, two sided tests performed on the three learning engagement sub-constructs showed that two of the Group 1 means were significantly higher than those of Group 2. For cognitive engagement, the p-value= 0.021whereas for affective engagement, p-value =0 (both p-values were less than 0.05) showing that the means for the two groups were significantly different with those of Group1 being significantly higher. However, the same could not be said for participation behavioural engagement where the p-value=0.543 was obtained which depicted that the means of both groups were not significantly different.

Nevertheless, the overall learning engagement was higher in Group 1 results could be said to have mirrored the qualitative findings particularly when the qualitative were quantitized. Given the relationship among the the variables which was established in this study using moderated regression analysis, it is not surprising that mean academic achivement of Group 1 was significantly higher than that of Group 2 as shown by a p-value= 0.00 which was also less than 0.05. More importantly, most Group 1 learners also indicated that they found Organic Chemistry easy. A correlation between the use of blended teaching and learning engagement as well as academic achievement could be said to be evident making the claim that the blend was effictive more plausible.

By stating the above, the study takes cognisance of the limitations of the blend which include challenges associated with policy changes at all levels (macro, meso and micro levels), budgetary constraints and potential resistance from the teachers and the learners. Furthermore, the blend suggested, could not include tested suggestions on how best to include simulations which requires further study. Additionally, while this study controlled threats to internal validity such as the teacher skills by ecouraging team teaching, it is possible that skills of both

teachers could have had a slightly negative impact on the study. For example, the control group teacher seemed to struggle with classroom management skills which resulted in inability to create a learning environment that was conducive to learning. Matching all the teacher skills is almost impossible and therefore acknowledged as a potential limitation of the study. There is a need to conduct further studies to determine important teacher skills using qualitative methods such as ethnography. While acknowledging that not everything is achievable, it must be noted that the blend that will emerge will definitely improve upon the traditional face-to-face teaching prevalent in the schools similar to the one used in this study.

It has also been pointed out in literature that blends can potentially become ineffective when there is a mismatch with learner needs and the needs of the school (Garrison & Vaughan, 2008). While there are many schools in the category of the school where this study was conducted, variations within the category and among learners resulting in slight differences in learner needs cannot be ruled out. In closing, it would be appropriate to quote Poe (2015), who said this following:“ We need to employ teaching techniques that engage the front rows and penetrate to those who silently lurk behind them” (p. 280).

CHAPTER EIGHT: CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

8.1 Conclusion

This mixed method study investigated the effectiveness of blended teaching of South Arica Grade 12 learners focusing on the Organic Chemistry topic at a Quintile level 1 school. This case study proved that it is possible to establish a blended learning system that caters for the broader South African schooling sector, which comprises the lower quintile levels. As pointed out earlier in this study, this research study context was a school that belongs to Quintile level 1, which happens to be the category that consists of the least advantaged schools in South Africa. Given that such schools are under-resourced, they normally lag in terms of educational technology and other resources, since the parents cannot afford to top up the government funding that such schools receive. It could be argued that being able to establish a somewhat effective blended teaching programmes was under such difficult conditions which were exacerbated by COVID-19 was phenomenal.

Most importantly, there is enough evidence to show that it appears that blended teaching (compared to traditional face-to-face teaching) was significantly more effective in developing learning engagement and improving academic achievement in South Africa Grade 12 Organic Chemistry. The success of the blended teaching could be attributed to learners that were eager and open to learn in a different way; 2) the teacher who was open to new ways of teaching and his willingness to invest time and other resources for the improvement of learning experiences of learners; 3) opportunities for active learning; 4) self-directed learning and self-regulatory learning on the part of learners; 5) researcher's experience in online learning; 6) technical support; 7) support from the school in providing suitable timetable; 8) alignment of the programme and activities with learner needs; 9) most importantly, guidance from the supervisors; and 10) close monitoring of learners' progress.

Furthermore, this study was instrumental in demonstrating that learning engagement as a third variable assumes the function of a moderator variable. This finding (even though it still needs to be tested further) is an important one given the paucity of research that is concerned with finding out role played by learning engagement in blended learning settings. This significant finding comes against the backdrop that most research findings have not been concerned with

the kind of variable that learning engagement assumes in educational settings. Moreover, as noted previously in this study, the few scholars that showed some interest did mention that learning engagement was either mediating variable or a moderator variable without taking time to provide detailed testing procedures that were conducted. Based on this, the present study appears to be groundbreaking and making a potentially significant contribution to the learning engagement theory which could be extended to other contexts besides the South Africa. It can be argued that this research finding is attributable to the high cognitive engagement and affective engagement, which contributed significantly to the overall learning engagement. However, the factor, participation behavioural engagement, did not have any significant moderating effect on the relationship between the independent variable teaching method (blended teaching and traditional face-to-face teaching) and the dependent variable (academic achievement).

Based on the above, it can be argued that cognitive engagement plays a key role in improving academic achievement, and that blended teaching was more effective in fostering cognitive engagement and affective engagement. However, it appears that neither blended teaching nor traditional face-to-face teaching approach was more effective in fostering participation behavioural engagement in learners. This claim strengthened by the corroboration between both the findings from both quantitative and qualitative analyses. However, since on the one hand, affective engagement was significantly higher in Group 1, while on the other hand, participation behavioural engagement was marginally higher in Group 2, the overall emotional engagement for Group 1 became marginally higher than that of Group 2. Considering that cognitive engagement was also significantly higher in Group 1 compared to Group 2, the overall learning engagement of (comprising the three sub-constructs) became higher. This conclusion is based on the idea that both affective engagement and cognitive engagement were significantly higher in Group 1 compared to Group 2 as shown by both the quantitative (descriptive statistics and t-tests) and qualitative data analyses. Accordingly, it can be concluded that blended teaching (compared to traditional face-to face teaching) is more effective learning engagement in high school learners in the South African context, and more specifically in Organic Chemistry.

Given the fact that academic achievement and learning engagement were higher in the group where blended teaching was used, it can be argued that the blend designed was an effective one. Most of the design features would still be applicable in the post-COVID-19 pandemic era

and other contextual factors other than those of South Africa. Though it was not the aim of the present study, to some degree, temporal transferability and ecological transferability of the study research results is a possibility. This claim is made against the backdrop that underfunded schools do not only exist in South Africa. Similarly, other schools across the world that may not necessarily be in a similar predicament can to some extent benefit from this study through implementing some of the design features of blended teaching system. Furthermore, these design features of the blend could still make it usable beyond the period of emergency caused by COVID-19. For example, an emphasis on active learning in which efforts to ensure that passive learning is not replicated during blended teaching would be applicable during normal teaching time. It could be argued that active learning could have influenced affective engagement.

Boredom as a facilitator of affective engagement which appears to have played a significant part in ensuring that Group 2 learners disengaged more could have benefited from active learning and the use of gamification. This claim is based on the idea that Group 1 learners did not only watch videos (passively) given that they had to complete a quiz based on the concepts covered in the video which could have prompted them to watch the video actively. Furthermore, the use of gamification could have sparked interest in learners that could have been bored. Additionally, the three attempts also rewarded learner efforts when they improved their marks. Arguably, these design features could be viewed as being relevant in all schooling settings beyond the South African context and during post COVID-19 pandemic times. Furthermore, some interviewees preferred watching videos while others preferred to use notes and both were provided. This could be pointing towards the idea that the blend could cater for learner diversity making it more effective in fostering academic achievement and learner engagement. The use of the chat function afforded the teacher an easy communication channel which he used to motivate and send reminders to learners in addition to directing learners to a new posting. Likewise, learners were also afforded opportunities to seek clarification from the teacher and ask other relevant questions using the chat. These design features would be ideal even during the post-COVID-19 era. On this basis, it could be argued that this study is relevant even beyond the COVID-19 pandemic.

Interestingly, another factor which appeared to influence learning engagement which in turn could have impacted negatively on academic achievement could have been unhealthy competition among learners. This appears to have been rifer amongst the blended teaching

group (Group 1) resulting in diminished effectiveness. This unexpected factor could be a contribution to the learning engagement theory. Based on this, this study could have contributed towards knowledge on learning engagement. Having said this, it is worth noting that like any other research this study has some limitations.

8.2 Limitations

The current study was conducted at only one school located in only one country (South Africa). The school was a disadvantaged school which belongs to Quintile level 1. Notably, these contextual factors are not uniform in all schools let alone in other countries. Accordingly, these results are not easily generalisable in schools and countries with different contextual factors. While on this note, it becomes important that learning engagement can also be influenced by other factors such as home background, cultural factors, teacher characteristics and learner characteristics. For example, literature shows that teachers who are angry and not well liked by the learners in addition to failure to encourage learners tend to struggle with developing learning engagement (Yurtseven & Ocak, 2021). The extent to which these factors influenced the research findings is not very noticeably clear. Even so, most of these factors were somewhat uniform among learners from both groups, which means that the major difference in academic achievement and learning engagement could be linked to blended teaching. Nevertheless, the teacher characteristics could not be said to be uniform even though the contribution of this factor was minimised due to team teaching, combined planning, and sharing of resources. However, this study remains significant because most learners in South Africa attend schools similar to the one from which the data were collected.

Collecting data using self-reports came with its own challenges, which included running the risk of learners providing dishonesty responses (Mandernach, 2015) and the idea that the sub-scales in the learning engagement questionnaire could lead to responses that are sometimes subjective (Fazal & Bryant, 2019). This is being highlighted as a potential limitation, even though, according to Reschly and Christenson (2012), learners are capable of providing accurate reports. However, this problem was mitigated using semi-structured interviews. While these interviews served particularly important functions, such as providing further explanations and corroboration, it is worth noting that only six learners (and the teachers for both groups) were from each of the two groups could be interviewed due to time constraints. The relatively smaller sample size of interviewees could have impacted negatively on this research study as

no statistical analysis of the responses could be undertaken during the quantitating of the subthemes and codes which happens to be a problem inherent in the use of mixed methods. As such the quantitated qualitative data could not be subjected to the same statistical treatment as one to which quantitative data were subjected since would have led to the loss of statistical power. However, the relatively smaller sample of interviewees still allowed for data saturation as no new themes emerged. This was in addition to affording opportunities to make the interviews deeper and richer in terms of qualitative data collected.

Additionally, the use of a predominantly sequential explanatory design also placed more pressure on the participants that were eventually interviewed. However, this problem was mitigated by keeping the interviews as short as possible, as well as by ensuring that the learners did not feel being coerced into participating in the interviews. The short interview sessions could have made it difficult to probe all the issues. However, some the learner interviewees had to be reminded to focus on Organic Chemistry only which was a result of the lengthy data collection period associated with sequential explanatory design which was exacerbated by the idea that a preliminary data analysis had to be undertaken before the interview process. By the time the preliminary quantitative data analysis was completed the learners were about to complete the next topic. This posed a limitation despite delaying in depth data analysis of the quantitative which had to coincide with the qualitative analysis which made the collection of data more efficient in addition to avoiding confirmation bias.

Furthermore, the research findings are based on data that were collected once from learners that were being exposed to blended teaching for the first time, which could have resulted in increased learning engagement. Based on this, it could not be determined through this study whether or not the positive effects of blended teaching could be sustained over a long period of time. The self-reports were also administered only once, which could have made it difficult for learners to report on a fluctuation of experience since some aspects of the Organic Chemistry topic could have been easier and more interesting than other others. However, efforts to minimise this included ensuring that the survey questionnaire items were relatively specific as opposed to being generalised. Secondly, the semi-structured interviews afforded the learners the opportunity to give more detail. The use of mixed-methods approach helped in mitigating this problem, even though some interviewees had to be constantly reminded that the interview was based on Organic Chemistry. Additionally, the method used to determine the

effectiveness of blended teaching by comparing it with traditional face-to-face teaching could have led to some limitations.

One such limitation, which is unavoidable, could have been the 'contrast effect' which could have introduced some kind of bias in which the effectiveness of blended teaching in fostering learning engagement and academic achievement could have been slightly exaggerated given that it was based on comparison. However, the researcher was aware of this kind of bias and made an effort to ensure that it was minimised by being as objective as possible. Even though the researcher tried to be as objective as possible, the 'contrast effect' cannot be completely ruled out. Furthermore, the use of the mixed methods approach in which both quantitative data and qualitative data were collected played a significant role in eliminating most of the potential bias. For example, the effectiveness of blended teaching on learning engagement was determined using descriptive statistics, and t-tests. However, the administration of the learning engagement questionnaire could have come with its own limitations in terms of the true reflection of how the learners were performing but the qualitative data from the interviews of learners and teachers helped mitigate this problem. While measures were taken to avoid contrast effects, it is important to note that a contrast effect cannot be completely avoided, hence it is hereby acknowledged as a potential limitation. In addition, it is worth noting that this study focused more on the teaching method used than on learner characteristics.

Research has shown that success of blended teaching is dependent on the level of motivation of learners, which is critical for successful online learning (Garrison & Vaughan, 2008). By extension, successful completion of homework which is not necessarily online also requires that learners be motivated. These levels of self-motivation could also be a limiting factor if one group is more highly motivated than the other. In this study, the success of blended teaching or traditional face-to-face could have been influenced by different self-motivation levels among learners. Furthermore, the issue of child-headed families became a limiting factor in this study. This was more so the case given that literature on learning engagement shows that this multidimensional concept is also influenced by parents (Skinner & Pitzer, 2012). More extensive interrogation of this factor that appears to influence learning engagement could not be undertaken, due to time constraints. More extensive research on parental support versus learning engagement and academic achievement in a variety of contexts in addition to the one similar to that of the present study needs to be conducted.

8.3 Recommendations

As noted earlier in this study, learning engagement was found to be having a moderating effect on the relationship between blended teaching (or traditional face-to-face teaching), however, this study did not test for the possibility that learning engagement could be both a mediator and moderator. Further research is needed to ascertain this, thereby extending knowledge on the consequences of learning engagement and the type of variable learning engagement assumes. For example, this could involve using a conditional process analysis with multicategorical antecedents such as the one suggested by Hayes (2022) using SPSS or SAS or R. However, specific methodology cannot be suggested as this is outside the scope of the present study. Secondly, the type of moderator learning engagement assumed was not determined in this study which requires further research.

Intricately related to learning engagement, the contribution of teacher characteristics on learning engagement was highlighted as a possible limitation even though efforts were made to control this threat to internal validity were made. There is a need to determine which teacher characteristics encourage higher levels of learning engagement using sequential exploratory design, for instance. Having said this, there is a need to extend this inquiry to other chemistry topics and indeed other disciplines. As noted earlier, this study was conducted during a part of term 1 of 2021 only, and as such, there is a need to carry out more longitudinal studies in the same study context in order to track learner progression at many different stages.

As noted earlier, the data collection phase coincided with the third wave of the COVID-19, which made it difficult to introduce all the planned aspects of the blended cycle. Of particular importance was the simulations, which could not be introduced. It would be interesting to determine how the learners would have fared with these simulations. However, the learners' perceptions on simulations were captured using interviews. Moreover, some of the learners bemoaned that they did not get to do many practical activities. As such, the use of simulations is recommended. Any future research ought to endeavour to establish the effectiveness of blended teaching in which simulations are an important component. While on this note, during the collection of data, previously large classes had been split into smaller ones, which was in keeping with the health regulations designed to minimise the spread of COVID-19. These smaller class sizes could have increased the effect size in terms of learning engagement. Research has shown that class sizes of between thirty-one learners and sixty have the highest

success rate when it comes to blended teaching. Based on this, it is recommended that class sizes be reduced to increase the benefits of blended teaching. However, further research that focuses on different class sizes versus blended teaching in a similar study context may be required which may lead to recommendations on revision of public education policy pertaining class sizes and teacher-learner ratio which could be hampered by resistance to change and budgetary constraints.

This research used a fusion of elements of ABL and flipped classroom. Even though this combination seems to have been effective in the study context, there is a need to conduct further investigations with ABL alone, flipped classroom alone, and indeed with other blended learning models such as station rotation, flex, a la carte, and supplemental, for example. As noted by other researchers, this research reiterates the need for clarification on the part played behavioural engagement in the whole puzzle of learning engagement sub-constructs. Consequently, this study did not include many items on behavioural engagement. While on this note, particularly educators and researchers need to agree on what constitutes behavioural engagement given that this learning engagement type appears to overlap more significantly with the other two sub-constructs, thereby making the concept of learning engagement unclear. This clarification ought to be followed up with a similar study that has more items on behavioural engagement. It is hoped that by carrying out this recommendation, the effectiveness of blended teaching in developing learning engagement and academic may become more comprehensive.

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APPENDICES

APPENDIX A: ETHICS CLEARANCE LETTER

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Chakawodza

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H20/11/11**
PROJECT TITLE	Effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 Learners
INVESTIGATOR(S)	Mrs J Chakawodza
SCHOOL/DEPARTMENT	Education/
DATE CONSIDERED	20 November 2020
DECISION OF THE COMMITTEE	Approved Risk Level: Low
EXPIRY DATE	20 December 2023

DATE 21 December 2020 **CHAIRPERSON** J Knight
(Professor J Knight)

cc: Supervisor : Professor E Vhurumuku

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I~~/We~~ fully understand the conditions under which I am~~/we are~~ authorized to carry out the abovementioned research and I~~/we~~ guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I~~/we~~ undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature **Date** 23/12/2020

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B: PERMISSION LETTER FROM MPUMALANGA DEPARTMENT OF EDUCATION

education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Building No. 5 Government Boulevard Riverside Park Mpumalanga Province
Private Bag X11341, Mbombela, 1200
Tel 013 766 5552/5115 Toll Free Line 0800 203 116

Litiko le Temfundvo Umnyango we Fundo Departement van Onderwys Ndzawulo ya Dyondzo

Ms Josephine Chakawodza
Cell phone: 073 823 2830.
Email: 1416315@students.wits.ac.za

RE: The effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 leaners

Your application to conduct research study was received and is therefore acknowledged. The tittle of your research project reads: **"The effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 leaners".**

I trust that the aims and the objectives of the study will benefit the whole department especially the beneficiaries. Your request is approved subject to you observing the provisions of the departmental research policy which is available in the department website. You are requested to adhere to your university's research ethics as spelt out in your research ethics.

In terms of the research policy, data or any research activity can be conducted after school hours as per appointment with affected participants. You are also requested to share your findings with the relevant sections of the department so that we may consider implementing your findings if that will be in the best interest of the department. To this effect, your final approved research report (both soft and hard copy) should be submitted to the department so that your recommendations could be implemented. You may be required to prepare a presentation and present at the departments' annual research dialogue.

For more information kindly liaise with the department's research unit @ 013 766 5124/5148 0r a.baloyi@mpuedu.gov.za

The department wishes you well in this important project and pledges to give you the necessary support you may need.

MR JR NKOSI
[A] HEAD: EDUCATION

21/10/2020
DATE

MPUMALANGA
THE PLACE OF THE RISING SUN

APPENDIX C: PERMISSION LETTER FROM SCHOOL PRINCIPAL



570 Mavuso Street
eThandukukhanya
Ptet Retief

P.O. Box 52
Ptet Retief 2380 Mpumalanga
Tel. (017) 826 1669
Fax (017) 826 1669

Josphine Chakawodza
Cell phone: 073 823 2830
Email: 1416315@students.wits.ac.za

RE: The effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 learners

Your request for permission to your conduct research study was received and therefore acknowledged. The title of your project reads: **"The effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 learners".** I trust that your proposed study will benefit our school, Ndlela Secondary School. Permission to conduct research at Ndlela Secondary School is therefore granted subject to you observing regulations stated in the departmental research policy which is available in the department website. You are further expected to follow adhere to university's research ethics as spelt out in your research ethics.

Your data collection processes should be scheduled to after school hours as per appointment with affected participants. You are requested to share your research findings with the school. The school would like to receive a copy of the final approved research report so that the school may consider implementing your research findings if that will be in the best interest of the school. You may be required to present your research to the school.

For further information please contact me on 0676303648 or via email adlelasec@webmail.com

The school wishes you well in this important project and pledges to give you support in the best way we can.

07-12-2020

DUBE DP
School principal: Ndlela Secondary School

Date

NDLELA SECONDARY SCHOOL
H.O.D. PHYSICAL SCIENCES & NATURAL SCIENCES
2020 -12- 07
SIGNATURE:
CONTROLLED QUALITY NOT QUALITY WORK

APPENDIX D: PARTICIPANT INFORMATION SHEET AND INFORMED CONSENT FOR TEACHERS

Participant Information Sheet for Experimental Group Teacher

Wits School of Education
27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

Dear Physical Sciences teacher,

My name is Josphine Chakawodza. I am a PhD (Education) student at the University of the Witwatersrand. I am conducting a study entitled, *The effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 Learners*. Globally, particularly more recently in the advent of the Covid-19 pandemic, some educational institutions adopted a blended teaching approach to minimize the risk associated with traditional face to face teaching methods. Considering this, and the need to continuously improve learning engagement and academic achievement, you and your learners can potentially benefit from this study. This study seeks to explore the effectiveness of using blended teaching on learning engagement and academic achievement in a developing nation context and in a High School setting. I am inviting you to participate in this study in which you will be using the blended teaching method to teach Organic Chemistry. As the researcher I will be assisting you with some of the online teaching of Organic Chemistry. I will run a 2-day workshop in February 2021 for all the participating teachers online.

Data collection process will include administering an online one-hour long test and a 15-minute questionnaire to your learners when all the Organic Chemistry content has been taught. This will be followed by 40-minute interviews (on learning engagement) of two teachers (1 from each group) and 12 learners above the age of 18 (6 from each group). During the interview I will be writing down and audio taping your responses. All this will be done after normal teaching time at the school premises or online, where possible to minimize any possible Covid-19 transmission. I promise to adhere to all Covid-19 protocols at all times such as sanitizing, wearing a mask, and maintaining social distance. Data collected will be kept safely in password protected files. All data collected will be read and heard by me and my supervisor only, used for academic purposes only and then destroyed after the qualification is obtained. Pseudonyms will be used and all the information that may give away your identity will be removed. This study is associated with a low risk due to the inevitable inclusion of minors. There are no material benefits associated with this study and you are unlikely going to be suffer from any discomfort either. Participation is voluntary, and you are free to withdraw from the study at any time without any negative consequences. If you decide to participate, please sign the attached consent form, and email it back to me. If you have any questions relating to this study, please feel free to contact me.

Yours sincerely,

Josphine M. Chakawodza
011 390 7817
1416315@students.wits.ac.za
Shaun Schoeman (Administrative officer| Research Office-Human Research Ethics Clearance)
011 717 1408
Shaun.Schoeman@wits.ac.za

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

Dear Physical Sciences teacher,

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I am inviting you to participate in this study in which you will be using the traditional face to face teaching method to teach Organic Chemistry. As the researcher I will be assisting you with some of the teaching of Organic Chemistry. I will run a 2-day workshop in February 2021 for all the participating teachers online. Data collection process will include administering an online one-hour long test and a 15-minute questionnaire to your learners when all the Organic Chemistry content has been taught. This will be followed by 40-minute interviews (on learning engagement) of two teachers (1 from each group) and 12 learners above the age of 18 (6 from each group). During the interview I will be writing down and audio taping your responses. All this will be done after normal teaching time at the school premises or online, where possible to minimize any possible Covid-19 transmission. I promise to always adhere to all Covid-19 protocols such as sanitizing, wearing a mask, and maintaining social distance. Data collected will be kept safely in password protected files. The data will be read and heard by me and my supervisor only and used for academic purposes only and then destroyed after the qualification is obtained. Pseudonyms will be used and all the information that may give away your identity will be removed. This study is associated with a low risk due to the inevitable inclusion of minors. There are no material benefits associated with this study and you are unlikely going to be suffer from any discomfort either. Participation is voluntary, and you are free to withdraw from the study at any time without any negative consequences. If you decide to participate, please sign the attached consent form, and email it back to me. If you have any questions relating to this study, please feel free to contact me.

Yours sincerely,

Josphine M. Chakawodza
011 390 7817
1416315@students.wits.ac.za
Shaun Schoeman (Administrative officer| Research Office-Human Research Ethics Clearance)
011 717 1408
Shaun.Schoeman@wits.ac.za

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

Research title: *An effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 learners.*
Name of researcher: Josphine Chakawodza
Consent form for Physical Sciences teachers
I, …… voluntarily agree to participate in the above-mentioned research project. I have read and understood what this research project is all about. This research has been explained to me and I understand what my participation will involve. I understand that I may stop participating without any negative consequences. I understand that all Covid-19 protocols will be always adhered to by the researcher. I was given sufficient time to ask questions and to decide on whether to participate and I agree to the following:
(Please circle the relevant option below.)
I agree to work with the researcher during this project. Yes No
I agree that my participation will be anonymous in the research report. Yes No
I agree that all information that may expose my identity will be removed
from the research reports and any quotes that may be used. Yes No
I understand and agree that anonymity at school level may **not** be
guaranteed due to the use of interviews. Yes No
I agree to be interviewed by the researcher (Josphine Chakawodza)
during this research project if I am requested to do so. Yes No
I agree that the researcher writes down and audio record what I say.
during the interview which is a part of this research project. Yes No
I agree that the information I provide be read and heard.
(In case of audio tapes) by the researcher and her supervisor only. Yes No
I further agree that the information that I provide during this research.
project be used for academic purposes (thesis and academic journals). Yes No
I agree that the information that I provide be stored in a safe place.
then destroyed after the qualification is obtained and any related.
contribution to academic journals is done. Yes No
…….. (Signature of participating teacher)
…… (Name of participating teacher)
…… (Signature of researcher seeking consent)
……. (Name of researcher seeking consent)
……..... (Date)

APPENDIX E: LETTER TO THE PARENTS AND PARENTAL CONSENT

Letter Requesting for Permission To Include Child in Research

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Re: Request for permission from parents or guardians to include their child in research.

Dear parent/ guardian,
My name is Josphine Chakawodza, and I am a PhD student at the University of the Witwatersrand. I am doing research entitled, *An effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 learners.* The research focuses on a difficult topic, Organic Chemistry. I am requesting for permission to include your child, …… in this research. If you grant your permission, your child will be taught Organic Chemistry by his/her teacher with assistance from me, the researcher for 3 weeks and then requested to complete a 15-minute-long questionnaire and write a one-hour-long test at the end of the all the teaching of the Organic Chemistry topic. Your child may also be requested to participate in a 40-minute interview which will be audio recorded. This test which will not be for marks and results that will not be shared with the teacher will give your child more opportunities to prepare for his/her examinations. Similarly, the questionnaire will provide an opportunity for your child to think about how he/she has been interacting with his/her Organic Chemistry work, with classmates and with his/her teacher. This data collection process will be done after the normal teaching time at the school premises or online where possible. I promise to observe all Covid-19 regulations such as sanitizing, wearing a mask all the time and minimising contact through use of online platforms and social distancing.

There are no material benefits associated with this study. Your child will be free to withdraw his/her participation or refrain from answering any questions at any time if she/he feels any form of discomfort without any negative consequences. The identity of your child will be protected in the research report through avoiding the use of your child's real name. Any information that may give away the identity of the school or that of your child will also be removed. The data will be kept in a safe place in an electronic format and in password protected files and only read and heard by me and my supervisor only. The data collected will be used for study purposes only and then destroyed after the qualification is obtained. You are free to choose whether your child can participate in the research. If you would like your child to participate in the study, I am kindly requesting that you sign the consent form attached. If you need any further information about this study, feel free to contact me.

Yours sincerely,

Josphine M. Chakawodza
011 390 7817
1416315@students.wits.ac.za

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Research project title: *An effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 learners.*
Name of researcher: Josphine Chakawodza
Consent form for parents/guardians
I, ……..., hereby agree that my child, …… in Grade…… may take part in the research mentioned above if wants to do so. I have read and understood what this research project is all about. This research has been explained to me and I understand what the participation of my child will involve. I also understand that my child may stop participating or refrain from answering any questions at any time during the study without any negative consequences. I understand that I am free to withdraw my consent at any time without giving any reason and without any negative consequences. I was given enough time to decide on whether or not to participate and I agree to the following:
(Please circle the relevant option below. You have to choose between *Yes* and *No* options provided at the end of each statement).

I understand and agree that anonymity of my child at school level may **not** be guaranteed due to the use of interviews. Yes No
I agree that my child may be interviewed by the researcher (Josphine Chakawodza) during this research project if requested to do so. Yes No
I agree that the researcher writes down and audio record what my child says during this interview which is a part of this research project. Yes No
I agree that the information my child provides be read and heard (in case of audio tapes) by the researcher and her supervisor only. Yes No
I further agree that the information that my child provides during this research project be used for study purposes only. Yes No
I agree that the information that my child provides be stored in a safe place until after the qualification has been obtained and the related academic paper(s) have been published and then destroyed thereafter. Yes No

…… (Signature of parent or guardian)
…… (Name of parent or guardian)
…… (Signature of researcher seeking consent)
…….. (Name of researcher seeking consent)
……... (Date)

APPENDIX F: ASSENT FORM AND PARTICIPANT INFORMATION SHEET

Wits School of Education
27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
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Assent Form

Research project title: *An effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 learners.*

Name of researcher: Josphine Chakawodza

Assent form for learners

I, …… of …… years of age, voluntarily agree to participate in the above-mentioned research project. I have read and understood what this research project is all about. This research also has been explained to me and I understand what my participation will involve. I understand that I may stop participating without any negative consequences. I understand all Covid-19 regulations will be followed during this research and by the researcher. I was given enough time to ask questions and decide on whether to participate and I agree to the following:

(Please circle the relevant option below. You must choose between *Yes* and *No* options provided at the end of each statement).

I agree that my participation will be anonymous in the research report. Yes No

I agree that all information that may expose my identity will be removed.
from the research reports and any quotes that may be used. Yes No

I understand and agree that anonymity at school level may **not** be
guaranteed due to the use of interviews. Yes No

I agree to be interviewed by the researcher (Josphine Chakawodza)
during this research project if I am requested to do so. Yes No

I agree that the researcher writes down and audio record what I say
during the interview which is a part of this research project. Yes No

I agree that the information I provide be read and heard
(in case of audio tapes) by the researcher and her supervisor only. Yes No

I further agree that the information that I provide during this research
project be used for academic purposes (thesis and academic journals). Yes No

I agree that the information that I provide be stored in a safe place until after the
qualification and any related contribution to academic journals is done. Yes No

…… (signature of participating learner)

…… (name of participating learner)

…… (signature of researcher seeking consent)

…… (name of researcher seeking consent)

……..... (Date)

Prospective Participant information sheet for learners

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27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
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Dear Physical Sciences learner,
My name is Josphine Chakawodza, and I am a PhD student in the Science Education Department of the University of the Witwatersrand. I am conducting a study entitled, *The effectiveness of blended teaching on learning engagement and academic achievement in Organic Chemistry: A case study of South Africa Grade 12 Learners.* In this study, blended teaching refers to the thoughtful combination of traditional face to face teaching and online teaching methods. Some studies conducted at mostly universities have shown that blended teaching can improve learning engagement and academic achievement. The question is, can the same be achieved at High School level and in a developing nation? Considering this and the need to reduce the risk of Covid-19 transmissions, you can benefit from this study as a learner.

I am inviting you to participate in this study as a Physical Sciences learner. Data collection process includes a one-hour long test which will not be for marks and results that will not be shared with your teacher in addition to completing a 15-minute questionnaire and possibly being interviewed for 40 minutes. The test will provide you with more opportunities to prepare for your examinations. Similarly, the questionnaire will also help you to think about the way you have been engaging with Organic Chemistry content, with peers and with your teacher. During the interview I will be writing down and audio recording what you say. All this will occur after normal teaching time at the school premises and online where possible to prevent the spread of Covid-19. This will be done in addition to sanitizing, wearing a mask, and minimizing contact by always maintaining physical distance. Data collected will be used for study purposes only and will be heard and read by my supervisor only. All data will be stored safely in password protected files and then destroyed after the qualification is obtained. Your real name will not be used in the research report and any information that may give away your identity will be removed. As the researcher, I will be working with your teacher. There are no material benefits associated with this study and participation is voluntary. You are free to withdraw from the study anytime you feel uncomfortable without any negative consequences to you. I am requesting you to sign the attached assent form and send it back to me via email if you wish to participate in this study. If you have any questions regarding this study, please feel free to contact me.

Yours sincerely,

Josphine Chakawodza
011 390 7817
1416315@students.wits.ac.za
Shaun Schoeman (Administrative officer| Research Office-Human Research Ethics Clearance)
011 717 1408
Shaun.Schoeman@wits.ac.za

APPENDIX G: KNOWLEDGE OF ORGANIC CHEMISTRY TEST

Knowledge of Organic Chemistry test (KOOCT)

Time: 1 hour **Total marks: 50**

This paper consists of two sections-A and B

Instructions to participants:

1. Answer **all** questions in this paper.
2. Answer section A on the first section of your answer sheet in ink..
3. Answer section B on the separate answer sheet provided and write in ink.
4. Take note of the marks allocated to each question which are in brackets (at the extreme right-hand side of each question) as these marks will determine the extent to which you answer each question.
5. Write neatly and legibly.

Section A: Multiple choice questions (14 marks)

Question 1: Each question carries 2 marks. You are provided with four options, A to D from which to choose the correct answer. Write down **only the letter** that corresponds to the answer of your choice. **For example: 1.1 D**. Each question only has **one** answer.

1.1 Which **ONE** of the following compounds is an aldehyde?

A Pentanal

B Ethyl propanoate

C Pentan-2-ol

D Pentan-2-one

1.2 Nthabiseng, a world renown scientist investigates a factor which influences the boiling points of alkanes. She determines the boiling points of the first six straight chain alkanes. Which **ONE** of the following is the **INDEPENDENT VARIABLE** in this investigation?

A Boiling point

B Functional group

C Branching

D Chain length

1.3 Which **ONE** of the following compounds is a **SATURATED** organic compound?

A Ethyne

B But-2-ene

C Propene

D 2-chloropropane

1.4 Which **ONE** of the following is an example of **SUBSTITUTION REACTION**?

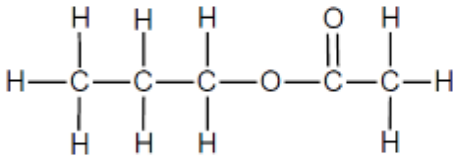
A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$

B $CH_2 = CH_2 + H_2O \rightarrow CH_3CH_2OH$

C $CH_3CH_2OH \rightarrow CH_2 = CH_2 + H_2O$

D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$

1.5 Consider the structural formula of a compound below.



Which **ONE** of the following pairs of reactants can be used to prepare **THE COMPOUND ABOVE** in the laboratory?

A Propanoic acid and ethanol

B Propanoic acid and methanol

C Ethanoic acid and propan-1-ol

D Methanoic and propan-1-ol

1.6 Which **ONE** of the following organic reactions will take place only when exposed to light?

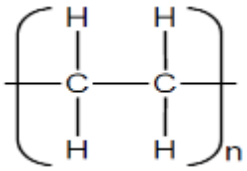
A $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$

B $CH_3CH_3 \rightarrow CH_2CH_2 + H_2$

C $CH_2CH_2 + C\ell_2 \rightarrow CH_2C\ellCH_2C\ell$

D $CH_3CH_3 + C\ell_2 \rightarrow CH_3CH_2C\ell + HC\ell$

1.7 Which organic compound is represented below?



A PVC

B Polystyrene

C Polyethene

D Nylon 6, 6

Section B

Question 2 (22 marks)

The table below shows the boiling points of three isomers.

	ISOMERS	BOILING POINT (^{0}C)
A	2,2-dimethylpropane	9
B	2-methylbutane	28
C	Pentane	36

USE THE DATA IN THE TABLE ABOVE TO ANSWER QUESTIONS 2.2 TO 2.5.

2.1 Define the term *structural isomer*. (2)

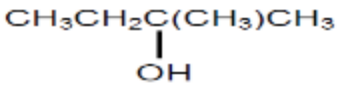
2.2 What type of isomers are these three compounds in the table above? (1)

2.3 Explain the **trend in the boiling points** from compound A to compound C. (3)

2.4 Which **ONE** of the three compounds **(A, B or C)** in the table above, has the highest vapour pressure? **Hint:** Refer to the data in the table above to give a reason. (2)

2.5 Using **MOLECULAR FORMULAE** write down **a balanced equation** for the complete combustion of compound B. (3)

2.6 Consider the formula of an organic compound below.



2.6.1 Is this a **primary, secondary, or tertiary** alcohol?

Give a reason for your answer. (2)

2.6.2 Write down the IUPAC name of the above compound. (2)

2.7 Bongi was given four straight chain alcohols one with a single carbon atom, another with two carbon atoms, third one with three carbon atoms and the last one with four carbon atoms which were produced from four straight chain alkanes.

2.7.1Explain the difference in the boiling points of an alkane and an alcohol, each with three carbon atoms per molecule, by referring to the type of intermolecular forces. (4)

2.7.2 Does the vapour pressure of the alcohols **INCREASE OR DECREASE** with an increase in the number of carbon atoms? (1)

2.7.3 How will the boiling point of **2-methylpropane** compare to that of its chain isomer? Is it going to be **HIGHER THAN, LOWER THAN OR EQUAL TO** that of the chain isomer? Give a reason for the answer by referring to the structural differences between the two compounds. (2)

Question 3 (14 marks)

Thabang and Matshepo are grade 12A learners at Phumelela secondary school. They used a bromine solution to distinguish between compounds X (pentane) and Y (pent-1-ene) on a Tuesday. They added the bromine solution to a sample of each of the two test different tubes. They observed that one compound decolourises the bromine solution immediately, while the other one only reacts with the bromine solution after the test tube was placed in direct sunlight.

3.1 Write down the:

3.1.1Letter **(X or Y)** of the compound that decolourises the bromine solution immediately. (1)

3.1.2 The type of reaction that takes place in the test tube that contains compound X. (1)

3.1.3 **One** precaution that Thabang and Matshepo must take. (1)

3.1.4 Name of reaction in test tube with compound Y. (1)

3.2 On a Thursday, Johan and Mary from the same class carried out a reaction between hydrogen bromide and pent-1-ene. Write down the following:

3.2.1 The **IUPAC** name of the **MAJOR PRODUCT** of this reaction. (1)

3.2.2 Whether the **MAJOR PRODUCT** is **PRIMARY, SECONDARY, OR TERTIARY** alkyl halide and why. (2)

3.2.3 A reason for your choice of the **MAJOR** product in 3.2.1 above. (2)

3.2.4 The **condensed structural formula** of the **MINOR** product for the reaction that Johan and Mary did. (1)

3.2.5 A balanced equation for the reaction that Johan and Mary did. (3)

3.2.6 The type of reaction this is. (1)

THE END

APPENDIX H: MEMORANDUM FOR KNOWLEDGE OF ORGANIC CHEMISTRY TEST

Memorandum for the Knowledge of Organic Chemistry test

Section A

1.1 A √√

1.2 D √√

1.3 D√√

1.4 D √√

1.5 C √√

1.6 D √√

1.7 C √√

Section B

Question 2

2.1 Compounds with the same molecular formula √ but different structural formulae. √

2.2 Chain √

2.3 From A to C

• Less branched/less compact/less spherical/longer chain length/larger surface area (over which intermolecular forces act) √

• Intermolecular forces

Stronger/more intermolecular forces /van der Waals forces/London forces/dispersion forces. √

• Energy

More energy needed to overcome or break intermolecular forces/van der Waals forces. √

OR From C to A

• Structure

More branched/more compact/spherical/smaller surface area (over which intermolecular forces act) √

• Intermolecular forces

Weaker/less intermolecular forces/van der Waals forces/London forces/dispersion forces √

• Energy

Less energy needed to overcome or break intermolecular forces/van der Waals forces √

2.4 A/2,2-dimethylpropane √

Reason: Has lowest boiling point √

2.5 $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ √√√

Mark distribution:

Correct reactants √

Correct products √

Balancing √

• Ignore double arrows and phases

• If condensed structural formulae are used maximum number of marks is 2/3

2.6.1 Tertiary alcohol√

Reason: The 3-C atoms are bonded to the C-atom that has the hydroxide (OH-group) attached to it/the C-atom bonded to the hydroxyl group has no H-atoms. √

2.6.2 2-methylbutan-2-ol/2-methyl-2-butanol √√

Mark distribution: 2-methyl √ Butan-2-ol/2-butanol √

2.7.1

• Alkanes have London/dispersion forces/induced dipole forces√

• Alcohols have H-bonding (in addition to London/dispersion/induced dipole and dipole-dipole

forces) √

• Hydrogen bonds are stronger intermolecular forces than London/dispersion/induced dipole forces. √

• More energy is needed to overcome or break intermolecular forces in alcohols √

• Alcohols have higher boiling points than alkanes. √

2.7.2 Decrease √

2.7.3 Lower than 2-methylpropane is more branched/has a smaller surface area/has a shorter chain length (butane/chain isomer) √
OR Butane/chain isomer is less branched/has larger surface area/longer chain length (than 2-methylpropane)

Question 3

3.1.1 Y √

3.1.2 Substitution reaction √

3.1.3 Ensure that you begin by placing both test tubes away from sunlight and at room temperature. Avoid getting the contents of the test tube in contact with your eyes. (Mark any one of these precautions correct) √

3.1.4 Addition reaction √

3.2.1 Major product is 2-bromopentane √

3.2.2 Secondary √ because the C-atom bonded to the halogen is attached to two alkyl groups/or
to only one hydrogen atom √

3.2.3 Br is added to the double bond C-atom containing the most alkyl substituents or fewer H atoms √ while H will bond to the double bonding C-atom with the most H atoms or fewer alkyl substituents √ (Markovnikov's rule)

3.2.4 $CH_3CH_2CH_2CH_2CH_2Br$ (1-bromopentane)

3.2.5 $2CH_3CH_2CH_2CH=CH_2+2HBr \rightarrow CH_3CH_2CH_2CHBrCH_3 + CH_3CH_2CH_2CH_2CH_2Br$

(Major product) (Minor product)

(Pent-1-ene) 2-bromopentane 1-bromopentane

Mark distribution

• Balancing √

• Reactants √

• Products √

3.2.6 Addition reaction √

APPENDIX I: ORGANIC CHEMISTRY LEARNING ENGAGEMENT SURVEY QUESTIONNAIRE

Organic Chemistry Learning Engagement Survey Questionnaire (OCLESQ)

Name of respondent: ……..... **Age:** ……

Gender: □ Male □ Female **Time:**15 minutes

Instructions:

1. Please indicate to what extent do you agree or disagree with the statements in sections A and B below.

2. Choose only **ONE** answer from the options given and indicate your answer by **ticking the box to the left of your answer**.

Section A: Emotional Engagement (EE)

1. I like Organic Chemistry content very much.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

2. I enjoyed most of the school based Organic Chemistry activities very much.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

3. I enjoyed all the Organic Chemistry activities which I had to do away from the school premises.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

4. I did not find working on the Organic Chemistry work frustrating.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

5. I did not feel anxious about learning Organic Chemistry.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

6. I worked many times with a classmate on Organic Chemistry project or practical or assignments.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

7. I shared ideas with a classmate on an Organic Chemistry assignment or homework many times (more than three times a day).

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

8. I worked with classmates on Organic Chemistry activities many times (more than three times a day) away from school premises.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

9. I could answer most of the questions that the teacher asked during the Organic Chemistry lessons for more than three times per lesson.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

10. I had many opportunities to ask for help from the teacher during the Organic Chemistry in-class lessons.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

11. I felt like I belong to the Organic Chemistry class.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

12. I have been concentrating a lot during most of my Organic Chemistry lessons.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

Section B: Cognitive Engagement (CE)

13. I found most of the in-class Organic Chemistry work less challenging most of the times.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

14. I found it extremely easy to prepare for Organic Chemistry lessons most of the time.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

15. I found it easy to understand the Organic Chemistry activities that I did away from school most of the time.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

16. I was able to answer most of the homework or quiz questions.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

17. I kept trying hard whenever I was given a difficult Organic Chemistry task to complete.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

18. I was able to relate most of things that I learnt to what I already knew.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

19. I found the Organic Chemistry content area remarkably interesting.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

20. I was learning and getting better at Organic Chemistry because of the activities that I did in class.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

21. I was learning and getting better at Organic Chemistry because of the Organic Chemistry activities that I did away from the school premises.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

22. I would like to have similar activities in the next topic.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

23. I found all the Organic Chemistry work important for my learning goals.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

24. The Organic Chemistry activities boosted my confidence in the topic.

□ 1=Strongly disagree □ 2=Disagree □ 3=Sometimes □ 4=Agree □ 5=Strongly agree

THE END

APPENDIX J: SEMI-STRUCTURED INTERVIEW GUIDES

Interview Guide for Learners

Name……..... Age…….

□ Female □ Male

Time: 40-70 minutes

Questions on Emotional Engagement Cognitive Engagement in Organic Chemistry

(Some of the following questions may be asked depending on the responses to the OCLESQ since this is a semi-structured interview)

Emotional Engagement (EE)

1. What did you like (or dislike) most about your interactions with the following: the teacher? learning material? classmates?
2. What made you enjoyed or dislike most of the following: a) School based activities? b) activities that you did away from school? Give an example of the type of activities that you liked or disliked most.
3. What made doing the Organic Chemistry activities frustrating or less frustrating?
4. What would you like to suggest that would make the Organic Chemistry activities less frustrating?
5. If you felt anxious about Organic Chemistry activities, what would you say is the source of this anxiety?
6. What made you concentrate a lot (or less) during Organic Chemistry lessons?
7. What suggestions would you recommend that would enable you to concentrate more on your class activities and on the activities that you had to complete at home?

Cognitive Engagement (CE)

1. What is it about the way you were taught do you think made you more successful (or less successful) in Organic Chemistry in terms of promoting your interactions with classmates, with the teacher and with learning materials?
2. What do you think should be done to the Organic Chemistry activities to make you more successful?
3. What type of Organic Chemistry activities would you like to do more? Give reasons for your answer.

4. What made the activities you did away from school less challenging (or more challenging)?
5. Why do you think you were learning and getting better (or not) at Organic Chemistry because of the following: a) School-based activities b) Activities that you did away from school-based lessons?
6. Why do you think the Organic Chemistry activities boosted your confidence or a had a negative effect on your confidence in the topic?
7. In what ways did the Organic Chemistry activities have a positive or negative impact on your learning goals?

APPENDIX K: INTERVIEW GUIDE FOR PHYSICAL SCIENCES TEACHERS

Name …… □ Female □ Male
Time: 40 minutes
Please note that some of these questions will be asked depending on the clarifications on learning engagement and academic achievement required.
Questions on Emotional Engagement (EE)
1. What did you do (if any) to motivate your learners to willingly participate during your Organic Chemistry lessons and to complete the tasks that they had to do away from school?

2. From your observations, what did your learners interact more with? a) Other learners? b) you as the teacher? c) the learning material?

3. What do you think your learners enjoyed most during the teaching of Organic Chemistry? a) interacting with peers b) the Organic Chemistry activities? interacting with you as the teacher?

4. What do you think promoted the interest in the type of interactions which your learners enjoyed most? What do you think needs to be done to improves all the three types of interactions for the benefit of your learners?

5. Would you say that your learners were free (or afraid) to answer or ask questions or to contribute towards discussions during the lesson and in afterschool learning activities?

6. How easily were your learners able to access the learning activities? What would you do in future to improve this?

Questions on Cognitive Engagement (CE)
1. From your observations, which learning tasks were your learners more successful at and which ones did they find difficult and why?

2. From your observations, which type of interaction helped your learners understand the Organic Chemistry concepts better? a) with classmates? b) with you as the teacher? c) with the content or learning materials?

3. From your observations, how did the learners that were highly engaged perform in the exercises compared to those that were less engaged?

4. Did your learners attempt all questions including the difficult ones which required them to spend a lot of time?

5. From your observations, did the after-school learning activities help your learners prepare for in-class lessons?

6. From your observations, did the learning platform of the learning task have any effect on the interactions and/or academic achievement? Would you use similar activities in your next topic?

APPENDIX L: VALIDATION REPORTS

Report 1

Dear

The test is valid. It's at different levels and covers all major components of the topic.

- Nomenclature
- Physical properties
- Reactions

Regards

Maletsau

Report 2

VALIDATION OF KNOWLEDGE OF ORGANIC CHEMISTRY TEST (KOOCT)

Afternoon xxx

Above matter refers.

1 Interview Schedule for learners

Items in both categories link well with the broader objectives of the study.

2 Interview Schedule for teachers

Both categories are well structured but there is a need to revisit item 3 under the Cognitive Engagement. The sentence is not clear.

3 Knowledge of Organic Chemistry Test

Most of the key concepts within Organic Chemistry section at that level are covered. Language editing may be needed as a way to minimize interpretation of the items. For instance, minor editing I suggested on the following items:

3.2.3 What is the reason (s) …

3.2.5 Provide a balanced …

3.2.6 What type of reaction …

4 Learning Engagement Survey Questionnaire

Items are fine but the student may need to improve on the presentational format of the instrument. The items are too "squashed". Create a "breathing" space by increasing the font size. This may also help in case of participant who may be having a learning challenge such as "sight".

Thanks for letting me preview your student's instruments.

Regards

…….

SIGNATURE

Report 3

I reviewed the test and my recommendations are as follows:

Section A:

- I observed that most of the items were asking for recall answers. I suggest that the items should be a mix of recall and high cognitive order questions. This also depends on how learners were taught and engaged. Very good multiple-choice problem-solving question or case study is required.
- Section B: Question 2.2. Allocation of marks does not seem to align with the type pf answers expected from learners. Unless if it's expected that each response will carry 0.5 or 0.25 mark

APPENDIX M: WORKSHOP OF BLENDED LEARNING



Workshop on
Blended teaching - Cc

APPENDIX N: MOODLE DEVELOPMENT AND INSTALLATION

Moodle: How to install?

Step 1: SSH to the server
https://xneelo.co.za/help-centre/website/ssh-to-your-hosting-server/

Step 2: In the home directory, run the following:
composer require moodle/moodle

Step 3: Create a folder called b moodledatab in the non-web-accessible root directory
mkdir moodledata

Step 4: Change directory to the following moodle folder
cd vendor/moodle/moodle

Step 4: Zip the content which is in the /vendor/moodle/moodle folder.
zip -qvr moodle.zip ./.

Step 5: Move the zip file to the web directory.

If for the main domain:
mv moodle.zip ~/public_html

If for a folder a Multiple domain: (replace b folderb with relavant folder name or Multiple domain name)
mv moodle.zip ~public_html/folder

Step 6: Change directory to where you have moved the zip file.

If for the main domain:
cd ~/public_html

If for a folder a Multiple domain: (replace b folderb with relavant folder name or Multiple domain name)
cd ~/public_html/folder

Step 7: Unpack the compressed file.
unzip moodle.zip

Step 8: Edit the install.php file:
vi install.php

Step 9: Navigate to line 90 and change the file path.

Hold down b shiftb , press b :b and then Type b 90b and hit enter
Press b Ib

If for the main domain:
Replace b require_once(DIR.\b /lib/classes/component.php\b);b
with b require_once b /usr/www/users/FTP_user/lib/classes/component.phpb ;b

If for a folder a Multiple domain: (replace b folderb with relavant folder name or Multiple domain name)
Replace b require_once(DIR.\b /lib/classes/component.php\b);b
with b require_once b /usr/www/users/FTP_user/multiple-domain.tld/lib/classes/component.phpb ;b

Step 10: Go to line 91 and change the file path:

If for the main domain:
replace b require_once(DIR.\b /lib/installlib.php\b);b
with b require_once b /usr/www/users/FTP_user/lib/installlib.phpb ;b

If for a folder a Multiple domain: (replace b folderb with relavant folder name or Multiple domain name)
replace b require_once(DIR.\b /lib/installlib.php\b);b
with b require_once b /usr/www/users/FTP_user/multiple-domain.tld/lib/installlib.phpb ;b

Step 11: Save the change
Hit b Escb and type b :wq!b

Step 12: Browse to the website and select the preferred language.

Step 13: Specify the Data directory file path.
Set the data directory as b /usr/home/FTP_user/moodledatab

Step 14: Select MariaDB

Step 15: Fill in the database connection strings.
To create a database in konsoleH, please refer to:
https://xneelo.co.za/help-centre/website/managing-website/mysql/how-do-i-create-and-manage-a-mysql-database-2/

22.1 Errors experienced during installation.

Fatal error: $CFG->dataroot is not configured properly, directory does not exist or is not accessible! Exiting.

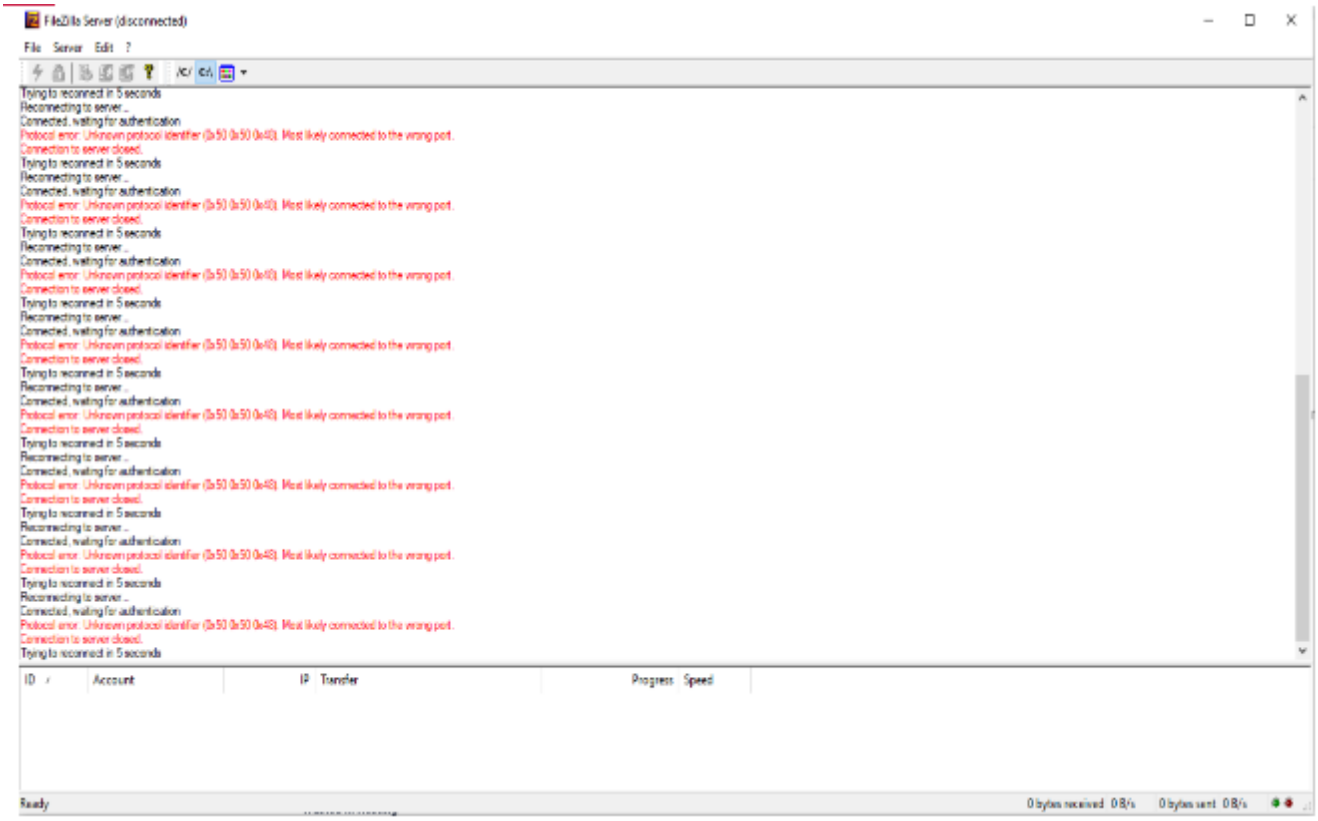
Internal Server Error

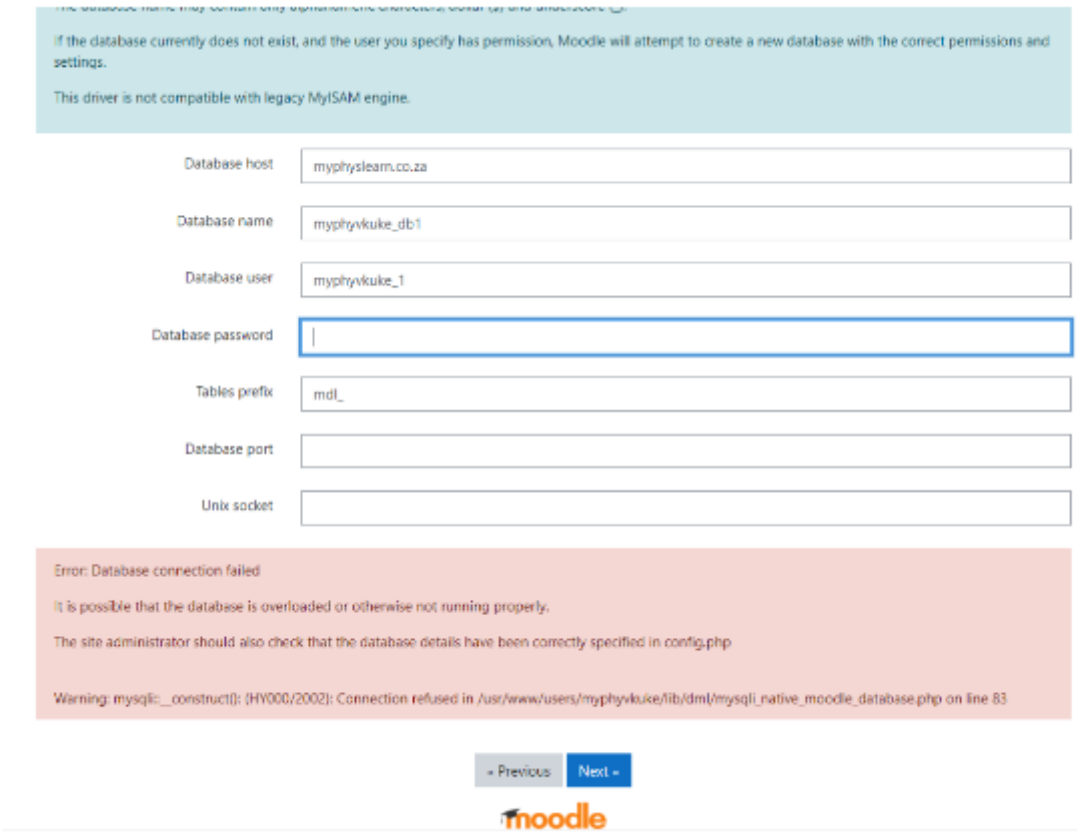
The server encountered an internal error or misconfiguration and was unable to complete your request.

Please contact the server administrator at webmaster@myphyslearn.co.za to inform them of the time this error occurred, and the actions you performed just before this error.

More information about this error may be available in the server error log.

Apache Server at myphyslearn.co.za Port 80




If the database currently does not exist, and the user you specify has permission, Moodle will attempt to create a new database with the correct permissions and settings.
This driver is not compatible with legacy MyISAM engine.
Database host
myphyslearn.co.za
Database name
myphyvkuke_db1
Database user
myphyvkuke_1
Database password
Tables prefix
mdl_
Database port
Unix socket
Error: Database connection failed
It is possible that the database is overloaded or otherwise not running properly.
The site administrator should also check that the database details have been correctly specified in config.php
Warning: mysqli::__construct(): (HY000/2002): Connection refused in /usr/www/users/myphyvkuke/lib/dml/mysqli_native_moodle_database.php on line 83
« Previous
Next »
moodle


Error

APPENDIX O: MYPHYSLEARN USER GUIDE FOR LEARNERS

MyPhysLEARN Student User Guide

https://myphyslearn.co.za

2021-03-14

Introduction

MyPhysLEARN

Contents

1 Getting started: 2

1.1 How to download the MyPhysLEARN Moodle app. 2

1.2 How to login into the MyPhysLEARN Moodle app. 2

2 Accessing course content: 3

1 Getting started:

1.1 How to download the MyPhysLEARN Moodle app

1. Download the Moodle official app using the following link:

• For Android users go to: https://play.google.com/store/apps/details=com.moodle.moodlemobile&hl=en_ZA&gl=US

• For Apple iphone users go to: https://apps.apple.com/za/app/moodle/id633359593

2. Alternatively, you can type ’Moodle’ in the Google play/App store and download the Moodle official app with the following icon:

1.2 How to login into the MyPhysLEARN Moodle app

After downloading the Moodle app do the following:

1. The app will ask for the site URL, type in ‘https://myphyslearn.co.za’ and click on the ’connect to site myphyslearn.co.za’.

2. Then type in the username and password you were provided with.

3. Click "Log in" and you are now logged in.

2 Accessing course content:

1. Once you logged in, site home -> Available courses -> Physical Sciences Grade 12.

2. To make course available offline, click ’download course’.

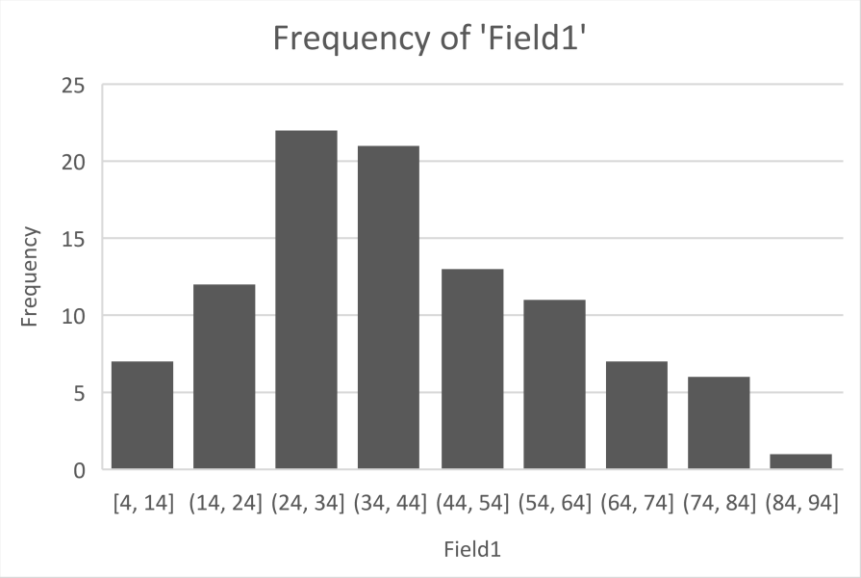
3. To simply look at the course content, click ’contents’.

4. To open in your web browser, click ’Open in browser’.

APPENDIX P: RAW DATA ON ACADEMIC ACHIEVEMENT

Group 1-KOOCT results

26	52
32	64
35	70
21	42
15	30
15	30
12	24
16	32
42	84
36	72
14	28
22	44
23	46
2	4
6	12
43	86
10	20
8	16
15	30
18	36
17	34
17	34
20	40
19	38
11	22
20	40
17	34



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14	28
15	30
12	24
13	26
10	20
24	48
25	50
21	42
5	10
18	36
8	16
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6	12
7	14
13	26
18	36
11	22
25	50
38	76
15	30
3	6
9	18
14	28
30	60
20	40
28	56
20	40
21	42
25	50
22	44

19	38
13	26
33	66
16	32
26	52
42	84
25	50
21	42
28	56
22	44
32	64
30	60
22	44
31	62
36	72
41	82
28	56
28	56
34	68
26	52
37	74
26	52
30	60
34	68
20	40
9	18
23	46
5	10
39	78
14	28
18	36

32	64
40	80
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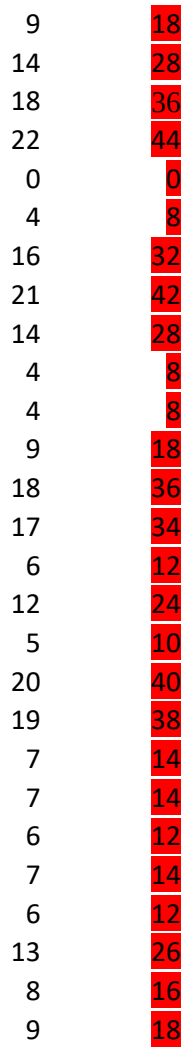
16	32
14	28
18	36
17	34
15	30
25	50

Group 2 KOOCT Results



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11	22
13	26
9	18
13	26
8	16
6	12
3	6
16	32
16	32
3	6
14	28
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7	14
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12	28
6	12
16	32
23	46
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15	30
7	14
8	16
22	44
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14	28
11	22
9	18
9	18
10	20

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5	10
10	20
12	24
16	32
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23	46
23	46
20	40
18	36
15	30
19	38
15	30
23	46
20	40
21	42
16	32
5	10
10	20
17	34
23	46
21	42
14	28
21	42
19	38
21	42
21	42
16	32
25	50
7	14
14	28

6	12
10	22
11	22
25	50
9	18
10	20
15	30
20	40
16	32
21	42
25	50

Key

Column one (not highlighted) is the mark out of 50

The column highlighted in red consists of column one marks converted to a percentage.

APPENDIX Q: RAW DATA ON LEARNING ENGAGEMENT

Group 1 Results For OCLESQ

EE4	EE5	EE6	EE7	EE8	EE9	EE10	EE11	EE12	EE-tot	CE13	CE14	CE15	CE16	CE17	CE18	CE19	CE20	CE21	CE22	CE23	CE24	CE-tot	Total
4	5	5	4	5	5	5	4	4	53	4	3	4	4	3	4	4	4	4	5	4	4	47	100
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4	4	3	3	4	2	4	3	4	41	3	4	3	4	4	4	4	4	4	4	4	4	46	87
3	4	3	4	3	3	4	3	4	41	3	4	3	3	4	3	4	4	3	4	4	4	43	84
2	2	3	1	4	3	5	1	3	34	3	4	2	3	4	4	3	4	3	4	3	2	39	73
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3	2	4	3	2	2	3	3	3	36	2	3	4	2	4	4	3	4	3	4	4	3	40	76
3	4	4	4	4	3	3	5	4	48	3	4	4	4	5	4	4	3	3	5	4	5	48	96
4	2	2	4	4	4	2	2	3	39	2	2	2	2	2	2	2	2	2	2	2	2	24	63

5	4	5	4	5	5	5	5	4	**57**	5	4	5	5	5	5	5	5	5	5	5	5	**59**	**116**
2	4	2	3	4	2	3	1	4	**34**	3	3	3	3	4	4	3	2	3	4	1	2	**35**	**69**
2	4	4	4	4	3	4	3	4	**40**	2	2	2	2	4	4	2	4	4	4	4	4	**38**	**78**
2	3	1	2	2	2	4	2	4	**30**	4	3	2	3	4	4	3	3	2	3	2	1	**34**	**64**
3	3	2	2	2	4	4	3	5	**38**	4	4	4	5	5	5	5	4	4	4	5	5	**54**	**92**
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3	4	5	4	4	3	5	5	5	**52**	4	4	4	5	4	5	5	4	5	5	5	5	**55**	**107**

Group 2 Results for OCLESQ

EE1	EE2	EE3	EE4	EE5	EE6	EE7	EE8	EE9	EE10	EE11	EE12	EE-tot	CE13	CE14	CE15	CE16	CE17	CE18	CE19	CE20	CE21	CE22	CE23	CE24	CE-tot	Total
5	5	5	3	2	5	5	5	3	3	5	5	51	5	5	5	3	5	5	5	5	5	5	5	5	58	109
3	3	4	2	4	4	3	4	4	4	3	2	40	5	4	5	3	2	3	3	2	4	4	3	3	41	81
4	4	4	4	4	4	4	3	4	4	4	3	46	4	3	4	3	4	4	3	4	4	3	4	3	43	89
4	5	4	2	4	4	4	4	3	4	4	4	46	3	4	4	4	4	4	3	4	4	4	3	4	45	91
2	3	2	2	4	4	5	5	5	3	4	4	43	2	4	5	3	4	4	4	4	5	4	3	3	45	88
3	3	3	2	2	4	3	3	2	3	3	2	33	3	2	4	3	3	3	3	3	2	4	2	1	33	66
3	4	5	3	2	5	5	5	3	5	5	5	50	5	5	5	3	5	5	5	5	5	5	5	4	57	107
3	3	2	3	4	3	3	2	2	2	3	2	32	3	3	2	3	3	5	4	3	1	2	2	1	32	64
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5	5	3	3	2	4	4	4	3	2	4	2	41	2	2	3	2	3	2	1	3	3	4	3	2	30	71
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5	4	5	4	5	4	4	5	5	5	5	5	56	4	5	5	5	4	5	5	4	5	5	5	5	57	113

APPENDIX R: WELCOME MESSAGE FROM THE ONLINE PLATFORM

Welcome to MyPhysLearn

Dear Grade 12 Physical Sciences learners,

A warm welcome to you all to this exciting online learning platform, MyPhysLearn which is a component of blended learning. MyPhysLearn can be accessed directly through the website or via a mobile App which you can use offline. We would like to emphasize that as part of blended learning, teaching, and learning is going to be on **both** this particular online platform (MyPhysLearn) and in your normal classrooms at the school. It is important to note that blended learning is increasingly becoming popular globally due to a variety of reasons. For instance, this mode of learning can benefit you, the learners in so many ways. For example, by using the MyPhysLearn site you will be able to learn anywhere, anytime and at a pace that is comfortable to you. By utilizing this site for learning purposes, more in-class time will be available, and you will be able to get more help from your teacher and to do more difficult questions which will improve your performance. We therefore encourage you to do all the learning activities assigned to you in both the classroom and on this wonderful site, MyPhysLearn. As your teachers, we would like to encourage you to do the following:

• Make it a point that you participate regularly on the discussion forum (at least once in 1-2 days per week and share information with fellow learners-this will not only benefit others, but it will also help you to further improve your understanding of physical sciences. **Avoid discussing anything that is not related Physical Sciences on this site.**

• Ask questions-others facing the same problem also stand to benefit.

• Do all learning activities posted.

• Study hard as this will help you post more meaningful contributions during discussions as well as ultimately improving your performance.

• Please follow the rules on online communication which requires that you use non offensive, respectful, and formal language (just to mention a few). Please avoid using sms/WhatsApp language. You are learning Physical Sciences in English-please stick to English for all communications on the site.

• Stick to the deadlines stipulated for each learning activity and follow instructions at all times.

As your teachers, we promise to do the following:

• To create a learning environment that is conducive to learning which includes enforcing rules.

• To visit the online learning platform at least once a day.

• To provide feedback on questions that need my attention once a day **(between 7pm and 8pm).**

• To post learning activities daily **5 days a week**.

We would like to emphasise that the success of this mode of learning rests on all of us-we can make it work and ultimately benefit from it.

Regards,
Physical Sciences teachers.

APPENDIX S: CALCULATION OF THE CRONBACH'S ALPHA TEST FOR THE OCLESQ

Cronbach's alpha can be written as a function of the number of test items and the average inter-correlation among the items. Below, for conceptual purposes, we show the formula for the Cronbach's alpha:

$$\alpha = \frac{N\bar{c}}{\bar{v} + (N-1)\bar{c}}$$

Here N is equal to the number of items, $\bar{c}$ is the average inter-item covariance among the items and $\bar{v}$ equals the average variance.

One can see from this formula that if you increase the number of items, you increase Cronbach's alpha. Additionally, if the average inter-item correlation is low, alpha will be low. As the average inter-item correlation increases, Cronbach's alpha increases as well (holding the number of items constant).

Screenshot showing the Results Cronbach Alpha test for the Questionnaire

```
#Cronbach alpha test
library(psych)
#calculating the Cronbach alpha:
#df will be my dataframe for the questionaire
alpha(df)$total$std.alpha
#alpha=0.8260078, this suggest that the variable have a relatively high internal consistency.
```

APPENDIX T: QUALITATIVE ANALYSIS CODES

Table T.1: Codes for Cognitive Engagement Theme

Cognitive engagement sub themes and their codes	General perceptions Organic Chemistry codes	Perseverance codes	Assessment codes	Learning material interactions codes	Learning goal/self-reflection codes	In-depth learning Codes	Interest codes	Self-directed and self-regulated learning Codes
	Organic Chemistry as easy. Organic Chemistry was difficult. Organic not easy at times	Perseverance Inconsistent perseverance Did not persevere at all.	Homework more helpful All activities helpful In-class activities easy at times In-class activities not helpful In-class activities difficult In-class activities easy Homework difficult Homework easy Some parts of the topic difficult	Notes helpful. Notes not helpful. Watched videos. Did not watch videos. Read notes. Read notes at times. Did not read notes. Notes too abstract.	Achievable Not achievable Goal at risk	Understood better. Desire to understand more about answers	Interesting Not interesting Interesting at times	Learners started working on their own. Learners initiated own Organic Chemistry discussions. Independent learning Many learners were asking for more activities. Learners did own extra work

Table T.2: Codes for Affective Engagement Theme

	Enjoyment codes	Frustration Codes	Learning material	Concentration codes	Anxiety codes	Opportunities to ask and answer questions codes	Confidence codes	Boredom codes	Sense of belonging codes	Negative interactions with teacher
Affective Engagement sub themes and the codes	Enjoyed topic. Not enjoying topic Liking game Enjoyment of in-class activities Lack of enjoyment of in-class activities Enjoying quizlet. Liked quizzes. Liked prompt feedback. Liked videos. Did not like watching videos. Favourite topic	Frustrated Work frustrating. Frustrated at times. Frustrated at first	Too many notes	Could have concentrated more. Not concentrating Concentrated a lot. Concentrated better at home. Concentrated less.	Felt unsettled. Anxious at times No anxiety Anxious at first	Asked questions. Answered questions. Answered questions at times. No chance to ask questions.	Felt confident. Confidence boosted. Not confident Confident at times Afraid that answer was wrong.	Learners are bored. Not bored Bored at times. Absenteeism Demotivated	Not part of the class We are family. Excluded from groups. Part of the class Belong to my class. Prefer learners from other schools. Prefer teachers from other schools.	Dislike interacting with teacher. Do not understand teacher when teaching. Asked teacher. Teacher helps me understand.

Table T.3: Codes for Participatory Behavioural Engagement Theme

Participation behavioural sub themes and their codes	**Sharing ideas codes**	**Help from other learners. codes**	**Debating issues codes**	**Working with classmates in class codes**	**Working with classmates after school codes**	**Participation on discussion forum codes**	**Negative interactions codes**	**Preference to work alone**
	Shared ideas Shared information	Classmates not helping others. Refusal of help from classmate	Debated	Worked classmates during extra lessons at times. Worked with classmates at times. No in-class working with classmates. Worked with classmates during lessons.	Worked with classmates after school. Worked alone afterschool. Worked Worked with classmate at times. No after-school work with classmates Formed groups after school. Worked with friends	Did not what to say there. Afraid there were many people on the forum	Excluded from groups. Fighting Groups not lasting. Unhealthy competition Disrespect	Prefers to work alone. Not a group person

APPENDIX U: COGNITIVE ENGAGEMENT TABLES SHOWING APPLICATION OF CODES

Table U.1: Frequency Counts of Positive Cognitive Engagement Theme for Groups 1 and 2

Theme	Group 1-Blended teaching (Experimental)		Group 2-Traditional face-to-face teaching (Control)	
	Sub-themes	**Code match and frequency**	**Sub themes**	**Code match and frequency**
Positive cognitive engagement	Organic Chemistry generally easy	1. Organic Chemistry was easy compared to other Physical Sciences topics. **(E-1) Reasons:** Fewer calculations and fewer notes 2.Organic Chemistry was easy **(E-2)** 3. Organic Chemistry is the easiest topic **(E-3)**	Organic Chemistry generally easy	
	Perceptions on assessment and effort	1. Found it easy because of a lot of practising on the app **(E-1)** 2. Performance improved **(E-7)** 2. Learners started attempting more challenging questions **(E-7)** 3 Did all the homework **(E-2)** 4. Perceived work as helpful **(E-2)** 5. Got good marks **(E-4)** 6. Could answer most of the questions **(E-5)** 7. Homework was more helpful **(E-6)** 8. App was helpful **(E-2)** 9. App was helpful **(E-3)** 10. In-class work was too easy **(E-4)**	Perceptions on assessment	1.Work done away from school was less challenging **Reason:** working with classmates **(C-2)** 2. Getting better because of after school activities. 3.Homework was more helpful. **(C-4)** 4. Learning better because of afterschool activities. **(C-5)** 5. Homework more helpful **(C-5)** 6. After class activities were more helpful **(C-3)**

	Learning material perceptions	1 used notes, videos, and quizzes **(E-3)** watched videos and found work helpful **(E-1)** 2. Learners interacted with content on the online platform **(E-7)** 3. Learners were more into videos **(E-7)** 4. Watched videos **(E-2)** 5. Read notes **(E-2)** 6. Practiced a lot with the questions **(E-2)** 7. Videos were informative **(E-4)** 8. Notes were helpful. **(E-5)**	Learning material perceptions	
	In-depth learning	Learners wanted to understand why answers were wrong or correct **(E-7)** Blended learning helped me to understand better **(E-1)**		
	Interest	1. Found Organic Chemistry interesting **(E-1)** 2. Activities were interesting-like wow! **(E-4)** 3. Found Organic Chemistry interesting **(E-6) Reason:** new and challenging topic.	Interest	Found it very interesting **(C-2)**
	Perseverance	1. Most learners used all the three attempts to improve their marks. **(E-7)** 2. Learners started doing longer questions. **(E-7)** 3. Learners were no longer leaving blank spaces. **(E-7)** 4. Learners started attempting more challenging questions. **(E-7)**	Perseverance	
	Self-directed learning and self-regulated learning	1. Learners started working on their own. **(E-7)**	Self-directed learning and self-regulated learning	

		2. Learners initiated own Organic Chemistry discussions. **(E-7)** 3. Independent learning **(E-2)** 4. Many learners were asking for more activities to be uploaded. **(E-7)** 5. Learners taking to do extra work		
	Learning goal	1. Perceived learning goals as achievable **(E-2)** 2. Perceived learning goals as achievable **(E-4)** 3. Perceived learning goal as achievable **(E-5)** 4. Learning goal achievable **(E-6)** 5. Learning goal achievable **(E-1)** 6. Perceived learning goal as achievable **(E-3)**	Learning goal	

Table U.2: Frequency Counts of Negative Cognitive Engagement for Groups 1 and 2

Theme	**Group 1-Blended teaching (Experimental)**		**Group 2-Traditional face-to-face teaching (Control)**	
	Sub themes	**Code match and frequency**	**Sub themes**	**Code match and frequency**
Negative cognitive engagement	Perception Organic Chemistry was difficult		Perception Organic Chemistry was difficult	Learners perceive Organic Chemistry as difficult **(C-7)** More lessons needed to become more successful **(C-5)**
	Inconsistent perseverance	Too tired to continue pushing **(E-4)**	Perseverance	Learners not doing work at all **(C-7)**
	Learning material		Learning material	1. Notes difficult to understand **(C-3)** 2. Notes not easy to understand **(C-2)** 3. Learners not studying **(C-7)** 4. Prefers to watch videos **(C-2)** 5. Only used notes **(C-5)**

	Assessment	1. Learners generally struggled with questions on Organic reactions. **(E-7)** 2. Learners struggled to with conditions of Organic reactions, identifying/listing down reactants and products **(E-7)** 3. Struggled with polymerization **(E-5)** 4. Work overload **(E-4)** 5. School-based activities deemed less important-too easy and unimportant **(E-6)**	Assessment	1. Organic reactions were challenging 2. Organic chemistry activities were difficult **(C-2)** 3. I am not doing well **(C-2)** 4. It was hard for me to answer the questions. 5. work done in class was more difficult. **(C-2)** **Reason:** fewer in-class interactions 6. Organic reactions were difficult **(C-1)** 7. Practice questions too few **(C-3)** 8. After school activities were more difficult. **(C-5)** 9. In-class activities not helpful **(C-4)** 10. Struggled with Organic Chemistry reactions **(C-6)** 11. Struggle with polymerization **(C-6)** 12 Learners failing to communicate the content effectively **(C-7)** 13. Found questions on practical work challenging **(C-3)** 14. Getting better because of after school activities **(C-6)** 15. Interpreting graphs on physical properties was difficult **(C-3)** 16. Struggled with polymers and Organic reactions **(C-3)** 17. More activities needed. **(C-1)** 18. More activities needed **(C-2)** 19. Practice questions were not enough **(C-4)** 20. Questions on practical work difficult **(C-2)**

	Learning goal		Learning goal	1. I do better in physics than Chemistry 2. Learning goal at risk because of Organic Chemistry **(C-1)** 2. Learning goal not achievable because of Organic Chemistry **(C-6)**
	Interest		Interest	Learners lack interest **(C-7)**
	Self-directed learning/self-regulation		Self-directed learning	1.Teacher reads notes for learners **(C-7)** 2. Learners not doing homework **(C-7)** 3. Some learners not doing homework **(C-7)**

Table U.3: Frequency Counts of Mixed Cognitive Engagement for Groups 1 and 2

Theme	Group 1-Blended teaching (Experimental)		Group 2-Traditional face-to-face teaching (Control)	
	Sub themes	**Code match and frequency**	**Sub themes**	**Code match and frequency**
Mixed cognitive engagement	Inconsistent perseverance	Left some of the work undone **Reason:** There were times I didn't understand a thing **(E-5)**	Inconsistent perseverance	Solution must come quickly **(C-7)**
	Not interested at times	Found Organic Chemistry interesting at times **(E-5)**	Not interesting at times	Organic Chemistry was not interesting at times **(C-2)**
	Learning material	1. Some learners did not read notes **(E-7)** 2. Learners ignored the other written material posted. **(E-7)** 3. Can't be reading notes all the time. **(E-6)** 4. Did not watch videos that much. **(E-6)**	Learning material	1. Sometimes notes were not easy to understand. **(C-3)** 2. Work sometimes too much **(C-2)**
	Assessment perceptions	1. In-class activities were more difficult compared to homework. **(E-5)** 2. Difficult at first **(E-6)** 3. Struggled with polymerization **(E-5)**	Assessment perceptions	1.Did not revise work consistently **(C-1)** 2. After class activities more helpful **(C-6)** 3. Found some activities difficult **(C-3)**
	Organic Chemistry difficult at times	1. Organic Chemistry was challenging at first **(E-4)** 2. Struggled with polymerization **(E-5)**	Organic Chemistry difficult at times Only understands some aspects of Organic Chemistry	1. Understood types of reactions better. **(C-4)** 2. Found some aspects of the topic less challenging (Organic reactions) **(C-6) Reason**-disruptions in class therefore not in-class activities 3. Did not understand the teacher on IUPAC naming and homologous series. **(C-5)-**I don't understand the teacher. 4 Naming was a bit hard for them **(C-7)**

APPENDIX V: AFFECTIVE ENGAGEMENT TABLES SHOWING APPLICATION OF CODES

Table V.1: Frequency Counts of Affective engagement Theme for Groups 1 and 2

Theme	**Group 1-Blended teaching (Experimental)**		**Group 2-Traditional face-to-face teaching (Control)**	
	Sub theme	**Code match and frequency**	**Sub theme**	**Code match and frequency**
Positive affective engagement	Enjoyment	1. That's my favourite topic **(E-2)** 2. Enjoyed the game **(E-4)** 3. Learners liked immediate feedback. **(E-7)** 4. Learners liked short quizzes where they could do quickly and finish **(E-7)** 5. It (game) was fun. ….. could play the game while learning **(E-3).** 6. Liked quizlet very much **(E-5)** 7. Liked the prompt feedback **(E-1)** 8. Liked the idea of getting immediate feedback **(E-3)**	Enjoyment	
	Confidence	1. Became more confident **(E-3)** 2. Felt confident **(E-1)** 3. Confidence was boosted **(E-4)**	Confident	Practicing with difficult questions helped **(C-3)** Activities boosted confidence **(C-4)**

	Opportunities to ask and answer questions	Given many opportunities to ask. **(E2)** Asked questions. **(E-3)** Learners were able to make contributions in class. **(E-7)** Learners were asking more questions. **(E-7)** Asked many questions especially on Organic reactions **(E-6)** Asked questions and participated **(E-4)** Asked questions the teacher **(E-5)**	Opportunities ask and answer questions	Answered the questions approximately twice. **(C-4)** Asked questions **(C-4)**
	Sense of belonging	1. I belong to my class **(E-4)** 2. Free to ask to express oneself **(E-3)**		
	Anxiety	New teaching method did not trigger any anxiety		
	Frustration		Frustration	
	Concentration			

Table V.2: Frequency Counts of Negative Affective engagement Theme for Groups 1 and 2

Theme	**Group 1-Blended teaching (Experimental)**		**Group 2-Traditional face-to-face teaching (Control)**	
	Sub themes	**Code match and frequency**	**Sub themes**	**Code match and frequency**
Negative affective engagement	Enjoyment (lack of it)	1. Did not enjoy school-based activities **(E-6)** 2. Learners do not like reading **(E-7)**	Enjoyment (Lack of it)	1.Too many notes **(C-7)** 2.Too abstract **(C-7)** 3.Dislikes interactions with classmates **(C-6) Reason:** they will be making noise 4. Disliked interactions with the teacher **(C-5) Reason:** Don't understand the teacher
	Anxiety		Anxiety	1. Felt anxious about Organic Chemistry activities. **(C-2) Reason:** Failure to understand. 2. Scared of making mistakes **(C-6)** 3. Felt anxious because of unexpected tests. **(C-1)**
	Sense of belonging (lack of it)	1. Not part of the class **(E-6) Reason:** Unhealthy competition 2. Classmates think highly of themselves **(E-1) Reason:** Unhealthy competition	Sense of belonging (lack of it)	1. Excluded from groups and notes stolen **(C-6)** 2. Prefers to work with learners from other schools. **(C-1)**
	Concentration (lack of it)		Concentration (lack of it)	1. Could not concentrate in class. **(C-1) Reason:** classroom conditions-poor classroom management skills. 2. Concentrated better at home than in class. **(C-4)** 3.Not concentrating **(C-2) Reason:** noisy classroom 4.Concentrated less because could not understand the teacher **(C-5)**
	Frustration		Frustration	1. Work difficult to understand **(C-1)** 2. Organic Chemistry frustrating **(C-2)**

	Confidence (lack of it)	Scared the answer was wrong **(E-4)**	Confidence (lack of it)	Successfully worked with learners and teachers from other schools once **(C-1)**
	Opportunities to ask questions and to answer questions (lack of it)		Opportunities to ask questions and to answer questions.	1. Didn't get a chance to ask questions **(C-3) Reason:** Time constraints 2. Answered questions only a few times **(C-3) Reason:** Doesn't understand the work
	Boredom		Boredom	1. Learners are bored and demotivated **Reason:** Covid-19 pandemic, teachers dying and other things. All they hear is death rates, and protests. **(C-7)** 2. Absenteeism and selective when attending extra lessons **(C-7)**

Table V.3: Frequency Counts of Mixed Affective engagement Theme for Groups 1 and 2

Theme	**Group 1-Blended teaching (Experimental)**		**Group 2-Traditional face-to-face teaching (Control)**	
	Sub themes	**Code match and frequency**	**Sub themes**	**Code match and frequency**
Mixed affective engagement	Initially frustrated	1. Thought Organic Chemistry was difficult but realised the mistakes were minor. Initially underestimated the topic. **(E-4)** 2. Frustrated at first **(E-3)** 3. Felt frustrated at times **(E-5)** 4. Felt frustrated at first **(E-6)**		
	Anxiety	Sometimes felt anxious **(E-5) Reason:** did not understand at times.	Anxiety	Sometimes felt anxious **Reason:** Lack of preparations

APPENDIX X: PARTICIPATION BEHAVIOURAL ENGAGEMENT TABLES SHOWING APPLICATION OF CODES

Table X.1: Frequency of Positive Participation behavioural engagement Theme for Groups 1 and 2

Theme	**Group 1-Blended teaching (Experimental)**		**Group 2-Traditional face-to-face teaching (Control)**	
	Sub-theme	**Code match and frequency**	**Sub-theme**	**Code match and frequency**
Positive participation behavioural engagement	Sharing ideas/information exchange	1. Shared information **(E-5)** 2. Learners participated during the F2F component **(E-7)** 3. Participated a lot in class **(E-6)**	Sharing ideas/information exchange	1. Worked with classmates after the lessons **(C-2)** 2. Working with classmates (after school) was helpful **(C-1)** 3. Worked with classmates after school **(C-3)** 4. Worked with classmates after school **(C-4)** 5.Worked with classmates after school (C-5)
	Helped by other learners	1.Got help from other learners. 2. Asked other learners during the lesson **(E-2)**	Helped by other learners	1. Helped by other learners after school. 2. Got help (from peers) during extra lessons

	Debating issues	Debated on questions and arrived at correct answer **(E-4)**	Debating issues	
	Groupwork/Discussions	Worked in groups during lessons **(E-3).**	Groupwork/Discussions	1. Learners have afterschool groups **(C-7)**

Table X.2: Frequency of Negative Participation behavioural engagement for Groups 1 and 2

Theme	**Group 1-Blended teaching (Experimental)**		**Group 2-Traditional face-to-face teaching (Control)**	
	Sub theme	**Code match and frequency**	**Sub theme**	**Code match and frequency**
Negative participation behavioural engagement	Groupwork/discussions (absence thereof)	1. Prefer to work alone **(E-2)** and **E-6** 2. Not a group person- Classmates looking down on others **(E-6)** 3. Would like more interactions other learners. **(E-1)** 4. No group lasts **(E-6)-** Fights	Groupwork/discussions (absence thereof)	Dislikes interactions with classmates **(C-6) Reason:** they will be making noise
	Sharing of ideas/information exchange (a lack thereof)	1. Did not get to share my ideas **(E-6).**	Sharing of ideas/information exchange (a lack thereof)	
	Debating issues (absence of)	Interacted with the teacher and worked individually.	Debating issues (absence of)	Interacted with teacher and worked alone **(C-1)**
	Helping others	1.Refused to be helped by other learners **(E-2)** 2. Classmates reluctant to help others **(E-5)** 3. I don't go to classmates **(E-6)**	Helping others	

Table X.3: Frequency of Mixed Participation behavioural engagement Theme for Groups 1 and 2

	Group 1-Blended teaching (Experimental)		**Group 2-Traditional face-to-face teaching (Control)**	
Theme	**Sub theme**	**Code match and frequency**	**Sub themes**	**Code match and frequency**
Mixed participation behavioural engagement	Sharing of ideas	1. Learners only wanted to contribute while they are in class but not online. **(E-7)**	Sharing ideas/information exchange	
	Debating			
	Groupwork/discussions	Few online discussions **(E-7)** In-class learner-learner interactions improved. **(E-7)** Interactions limited to during the lesson.	Groupwork/discussions	1. Sometimes worked in groups. **)** 2. Few in-class interactions **(C-1)** Reason: Chaotic lessons 3. Sometimes on my own, sometimes with my classmates **(C-2) Reason:** Most learners making noise 4. Teacher abandoning the lesson **(C-6)** 5. Teacher abandoning the lesson **(C-1)**
	Helped by others at times		Helped by others at times	

APPENDIX Y: CODE MATCH FOR NATURE OF BLEND

Table Y.1: Code match for the Nature of Blend Theme

Theme	Group 1-Blended teaching		Group 2-Traditional face-to-face teaching (Control)
	Sub theme	**Code match and frequency**	**Codes**
Nature of blend	Immediate feedback	Learnt from mistakes in time **(E-1)**	
	More than one attempt	Most learners used all three attempts **(E-7)**	
	Promote active learning	Combining quizzes and video watching was a gamechanger **(E-7), (E-2)**	
	Vary activity type	Cater for different learning styles **(E-7)**	
	Quizzes, quizlets, and videos	Learners were more into videos **(E-7)** I watched videos and did the quiz **(E-1), (E-2), (E-3), (E-4) (E-5) (E-6)**	More practice questions **(C-2)** More explanations **(C-3)** Would like videos **(C-5)**
	include gamification.	The game was like wow! **(E-3)** Enjoyed the game **(E-2)**	
	Include simulations and practical work	Include simulations and practical work **(E-1)**	Need more practical work **(C-3)** No practical work done **(C-4)** Include simulations **(C-6)**
	Online learner interaction	I did not know what to say on that discussion forum (E-5) Improve online interaction**(E-7)** I did not know how many people were on that discussion forum **(E-4)**	Would like online interactions with other learners **(C-1)**
	Sense of belonging	**Classroom environment/structure** I belong to my class **(E-3), (E-4)** I don't belong to that class **(E-6)**	**Classroom environment/structure** Classroom management skills **(C-7)** They form groups that exclude **(C-6)** Ill-disciplined learners
	Contextual factors-economic	Contextual factors-economic	Problems to secure data (C-6)
	Contextual factors-Home background	Contextual factors-Home background and lack of parental support	Learners staying alone (C-6)