A teacher's explorative investigation of using drawings to stimulate learner talk in the Grade 11 Life Sciences classrooms.

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Abstract

The tendency of employing written assessments to establish learning which is widespread in the majority of public schools in South Africa was criticized for disadvantaging some learners in multilingual circumstances (Dempster & Stears, 2013). Drawings, which offer visual

representations (drawings), can be employed as successful tools that bridge the gap between learners' knowledge and the teacher's comprehension of the presented drawings, to facilitate better engagement through talk (Dempster & Stears, 2013; Pintó, Gutierrez & Ametller, 2005).

This research reports on a case study where knowledge was generated about the use of learners' drawings to stimulate talk from a scenario that involved the chewing of sandwich and drinking juice. The activity required the content on digestion and excretion which were topics that are covered at Grade 11 Life Sciences. The aim of the study was to explore how learners used talk, to articulate the accuracy and relevancy of their drawings to the given scenario. The visual representations (drawings) were employed as tools that bridged the gap between learners' knowledge and the teacher's comprehension of the presented drawings, to facilitate engagement. Additionally, the researcher also wanted to listen to the learners' experiences on using drawings for the purpose of professional development and improving the use of drawings as a science practice. The participants for the study were 58 Grade 11 Life Sciences learners, two critical friends and the teacher-researcher, who was the participant observer during the generation of data. The case study methodology was employed to generate and analyze the numerous data that were produced through some drawing activities, classroom observations, written questionnaire responses and audio recordings from peer-discussions of the drawings and from focus-group interviews on the emergent issues. The audio recorded data were transcribed for analysis and the drawings were analyzed according to the seven-scoring scale adopted from Reiss and Tunnicliffe (2001) and then inductive-thematic approach was used to analyze the questionnaire responses. The learner talk forms were analyzed by matching them to the characteristics of the 3 types of social talk adopted from Wegerif and Mercer (1997). The findings revealed that 21% of the drawings represented the expected body systems and they were scored at level six and many other drawings represented 31% completed alimentary canals which were scored at level 5 then the rest of the drawings depicted uncompleted systems for the urinary and alimentary canal which were scored at lower levels. The participants acknowledged being familiar to making and using drawings in the subject and that they benefitted from the visual representations of the abstract concepts in spite of the difficulties they had with creating the drawings. The talk forms in peer groups were mainly cumulative with minimum references to the drawings and some relevant scientific terminologies were distortedly used. Contrastingly, the focus group interviewees consulted their drawings, distinctly, as they explored and disputed about their drawings and they also used scientific terms appropriately. Therefore, based on the focus group's use of the explorative and disputational talk forms, it was concluded that utilizing drawings and learner talk facilitated learners to reveal their understanding. However, one of the focus group male learners revealed how he could not display and talk about the reproductive organs to youngsters publicly because of his cultural factors and the view was supported by the other male learners. Therefore, based on the findings, further investigations were necessary to establish how drawings could stimulate talk without infringing on some learners' cultural factors.

KEY WORDS: drawings, stimulate talk, alimentary canal, learner talk, Grade 11 Life Sciences,

Dedication

To my sons, Nigel, Puwai, Faro, Nashe and daughters, Nataly and Kuku, as an empowerment in their endeavors.

In memories of my dad who was always my source of inspiration.

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- Most importantly, I am grateful to my critical friends and the learners who shouldered the demands of the investigation without whom the study would not have been possible.

Declaration

I, Patricia Truzumbah, declare that this research report is my own, unaided work. It is being submitted for partial fulfilment of the Masters in Education Degree in Science Education in the University of the Witwatersrand, Johannesburg. It has not been prepared under the guidance or with the assistance of any other body or organization or person outside the University of the Witwatersrand, Johannesburg.

Signature____ 
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Chapter One: Background

1.0 Context

Drawings as products of mental engagement were used to represent information about the learners' knowledge of the human anatomy (Aydin, 2016; Çuçin, Özgür & Cabbar, 2020; Dempster & Stears, 2013; Quillin & Thomas, 2014; Reiss, et al., 2002). On the other hand, research on learner talk in the classroom reported that there was a link between learners' talk and individual learning (Tanner, 2004; 2009; Mercer, 2008). Additionally, there were reports on the relationship between thoughts and language development (Vygotsky, 1932; Asoulin, 2016) where the language formed the medium of transferring thoughts. The language played the role of iterating the learners' thoughts which was regarded as "self-explanation" (Ploztner, 2009, p. 3). The latter findings implied that learners needed the language to express their thoughts therefore making thoughts and language inseparable. The ability to explain ones' ideas, (self-explanation) relieved the mind over what needed to be expressed which was also referred to as "cognitive reflection" (Spiro, Collins & Ramchandran, 2007). The openness of the mind, thought or ideas allowed the individual to understand and that further led to learning (Spiro, et al., 2007).

Nonetheless, besides all the findings about the relation between thoughts and language, there are minimal research that explored the use of drawings (thoughts) to stimulate learner talk (language) especially with Grade 11 Life Sciences learners. The link between the drawings and learner talk could be an interactive strategy for science classroom assessments. The currently proposed study took a qualitative case study approach to address the phenomenon about digestion and excretion where learners were instructed to use drawings to stimulate learner talk. The findings from related studies that were conducted with Grade 9s revealed that learners struggled to make drawings and to explain the link between the digestive system and the other body systems. The learners struggled to represent what happened to the substances through drawings and where they had succeeded to make drawings, they missed to mention the involvement of the blood circulatory system (Enochson & Reidfors, 2012; Enochson, et al., 2015). Consequently, application skills are crucial to evaluate understanding biological concepts and they are highly regarded in the examinations

too, such that early exposure to the skills could benefit the learners. The investigation considered the learners making accurate drawings and using them to stimulate learner talk that iterated on the drawings to show, further, the understanding of the topics and processes involved in the research activity.

In a country where 11 official languages are used for communication, it was possible that the learners could be very fluent in one and not be proficient in others. Such circumstances, led to bilingual challenges that harbor meaningful teaching and learning of biological concepts that are abstract and are taught in English. The situation needed a form of talk or language that the learners were comfortable to use for expressing their knowledge. If the teachers were informed about the learners' form/s of talk which could be considered during classroom social interactions then learning could be meaningful (Ausubel, 1968). According to David Ausubel (1968) it was important to establish what the learners knew as their prior knowledge since they referred to it to make meanings/understand the new concepts. Therefore, the learners' prior knowledge was a pre-requisite for a learner-centered socio-constructive orientated education system such as the situation in South Africa. Consequently, in the study at hand, the drawings worked to reveal the learners' interpretation of the research activity based on their prior knowledge of the concepts and the learner talk showed how learners articulated their drawings to illustrate their understanding of the given phenomenon. Ultimately, the whole investigation worked to benefit the teacher by reducing the use of pen and paper tests with learners who have multi-lingual circumstances similar to South Africa (Dempster & Stears, 2013).

The latest education curriculum assessment policy in South Africa, which is termed the National Curriculum Statement Grades R-12, NCS, was effectively implemented in 2012. This new education policy employed the assessment guides known as the curriculum and assessment policy statements, CAPS, for all approved subjects which included Life Sciences. The NCS was designed, ideally, for a learner-centered approach and to promote equal education opportunities for all learners through employing inclusivity principles in the learning (DBE, 2011). Diversified teaching and learning strategies became a requirement to meet the learners' academic needs (DBE,

2011). At the center of all these changes, the policy implement set-up some learner performance monitoring structures of the CAPS outcomes in subjects such as, English language, science and mathematics curriculum. Apparently, learners' performance in English language, science and mathematics curriculum for the fifth and eighth or ninth graders of South Africa was established since 1995 (Mouton, 2014). The learners' performance in the identified subjects have been conducted at international level by the International Association for the Evaluation of Educational Achievement, IEA, exampled by the Third International Mathematics and Science Study, TIMSS, (Gustafsson, 2017; Spaull, 2015). Another advanced TIMMS was also organized for the Grade 12 Physical sciences. The TIMMS assessments which started off with low performance results have long revealed improved progress in the science and mathematics subjects at GET level (TIMSS 2015) and further assessments for 2019 are underway. While these assessments were set-up for the respective grades, there are minimum performance monitoring assessments reported on the Grade 11s before matriculation especially in Life Sciences.

Life Sciences is one of the science subjects that is studied at FET in many South African high schools (Department of Education, 2011). The subject assessment structure targets three subject specific aims which involve; acquisition of the subject content knowledge (theory) (SA1), then a practical and investigatory aspect (practical) SA2 and lastly, the understanding of the application of Life Sciences in everyday life to historical scientific discoveries in relation to the local scientific knowledge (application) SA3. These specific aims inform the classroom teaching and learning of the subject according to CAPS (DBE, 2011). However, when the learners got to the classrooms, they applied their everyday knowledge to inform them about the worldviews and their surroundings (Duit & Treagust, 1998) instead. Now, according to the adopted social constructivists approach, the education policy required that teachers planned their lessons relevant to the learners' everyday knowledge which formed their prior knowledge (DBE, 2011). Therefore, the use of relevant scenarios similar to the one in the current research activity, would help learners to relate the school science to their everyday experiences. It is a curriculum requirement that the Life Sciences learners demonstrate their competency in biological knowledge and their communication skills, however, it is the translation of problems and the transfer of the learnt biological knowledge to novelty scenarios that measures the learners' understanding better (Schönborn & Bögeholz, 2009). Demonstrating such abilities becomes a requirement for combating some of the problems

in the communities where the learners live. This notion then echoed the envisioned mission of the Life Sciences curriculum of South Africa which stated that, "…children [should] acquire and apply knowledge and skills in ways that are meaningful to their lives…for self-fulfillment, and meaningful participation as citizens of a free country.' (DBE, 2011, p.4). Therefore, this issue of transfer and translation of biological knowledge is of paramount importance to both the learners as evidence of acquiring the biological concepts and to the National Curriculum Statement, NCS Grade R-12, as proof that it met its targeted goals.

1.1 The location of the study

The study was conducted from a secondary school situated in the urban community of Johannesburg in South Africa. The school's catchment area offered a diversified population of learners from the neighboring residential areas. The learners' mother tongue (MT) languages comprised of three categories which were Afrikaans for many, one of the nine vernacular languages of South Africa for others and a smaller number spoke English. At school, English was the language of learning and teaching (LOLT) and Afrikaans was the second language that learners were taught. This language situation made the vernacular speaking learners to adapt to the two languages for their high school learning. The social-constructivist perspective noted that language plays a mediatory role in communication and the construction of knowledge (Vygotsky, 1978). Therefore, the vernacular speaking learners from the identified school were forced to be multilingual in their communication. The latter situation was the objective for investigating how drawings could be used to stimulate learner talk, as a potential strategy to enable the multilingual learners to interact actively in the Life Sciences classrooms.

The skill of making and using drawings to record and analyze information was recommended in the further education and training phase (FET) Life Sciences curriculum (DBE, 2011). Therefore, the use of drawings in Life Sciences was mandatory in spite of the reports from other studies that there were minimum use of drawings in biology classes (Çakıcı, 2018; Landin, 2015; Quillin & Thomas, 2014). The current study focused on the Grade 11s who were a senior grade which was one year from matriculating and were mature to benefit from the experiences while their

contributions would make the study a worthwhile investigation. Therefore, these learners were identified as multilingual and it was important to understand the forms of talk they employed to transmit the scientific concepts thereof (Lemke, 1990; Mercer, 2008). Lastly, the research population was in the age group of 16 to19 years and in their second year of making and using drawings on human digestion and urinary system after the introduction in Grade 9 Natural Sciences curriculum (DBE, 2011). The Grade 11 Life Sciences learners were chosen for this study because they were a senior grade, mature and more available than the Grade 12s who could have benefited from the study too.

1.2 Introduction

The practice of establishing the learners' prior knowledge before a lesson starts is a social constructive approach to good professionalism. However employing that practice interactively in the Grade 11 Life Sciences classrooms has been problematic for years for me. The required creativeness was challenged by the inclusiveness of the education situation which targeted providing equal education opportunities to learners irrespective of their academic capabilities (DBE, 2011). Additionally, teaching strategies needed to cater for the diversified learning requirements of the learners who have multilingual situations such as 11offical languages, in South Africa. The strategies that had been utilized which included written tests and oral discourses were found to be disadvantaging learners with bilingual challenges (Dempster & Stears, 2014). Therefore, suggestions were made based on research findings that drawings could relief learners in multilingual environments to articulate scientific concepts (Dempster & Stears, 2014). However, the studies were conducted with Grade 9 learners and so, the present study aimed to develop the drawings and utilize them interactively to stimulate learner talk in the Grade 11 Life Sciences classrooms. This position was chosen because drawings would allow for the learners' prior knowledge to be viewed visually rather than textually presented. That way, visual mode was employed over the textual because it would reduce the learners' bilingual challenge besides revealing some details that would be missed through text mode (Landin, 2015). Talk was included so that the learners could elaborate on their drawings just as was done in other science subjects such as chemistry, physics, engineering and mathematics (NRC, 2012; Quillin & Thomas, 2014). According to the Life Sciences subject's specific aim two (SA 2), drawings engaged learners through multiple modalities such as; mental, psychomotor and sight (VAK), (Fleming, cited in

Jaleel, 2019). Consequently, the use of drawings to stimulate talk was another dimension of implementing drawings which was supportive of the socio-constructive in support of the practical skills recommended in the new curriculum and assessment policy statement (CAPS) (DBE, 2011).

The current study focused on the potential of drawings stimulating learners' talk as the interactive teaching and learning strategy which were promoted in the science classrooms according to CAPS (DBE, 2011). Learners' talk in the science classrooms was also recommended as a social constructivists' perspective to constructing knowledge (Vygotsky, 1978). During the learners' talk, the inter-psychological interaction would allow for the intra-psychological changes that facilitates the learners' understanding of the scientific concepts (Vygotsky, 1978) and the scaffolding of the less knowledgeable learners by their more knowledgeable peers (Brunner, 1976). Furthermore, as learners talked, they verbalized their thinking which promoted togetherness through collaborative interactions rather than competition in the classroom (Tanner, 2004; 2009). This active way of using learner talk was currently recommended internationally for science classes (American Association for the Advancement of Science (AAAS), 1993, 2008; National Research Council (NRC), 1996, 2011). Therefore, learning would be irrelevant if learners cannot talk about it in their social forums (DBE, 2011) and so they could practice using the scientific language during their classroom talk (Lemke, 1990). According to Lemke, science talk encompassed the doing (drawings for practical skills, in the current study) and the verbalization (for language development) (Lemke, 1990) this was the link explored that through the current study.

1.3 Problem Statement

The new South African education curriculum, NCS (DBE, 2011) promoted a learner-centered approach and equal educational opportunities for all the learners with active interactions in order to achieve critical reasoning CAPS (DBE, 2011). Though the CAPS (DBE, 2011), envisaged interactivity in the science classes like that, it did not specify how the learners could initiate constructive interactivity for specific topics, especially in the Life Sciences classrooms.

1.4 Purpose Statement

This research proposed to promote a social interactive teaching strategy in the Grade 11 Life Sciences classrooms by exploring the use of the learners' drawings to stimulate learner talk. The drawings acted as informal assessment tools that revealed the learners' prior knowledge while the learner's talk introduced social interactivity which was envisaged by the new education policy CAPS (DBE, 2011).

1.5 Rationale

There were minimal classroom-practice research recorded on the use of learner's drawings to stimulate learner talk among the Grade 11 Life Sciences as a teaching and learning strategy. Taking the learners' drawings as visual representations of their mental models of any given task (Gilbert, 2008), it therefore implied that the misunderstandings and the misconceptions revealed in the learners' drawings thereof, represented the learners' failure to articulate given ideas. In that instance, the current study then offered learners the opportunity to talk about their drawings in order to express their understanding of the alimentary canal and urinary system visual representations. Such learner talk about their drawings could be a strategy to understand the mental models that learners held on the human body systems which could also be useful for both classroom formative and summative assessments, planning and teaching activities. Moreover, through the drawings' correctness, educators could assess the learners' translation of the given instructions. The link between the correctness of the learners' visual representations (as drawings) and their talk helped to "listen to the learners' thinking, misconceptions, confusions", frustrations as part of understanding them (Tanner, 2009, p. 93). Tanner (2009), suggested a strategy termed "Think-Pair-Shares" that offered learners the opportunity to think about their ideas/responses in pairs prior to sharing to the class. Similarly, the drawings to stimulate learner talk strategy which was under investigation currently, could offer equivalent opportunities with the advantage of providing visual representations to refer to during the learner talk. Unfortunately, the use of the learner's drawings dwindled from the Life Sciences classrooms as revealed by Quillin and Thomas, (2014) also noted by Landin (2015) and the reasons varied from improvements in the cameras (Katz, 2017) as biology class sizes increased for a single teacher to implement the use of drawings in the 20th century. Therefore, the current study was necessary to investigate if the drawings could stimulate learner talk as teaching and learning strategies.

1.6 Significance of the study

There are minimal research where practioners shared their experiences with using certain classroom practices for the purpose of developing the profession with Grade 11 Life Sciences classes. The study serves to reveal what goes on during the Grade 11 Life Sciences classroom using drawings, a practice common in many science disciplines, STEM (NRC, 2012). Knowing the learners' voices about the practices benefited to see the gaps, usefulness or the frustrations experienced by the learners thereof (Tanner, 2009; Stears & Gopal, 2010). Drawings were recommended to be used to make visual representations of investigatory findings (DBE, 2011), but they were also used to enhance learning of structures and processes of biological concepts in Life Sciences (Ainsworth, et al., 2011; Schönborn Anderson, 2010). Therefore, it implied that knowing more about how learners implemented the practice could improve its classroom use.

The study was promoting the use of the drawings to stimulate talk. This strategy could add to some learners' interactivity which was envisioned in the new curriculum (CAPS, cited in DBE, 2011), besides supporting the learner-centeredness from a social constructivist perspective. As such, the study served to benefit both as a teaching strategy that would relief the teacher in manners similar to those adopted from Tanner (2009, p. 89) identified below;

Breaks-down the big class into active small groups where the usually quiet learners could have a voice

The learners' thoughts could be visually represented, thereby making it easy for the more knowledgeable others to scaffold and the speakers to regulate self (internalization)

The teacher takes time to walk around and listen to the learners' talk, confusion, complains, alternative ideas instead of the traditional monology

The identified benefits were of particular importance to the studied school where classes were also large such that learner-learner interactions could be hindered.

1.7 Research Questions

The research will be guided by the following main research question and sub questions:

Main Question: How do drawings stimulate learner talk in the Grade 11 Life Sciences classrooms?

RQ1: How correct are the drawings of the human alimentary canal and urinary system that Grade 11 Life Sciences learners make?

RQ2: What are the Grade 11 Life Sciences learners' experiences of using drawings concerning talk to build their understanding of the human alimentary canal and the urinary system?

RQ3: What is the nature of the learner-learner talk that emerges from the drawings of the human alimentary canal and the urinary system of these Grade 11 Life Sciences learners?

1.8 Conclusion

The contextual situation of the South African education curriculum and policy was changed in search of improving the learning outcomes of the majority of the learners who were disadvantaged by the former education system (DBE, 2011). The chosen curriculum, National Curriculum Statement Grades R-12, promoted learner-centered approach where learners were entitled to be more actively involved in their learning as the citizens of the country. The teachers were also, likewise, challenged to create teaching and learning strategies that matched the diversified academic needs of this learner-centered approach education policy (DBE, 2011).

The current study, therefore, responded to the call for diversified teaching and learning strategies that allowed for active participation of learners in the Life Sciences classrooms. The study employed drawings which were components of the doing sciences (CAPS, 2011) to stimulate social interactivity through learner talk. However, there were reports of minimal usage of learner generated drawings in both the teaching and learning and the public examinations of Life Sciences, when compared to other science disciplines such as chemistry, physics, engineering and mathematics (Dempster & Stears, 2013; Landin, 2015; NRC, 2012; Quillin & Thomas, 2014). Therefore, the current study was a microscopic response towards exploring this science practice in the Grade 11 Life Sciences classrooms since the gap on the use of drawings to stimulate learner talk in the classrooms cannot be bridged by a single study. More developments of the current study were covered in the chapters that followed.

CHAPTER TWO

Conceptual Framework & Literature Review

2.0 Introduction

The study was a teacher-initiated exploration of the use of drawings to stimulate learner talk for the purpose of the teacher's professional development and the improvement in the use of drawings and talk as the teaching and learning strategies in Grade 11 Life Sciences classrooms. Based on the stated purpose of the study, the current chapter addressed; (1) the conceptual framework where, drawings and learner talk were covered as the main key concepts in addition to the other concepts and then (2) some literature review that helped the researcher to understand the study and see why the study was necessary and lastly, (3) the theoretical lens through which the study was viewed.

2.1.0 Conceptual Framework

2.1.1 The nature of drawings

Knowing the meaning of the term drawings helped to contextualize it for the current study where the plural form was employed referring to the finished product/s. That way of using the term considered the noun rather than the verbal form of the term which was a stance adopted in the CAPS document (DBE, 2011), and some other research studies (Aydin, 2017; Dempster & Stears, 2013; Gilbert, 2008; Katz, 2017; Landin, 2015; Reiss & Tunnicliffe, 2001). The term drawings, as a noun, was associated with products such as; sketches, diagrams, external representations, external models, visualization, illustrations, pictures (Quillin & Thomas, 2015) and the identified products positioned drawings as being visual representations. In that regard, the current study considered drawings as the; "…learner-generated external visual representation depicting any type of content, whether structure, relationship, or process…" (Quillin & Thomas, 2015, p.2). Based on that definition, the drawings that the learners created implied that they (drawings) were the representations of their mental models (Gilbert, 2008) and that suited the Life Sciences curriculum which required learners to show individualized understanding of the human anatomy at the structural, the functional and in relation to the other body systems (CAPS, cited in DBE, 2011). Consequently, the present study considered two levels of understanding which were depicted

through the correctness of the named organs and the body systems represented in response to the research instructions.

2.1.2 Why Drawings?

Knowing the impact of drawings in the science classrooms responded to the questions on why making drawings was an important practice. Some research findings supported that drawings were tools that revealed the learners' understanding of the scientific concepts more than the written answers, interviews, questionnaires and concept mapping (Aydin, 2016; Enochson, et al., 2015; Stears & Dempster, 2017). Some other study stated that drawings could replace ten thousand words (Larkin & Simons, 1987) in a text and in that context, drawings could be used to relief some children in rural and township schools who have bilingual challenges in their learning (Dempster & Stears, 2013). On the other hand, drawings were recommended for recording information in science classes because they (drawings) were products of active interactions that promoted cognitive and practical skills development (DBE, 2011). Such an active role of drawings in the science classrooms was termed "doing science" (Lemke, 1990) and it complimented what was also called "talking science" (Lemke, 1990). Lemke identified science as the subject whose abstract concepts were better accessed through the doing and the talking for it to be understood. The position of Lemke about talking science was summarized in the quotation below.

> *They do not present and organize information only verbally; they do not construct logical arguments in purely verbal form. They combine, interconnect, and integrate verbal text with mathematical expressions, quantitative graphs, information tables, abstract diagrams, maps, drawings, photographs, and a host of unique specialized visual genres seen nowhere else. Lemke, 1998, p. (n.d)*

Lemke identified the complexity and abstractness of science concepts which required multiple modes of visual representation besides verbal mode (1998) for learners to grasp the concepts (Lemke, 1998). Other science subjects such as mathematics, physical science, technology and

engineering (STEM) used the various modes of visual representation to operate and it was reported that use of drawings in biology were minimal when compared to the STEM (Landin, 2015; NRC, 2012; Quillin & Thomas, 2015). Therefore, the current study responded to the gap in the minimum use of drawings in the biology classes such as Life Sciences because drawings were integral to the teaching and learning of science and the better understanding of the abstract concepts (Lemke, 1998).

2.1.3 Research perspective of drawings

The findings by Lemke (1998) revealed how drawings could be important in the teaching and learning of Life Sciences, as one of the STEM subjects. However, it was vital to understand the wider views about the role of drawings which were illustrated below.

2.1.3.1 Literature reviews

Some research findings revealed that the learners' knowledge of the human body improved relative to their cognition development (Dempster & Stears, 2013, 2017; Reiss & Tunnicliffe, 2001). Based on such findings, if the learners' drawings could be visual representations of their cognitive models at a particular stage of development, then the diagram could in turn represent the learner's understanding of any given instruction (Reiss & Tunnicliffe, 2001; Katz, 2017). The position of using drawings to represent the learners' understanding of the human body was adopted by some researchers in South Africa (Enochson, et al., 2015; Dempster & Stears, 2013) and internationally, during some cross-national study (Reiss &Tunnicliffe, 2001). However, the drawings that learners generated from some of the identified studies varied relative to the type of research instructions, as was discovered by Prokop &Fančovičová, 2006. In some other task-based research, the participating students struggled to apply scientific knowledge and to transfer the processes involved in the body systems for the given scenarios (Enochson & Redfors, 2012). Similar difficulties were obtained when the studies were repeated with some Grade 9s from South Africa (Enochson & Redfors, 2015). The study design required the participants to make drawings that described the three presented scenarios involving sandwich, painkiller and water ingestion (Enochson & Redfors, 2015). The latter research design was similar to the current study except for the following changes; the Grade 11s were involved instead of Grade 9s while sandwich and juice were ingested sequentially instead of water and painkiller. The participating learners in the current

study were expected to draw and use their drawings further to stimulate learner talk in peer groups and focus groups.

Therefore, the findings from the study by Enochson and Redfors (2015) informed discussions of the current results later in the chapters (See Section 4.1.1). The studies by Enochson and Redfors (2015) were different in that the sandwich with juice scenario were represented on the same body outline in the present study. Moreover, the participants in the current study were mature (in Grade 11) and used their drawings to stimulate learner talk rather than talking to their teacher directly. The participants were free to decide on the appropriateness of what to draw and how to represent it since they were tasked to use their drawings to explain the given scenario to a Grade 8 learner. Therefore, the participants could decide to reduce the details to accommodate the level of the Grade 8 learner or they could also make annotated drawings for the Grade 8 learner to understand the scenario. The other challenge for the participants involved representing the three related systems; the digestive system/alimentary canal, the blood circulation and the urinary systems, as linked systems on one body outline after they had covered them sequentially as separate systems in Grade 9, Grade10 and Grade 11 curricula. All the listed adjustment possibilities made the type of drawings that the learners could make unpredictable until during data analysis (see Section 4.1.1).

2.1.3.2 Drawings as universal language

Besides the curricula perspective of what drawings were, there was also a worldwide view of drawings which expressed the physical, mental, emotional, and contextual effects to both the creators and the interpreters (Katz, 2017). In the book on "Drawing for Science Education" edited by Katz, 2017, drawings were regarded as 'multiple tool[s] for teaching and investigating people's thoughts (Katz, 2017). The term visual language was also employed to imply that drawings conveyed some meanings or message in the visual form (Kress & van Leeuwen, 1996). On that same note, when regarding the ancient paintings/drawings preserved on rocks which still communicate to people of diverse language today (Katz, 2017), then drawings are some worldwide visual language. Finally, seeing that drawings are utilized to convey safety messages and signs on airplanes, road constructions sites or the traffic signs, that are understood worldwide (Kress & van Leeuwen, 1996), then drawings qualified as the universal language. The researcher in the current

study wondered if drawings could generate such universal understanding in Life Sciences teaching and learning too.

2.1.3.3 Drawings as a multimodal for teaching and learning Science

Therefore, considering drawings from the classroom point view, researchers such as Lemke (1990) identified communication in science as being at a verbal and practical level. That perspective was supported by the dual coding theory (DCT) which posited that humans use imagery (nonverbal) and speech (verbal) modes when making drawings (Clark & Paivio, 1991). Therefore, according to Clark and Paivio (1991), the two modes, the verbal and the imagery modes complemented each other such that while the learner was busy with the verbal mode, for instance, then, the image of the concept would play in his/her mind making drawings an additional mode of learning. Extrapolating on that point, the issue of learners having different learning styles, which are their preferred ways for learning and processing information (Conner, 1993-2008) could be implicated here to show that there could be learners who would benefit from drawings as a multimodal of teaching and learning. Therefore, if drawings could facilitate the learners' learning in the classroom then, the current study was worthy exploring. The current study was not diverting into learning styles, but it took cognizance of the diversity that is required to make learning meaningful in the Sciences classrooms where inclusivity approach is recommended for learners with diversified social backgrounds.

2.1.3.4 Drawings as visual representation of learners' mind

Finally, drawings could inform the teacher about the learners' prior knowledge (Duit & Treagust, 2003), in order to plan for effective learning (Ausubel, 1968). Addressing the learners' prior knowledge in order to improve the topic delivery formed the teacher's professional practice (Shulman, 1986, 1987). The knowledge that is gained from the drawings informed the teacher's content as well as the teaching/pedagogy and starting lessons from the learners' prior knowledge supported the perspective of a constructivist teacher's good professional practices where knowledge was built from the known to the unknown through active social interactions (Vygotsky, 1986). Therefore, what the learners brought to the Sciences classrooms as their prior knowledge could impact on their social construction of knowledge, especially when it was considered that it was sourced from previous curricula at Grade 9 (which was two years back) and personal resources, then, their generated drawings helped to review what their didactic or the

epistemological factors (Clement, 1998; 2001a, 2003a) were indeed. Some research findings from Clement (1998; 2001a, 2003a) suggested that learners' learning had some bearing on the previous teachings and learning which could be both formal and informal.

2.1.4 Learner talk

The study investigated how drawings were used to stimulate learner talk and, on that viewpoint, it was important to understand the contextual perspective of learner talk.

2.1.4.1: What is learner talk and why should learners talk?

"Children, we now know, need to talk, and to experience a rich diet of spoken language, in order to think and to learn. Reading, writing and number may be the acknowledged curriculum 'basics'' but talk is arguably the true foundation of learning." (Alexander, 2004, p.5)

Alexander supported that talking lead to thinking and learning (2004). Therefore, if the drawings were the learners' products of their mental activity, which were also their universal language visually represented (as explained in Section 2.1.3.2) then, the drawings qualified as the true language of the learners which deserved to be heard. Now, since language was the medium for thoughts (Asoulin, 2016) to be known, it was necessary that the drawings (which were the thoughts) stimulated the verbal language in order to complement the two modes, according to the dual code theory (Clark & Paivio, 1991) explained in Section 2.1.3.3. Therefore, when adopting Alexander's concept of talk, the drawings, which involved the thinking that led to learning, needed talk to reiterate the presented thoughts so that meaningful understanding occurred (Alexander, 2004). Alexander added that the advantage of talk was that it allowed for "trial thinking and understanding" (Alexander, 2004, p. 7) to occur concurrently as the learner was talking. Apparently, it is prominent that learning is a process that requires time to reflect on old knowledge before accepting the new ideas, that is accommodation and or assimilation processes occur prior equilibration processes (Piagetian terms).

2.1.4.2: Learners' talk as part of communicating Science

Talking in science was a term that Jay Lemke (1990), who is popular for writing to promote "talking science" applied to describe the activities that occur in the science classroom. He defined talk not just as the verbal, but he included the non-verbal components that he termed "doing

science" (Lemke, 1990, p. 1). Therefore, according to Lemke (1990), to talk, teach and work science does not use verbal means alone but rather it included, "gesture, imaginary movements in the visible spaces which are defined by graphical representations and simulations which in turn have mathematical expressions that can be integrated into speech" (Lemke, 2014, p. 4). Lemke further described, the written scientific text as comprising of the verbal text with mathematical expressions, which included "the quantitative graphs, tabulated information, mapped, drawn, photographed and abstract diagrams all making a visible multi-mediation genres" (Lemke, 2014, p. 4) which was also supported by Scheflen (1975). These verbal components from the mathematical expressions, graphical-visual representation and motor operations were employed to express the non-verbal science concepts Lemke, 2014). Therefore, in the current study, the participants possibly used actions, verbal, and drawings to make their meanings of the scientific concepts more accessible. The use of semiotics to make meanings of scientific concepts was considered as multiplying meanings (Lemke, 2002; Roth & Bowen, 2000) and that perception about semiotics' role to understanding scientific concepts was supported by other researchers like Jewitt, Kress, Ogborn, & Charalampos (2001). Similarly, the current study proposed the use of drawings (which were visual representations) to stimulate talk (which was some verbal representation). In order to describe talk, some researchers stated it as a vocal representation characterized by actions such as speech where motor actions that varied by flows, modulation of pacing and the intensity of events (Bateson in Wilden, 1980, Peirce, 1955; Thom, 1975). In some other study, talk was further characterized by images, gestures, and material apparatus which were used interchangeably or simultaneously (Kress, Ogborn and Martins, 1998). Ultimately in the current study, talk was considered to involve multimodalities of verbal and gestures which facilitated the explanations of scientific phenomena (Roth & Lawless, 2002) and during some mathematics research too (Tang et al., 2009).

2.1.4.3: Learners' talk as multimodality for learning

How does talk work to make concepts accessible through the identified multimodalities? Work on the types of talk was done by Barnes (1976) and he identified two types of talk that he termed; presentational (which was guided by the teacher) and explorative (where learners worked on their own). Barnes recommended the explorative talk for allowing the organization of thoughts which lead to the construction of knowledge (Barnes, 1976). Furthermore, the extended work on what Barnes started revealed that there were three types of talk that learners used which were:

cumulative, disputation and explorative. In support of Barnes' (1976) work, the explorative talk was, once again, identified as the talk which was associated with the construction of knowledge (Mercer, 1996). Contrary, the presentational talk was designated further as characterized by, the Initiation, Response, Feedback (I-R-F) pattern similar to what was studied by Sinclair and Coulthard (1977). A shift in the research on the talk patterns revealed a need for training the learners so that their dialogue could be improved (Galton &Williamson, 1992, cited in Mercer, et al., 1999). The idea of quality in dialogue was supported by (Mercer, 2010b) whose argument was that learners were born without the ability to talk cooperatively. Dawes, Fisher and Mercer (1992) and Fisher (1994) made an ultimate breakthrough to this search for the talk that learners used in the classroom.

2.1.4.4: Learners' talk to construct knowledge

Ultimately, the three types of talk were employed to analyze the talk of the peer groups and the focus group (Dawes, Fisher and Mercer, 1992; Fisher, 1994; Mercer, 1996). The various talk typologies would response to the research question 3 which required the talk types that the participants engaged in. The learners should talk because it promotes the social construction of knowledge (Vygotsky, 1978) which is necessary for the critical reasoning which is promoted in the new South African education policy (CAPS, DBE, 2011). It has been discussed in the introductory chapter of the study that the new education policy is supporting a child-centered approach where in this case, the learner's voice needs to feature more in the classroom activities than the teachers'. Talking about the scientific concepts in the classrooms, leads to the proficiency in the scientific literacy (Lemke, 1990), while the learners get prepared for the critical reasoning that they would exercise in the social debates (DBE, 2011). According to one of the studies that were conducted in South Africa, the learners succeeded to talk science during peer discussions even though they used home language (Msimanga, et al., 2014). The findings confirmed that science talk was not limited to the convectional forms of talk, but that, learners could still talk under multilingual context (Msimanga, et al., 2014). The findings motivated the study since they confirmed that learners can talk and can include science concepts in their group talk. So, the participants were allowed to interact in any language of preference to as long as that stimulates talk. The latter research informed the current study because it was conducted under South African context but unlike the argumentation discourses, the current study is exploring the learners as they talk in their natural environments without formal training on argumentation discourses. The researcher

employed Mercer's three types of talk which work in social modes of thinking to analyze the learners' talk (Fisher, 1994; Mercer, 1994; 1995). The three types of learner talk that were analyzed were given below.

-Disputational talk has disagreements and individual decision and there can be few attempts to accumulate resources, or to propose constructive criticism. Some short exchanges consisting of proclamations and challenges or counter claims discourse can also feature.

-Cumulative talk, unlike the disputational talk, has the speakers developing on what the others have said uncritically. Therefore, there is the amassing of shared knowledge which is characterized by repeats, approvals and explanations. It is commonly used when sharing an undebatable knowledge.

-Exploratory talk, however, shows critical and construction of ideas. Considerations are given to suggestions, challenges and counter-challenges and alternative hypotheses before making joint decisions (Barnes & Todd, 1978). Contrary to the other two above, exploratory talk shows some educational reasoning where evidence is given before reaching an agreement (Mercer 1995; Wegerif &Mercer, 1996). The explorative talk has characteristics which are similar to the argumentation format by Erduran et al., (2004) except that the learners in this study were not trained for the long claims, warrants nor rebuttals. The three types of talk could be analyzed further to show the four levels Wegerif and Mercer (1997a) that were beyond the scope of this study.

2.1.5 Stimulation of talk

Given the impression that, talk and thinking are inseparable entities (Asoulin, 2016), how then do the drawings stimulate learners to talk? This is the question that was explored through the current study**.** If speakers are supposed to reason before, during and after their utterance, then it implies that there is cognitive development that follows by interactions between children, adults and society (Vygotsky, 1978; Brunner & Haste, 1987; Halliday, 1993). Therefore, talk facilitates language development at an individual (intra-psychological) and social (inter-psychological) levels (Vygotsky, 1978). These active interactions are what the CAPS document is promoting as better environments for constructing meaningful knowledge "…active and critical learning rather

than rote learning…" (DBE, 2011, p. 4). Another reason why talk should be stimulated was expressed in the quotation below.

> There is now an increasing understanding that occasions of communication always draw on a multiplicity of modes of communication at the same time. When we speak we also make facial expressions, we gesture, stand at a certain distance, and so on, all of which makes meaning together. This ensemble of modes we regard as the normal condition of communication and we refer to that as multimodal communication or as multimodality (Jewitt, et al., 2001, p.6).

The quotation cited additional components of communication that included non-verbal body modes/strategies which enriched the listeners and without which then the communication would be abnormal and meaningless (Jewitt, et al., 2001). Talk also provokes thinking/reasoning which will then occur simultaneously (Fisher, 1994; Mercer 1994; 1995). In this study, drawings were explored as the drawings mode to stimulate learner talk. In the CAPS document it was stated that; "the learners should be able to identify and solve problems using critical and creative reasoning and then they should communicate effectively using visual, symbolic, or language skills in varying modes" (DBE, 2011, p. 5). These communication standards that the CAPS document has envisioned are similar to how talking science should be according to Lemke (1990). He observed that science talk combined the verbal communication and the pragmatic component and following on Lemke, therefore, science has specific language which has to be spoken proficiently in order to communicate the intended science (Lemke, 1990). However, doing science encompassed many of the practical skills similar to the ones stipulated in the CAPS document, which include ;" drawings, descriptions…" which follow under the investigating phenomena, which makes the subject's specific aim two (SA 2) (DBE, 2011, p. 15). Additionally, when talk was stimulated, the more knowledgeable peers scaffold the less knowledgeable others (Wood, Bruner, & Ross, 1976) and the speakers practiced expressing the scientific language (Halliday, 1993; Lemke, 1990). Similarly, the teachers could be informed about the learners' levels of reasoning, understanding and the misconceptions with the confusions thereof (Fisher, 1994; Mercer 1994; 1995; Tanner, 2009). In this study, the learners were allowed time to talk about their drawings so that the owners of the drawings would improve their scientific literacy /her and regulate their thoughts.

2.1.6 Human alimentary canal and urinary system drawings

The historical use of diagrams to analyze the human body anatomy dates back to the times of Galen who employed diagrams to understand the nature of the human body diseases (AD 129-200). Galen used drawings of the human body to understand the health problems. Life Sciences is a subject that deals with human body systems and the learners could comprehend the anatomy studies better through making their own visual representations (drawings) rather than the ready-made pictures and diagrams. Children learn about these body systems through their everyday experiences that includes their; breathing, eating or illness (Gellert, 1962) and therefore, their knowledge about the body systems starts long before the formal teaching (Ramadas & Nair, 1996; Reiss & Tunnicliffe, 2001). Research findings also showed that the learners could use their diagrams to explain the functions of body systems better than when they used the written textual modes (Ainsworth & Loizou, 2003; Dempster & Stears, 2013).

The current study employed the human alimentary canal and urinary system drawings where research findings confirmed that the alimentary canal (as digestive system) was the most understood anatomy (Çakici, 2018; Dempster & Stears, 2013; Enochson & Redfors, 2015; Reiss & Tunnicliffe, 2001; It is an act of good teaching professional practice to use the learners' prior knowledge before teaching a new topic (Wilson, 1992; Shulman, 1987). Reiss et al., 2002) thereby qualifying it as the learners' starting point for the studies on human body systems. The investigation focused on how the drawings could possibly stimulate learner talk amongst Grade 11 Life Sciences. This was the first time such a study has been conducted in South Africa with the Grade 11 Life Sciences learners after some similar study where Grade 9s were involved and drawings on sandwich, painkiller and water were generated (Enochson, et al., 2015). The participants from the identified study made drawings for each scenario followed by explanations on how each substance was processed. In contrast, the current study's instructions required the participants to use one body outline to represent the given scenario and then explain/talk to a learner in a lower grade about the processes involved in the drawings to illustrate their understanding of the concepts. However, the current study was similar to some related investigation where scenarios were employed to facilitate the illustration of the knowledge on body systems and the biological processes involved (Enochson, et al., 2015). The participants were expected to draw the body systems and explain the processes of transfer of metabolic substances

thereof. The approach was different from just naming organs or systems that learners knew which was done in other research (Çakici, 2018; Dempster & Stears, 2013; Reiss & Tunnicliffe, 2001; Reiss et al., 2002). The investigation by Enochson, et al (2015) required learners to apply the knowledge of nutrient transfer through various body organs and systems from the given life scenarios. The cognition level for the investigation was at *application* stage which implied that the investigation demanded high order of the Bloom's Taxonomy (1956, cited in Huitt, 2011), when compared to other researchers who required learners to draw according to how they *remembered* the structures (Dempster & Stears, 2013; Reiss & Tunnicliffe, 2001; Reiss et al., 2002). In the same manner, the current study explored the use of a real-life scenario to generated appropriate drawings which learners would use to stimulate talk about how the processes occurred.

In some studies, learners were required to draw to illustrate what they knew about human body systems as stated in earlier passages, but contrarily in the current study, the learners were to use drawings and talk modes to articulate their knowledge as a way to diversify the teaching and learning strategies in the Life Sciences classrooms. The choice to use drawings to diversify learning strategies was also supported by the research findings from the studies conducted for learners who experienced multilingual challenges from some semi-urban and rural schools in South Africa (Dempster & Stears, 2013).

2.1.7 Significance of the learners' drawings as prior knowledge

Besides diversifying the teaching and learning strategies through using the learners' generated drawings, the drawings themselves could represent the learners' prior knowledge on concepts of the body systems which they developed through observing ordinary processes such as; breathing, eating or illness, as stated earlier (Gellert, 1962). And these learners' prior knowledge improved as they matured and, in some instances, it was influenced by cultural factors and the latter factor was supported by the research findings from some investigations that Reiss and Tunnicliffe (2001) conducted in South England. In the study, the two researchers employed a cross-sectional approach with participants aged; 4, 6, 8, 10, 14 and some first-year undergraduates aged 18 to 20years. The findings revealed that, while the younger participants had no problems with labeling the reproductive organs, the under-graduates male students (aged 18 to 20years) substituted scientific terms for non-scientific ones like, "wedding tackle" and they avoided naming and labelling the reproductive organs (Reiss & Tunnicliffe, 2001, p. 393) due to cultural reasons. Similar findings

on cultural factors' influence on learners' prior knowledge were confirmed from KwaZulu-Natal region of South Africa, where reproductive organs were not discussed openly and or the participants were reluctant to part-take in the activities (Dempster and Stears, 2013). Now based on the published impact of cultural factors on learners' prior knowledge of human body organs, it was worthwhile to explore the types of drawings that the Grade 11 Life Sciences learners revealed in the classrooms and listen to how they used them to stimulate their talk about the body systems thereof. Consequently, the drawings will reveal a lot about the learner's level of understanding of the human alimentary canal which was summed by Tversky as follows.

> Drawings, then, are representations of reality, not presentations of reality. Drawings can omit things that are there, they can distort things that are there, they can add things that are not there. They need not have a consistent point of view or a point of view at all. As such, drawings are of even greater interest to art critics, designers, and psychologists alike. They can provide insights into conceptualizations not just imaginings. Tversky, (1999, p. 3)

The quotation revealed that drawings were a just representations of reality while showed the learners' conceptualization of the given task but, however, the owners of the drawings needed to reiterate on their drawings for someone to understand their intended meanings. That position matched the purpose of the current study which was to explore the use of drawings to stimulate learner talk. Some research findings showed that learners used previous curricula, peers or family and personal resources as their references before they accepted new concepts (Duit & Treagust, 1998). These various sources of information that the learners experienced formed their everyday knowledge (Stears, Malcolm & Kowlas, 2013) which also could be their indigenous knowledge systems (IKS) according to the CAPS document (DBE, 2011). The problems with such learners' experiences was that in situations where it contradicted with the school science knowledge, then learning was compromised. And now, considering that the South African education system followed the inclusivity education principle (DBE, 2011) which entailed teaching all learners a similar education regardless of academic challenges, then it was the teachers' responsibility to address and minimizes learning barriers for the learners (DBE, 2011) before implementing new concepts in order to address the misconceptions therein (Ledbetter, 1987; Driver & Bell, 1986; Pope & Gilbert 1983; Osborne & Gilbert, 1980; Erickson, 1979; Ausubel, 1968). This study

explored the use of drawings to reveal the learners' prior knowledge about the human alimentary canal and urinary system and stimulated peer talk in order to understand the learners' reasoning/thinking (Mercer, 2000) thereof.

2.1.8 Life Sciences

Life Sciences is a science subject that teaches about life in place of biology in most South African schools like the one where the current study was located. According to the CAPS document (DBE, 2011), the study of Life Sciences subject entails developing the understanding of; the subject content (theoretical), the scientific process skills (doing practical work) and the roles of sciences in the society (application and integration specific topics of the school science to the indigenous knowledge systems) (DBE, 2011). The three named aims comprised the various assessment levels that the learners needed to attain to be progressed. There is integration of topics on human body systems that is taught in grade 9 Natural sciences at grade 11 level including the human alimentary canal (DBE, 2011). I have chosen to explore the use of drawings as a classroom strategy to this grade because they are a senior grade which is one grade from to matriculation and they would benefit from utilizing drawings since they (drawings) would enhances their "conceptualization rather than perception" (Tversky, 1999, p. 2). Conceptualization of these biological concepts is vital especially when considering the role of Life Sciences in the study of biotechnology to the societal problems such as; health, medicinal, agricultural disciplines. There are a lot of career opportunities and developments that are still needed in the subject and it is one of the educational goals to provide "…employers with a sufficient profile of a learners' competences in the workplace" (CAPS document in DBE, 2011, p. 4). Deep understanding of the subject will lead towards achieving the educational goal of making the Life Sciences learners significant participants in the society as citizens of the country (DBE, 2011, p. 4).

> To do science, to talk science, to read and write science it is necessary to juggle and combine in canonical ways verbal discourse, mathematical expression, graphical-visual representation, and motor operations in the "natural" (including human-as-natural) world Lemke, (1998b, p. n.d.)

The current study was supported by the statements from Lemke (1998b) which promoted the use of multiple strategies in order for learning of the abstract concepts in Life Sciences to be meaningful.

2.2 Theoretical Framework: The constructivists' perspective

The study started from when the learners made drawings of the human body systems followed by the peer discussions of the drawings. The position was taken to establish the learners' prior knowledge of the relevant body systems and such strategy of starting from the known knowledge was identified as good teaching practice, according to the constructivists' approach (Bruner, Paget & Vygotsky). Therefore, the constructivists' approach supported that the learners' experiences acted as their (the learners') existing knowledge which was termed prior knowledge and they used it as their reference when constructing new knowledge. Similarly, the current study supported the constructivists approach by commencing from when the learners generated visual representations of what they understood about the research instructions. The latter strategy permitted the learners to display their prior knowledge which they reiterated later during peer discussions and that made their meanings understood further. The meanings that resulted through the peer discussions confirmed the constructivists' theory that knowledge was constructed through active social interactions (Vygotsky, 1978). On the other hand, when the learners made drawings, it implied that they were engaged in some individual mental processes which in turn supported the cognitive developments perspective by Piaget (1968). According to the cognitive perspective, learners' development could result from individual interactions rather than social interactions as proposed by the social-constructivists' theory (Vygotsky, 1978).

Based on the possibility of the two perspectives' influence on the learners' development in the classroom interactions, it then indicated that the current research was pinned by both the cognitive and the socio-constructivists' lens. In the current study, the learners were allowed to interact actively through the use of the language to communicate their knowledge of the visual representations (their drawings).

Some studies showed that the thinking and talk processes occurred concurrently in an individual (Mercer, 2003; Wertsch, 1991). The language played a mediatory role for the thinking and the talking (Mercer, 2003; Vygotsky, 1962, 1978). Under such social interactions, the participants

employed their background experiences which were also their prior knowledge and assumptions, (Wertsch, 1991). Extending on the issue of prior knowledge and assumptions, Wertsch (1991) and Vygotsky (1991) both agreed that the learners' interactions displayed their stages of cultural development as indicated in the quotation below;

> "…the child's cultural development appears on the stage twice, on two planes, first on the social plane and then on the psychological, first among people as an intermental category and then within the child as an intramental category. (Vygotsky 1991, p. 40)

It was therefore assumed that the participants would learn at two stages through using their drawings to stimulate learner talk. The research sort to employ the language as a tool or mediator for sharing ideas and allow mental development to occur (Vygotsky, 1991; Wertsch, 1996). The possibility of dual development resulting from using drawings and to talk in the classrooms was supportive of Lemke's (1990) findings on science talk. Lemke proposed that meaningful learning in science involved *scientific language* and *doing science*. The itialized terms from Lemke (1990) could respectively be equated to making drawings, diagrams, writing formulae and doing experiments (Lemke, 1992, 1998) which are components of meaningful learning. Then, when referring to meaningful learning, critical reasoning, and active interaction, are considered as necessary components for meaningful construction of scientific knowledge rather than rote learning (DBE, 2011, p. 4-5) which the CAPS document advocates for. Therefore, the present study explored the use of the resources that the teachers and learners have in their CAPS document to promote active social interaction in the science classrooms as envisioned by the educational policy (DBE, 2011, p. 4-5).

2.3 Conclusion

Discussions were performed on the identified keywords which were drawings, learner talk, stimulate talk, Life Sciences, and they were conceptualized to link to the study. Drawings, defined as products of the participants' mental models represented on paper (Gilbet, 2008) was adopted in the study. Additionally, drawings which are visual representations, were considered as a visual language (Pintó, Gutierrez & Ametller, 2000). In that context, the correctness of the representations revealed the learners' level of understanding of the topic/research instructions and the meanings thereof (Halliday, 1978; Kress & van Leeuwen, 1996; Lemke, 1998). Science has complex

concepts which require the integration of multiple communication modalities to facilitate the process of making meanings (Katz, 2017; Lemke, 1998). These multiple modalities are visual, textual and mathematical elements (Pintó, et al, 2000) and so, the study focused on the visual and verbal elements (which constituted the 'doing and talking science' respectively) (Lemke, 1990, 1998b).

The use of talk or language to mediate science meanings is a socio-constructivist approach to learning and according to the socio-genesis theory, social interaction opened way for internalization (Vygotsky, 1962). Therefore, the current study, could benefit the participants through experiencing deeper understanding of the scientific concepts which were being studied. The methodology that was employed to understand the study were described in the chapter that followed below

Chapter Three: Research Design

3.0 Introduction

This chapter described the research design that was selected for the study. The research paradigm of the study was identified which included the population for the study, the sample size, the sampling technique, the data collecting tools with the procedures that were followed and the ethical concerns that were addressed. Finally, the analysis procedures for all the generated data were discussed. The study sought to answer the research questions that follow as set out in Section 1.7.

In the current study, the researcher teacher, investigated how drawings were used by the Grade 11 Life Sciences learners to stimulate talk on a biological topic. The literature review such as that from Aydin (2016), Reiss and Tunnicliffe (2001), Dempster and Stears (2013) had showed that the drawings that learners generated could display useful evidence about the learners' knowledge. Therefore, this study sought to lead to professional development in the use of drawings as a classroom practice. The research instructions that the learners responded to were stated below.

A Grade 8 learner observed a friend eating a sandwich and drinking juice soon after swallowing. The learner then asked a Grade 11 Life Sciences learner to explain what happened to the juice and the sandwich. The Grade 11 learner then opted to use drawings to explain the details.

In the given instance, the learners for the current study were then expected to act as the Grade 11 learner mentioned from the above scenario and respond to the task as required.

3.1 Research Approach: Qualitative exploration

The study was addressing *how* drawings, as a scientific practice, were employed to stimulate talk by Grade 11 Life Sciences learners and such objective for details of how humans allocated their meanings and understanding to a given problem was associated with qualitative research (Creswell, 2009). Therefore, in the similar manner, the researcher in the current study who intended to make sense of the learners' experiences of using drawings to stimulate talk to understand using drawings as a science practice in the named subject, took a qualitative approach (Cohen & Manion, 1994). That was because qualitative approach offered descriptive and not quantitative responses. In addition, given that related studies which were conducted in South Africa had involved Grade 9s (Enochson, et al., 2015) instead of Grade 11 Life Sciences learners, the current study took a new dimension which befitted an explorative and qualitative approach since the approach functions to investigate a phenomenon where new ideas are required (Bhattacherjee, 2012).

3.2 Research Paradigm

Based on the minimum published works, which was related to using drawings to stimulate talk, the researcher in the current study had to rely on observations and translations of the participating learners' interactions to make meanings of the investigation (Thanh & Thanh, 2015). Such manner of gathering information is regarded as the interpretive paradigm because according to the interpretive paradigm, works where the researcher uses the subjects in the study for understanding the investigation as was in the presented case. Therefore, the responses that the researcher employed to understand the study depended on "series of individual eyes" (McQueen, cited in Thanh, 2015, p. 26) of the subject/participating learners' which they then displayed socially. In the same manner, the ontological view in the present study was multiple and relative to the individual learners' diversified socio-backgrounds (Creswell, 2016; Guba & Lincoln, 1994; Mason, 2002).

3.3 Research method: The Case Study

The specific requirements of the study needed a closer investigation of a real-life context which could be offered by the case study approach since case study "investigates a contemporary phenomenon within its real-life context and addresses a situation in which the boundaries between phenomenon and context are not clearly evident" (Yin, 1993, p. 59). Therefore, the researcher chose the case study in order to understand the particularity and complexity of each of the many ways that drawings were utilized by the learners. The generated drawings were products of the individual learners' engagement and so, each was unique and provided rich information about the uses of drawings. The term, *unit of study* was used in some researches to refer to the "…persons, as individuals or groups, organizations and object/s that were targeted for investigation (Bhattacherjee, 2012, p. 9) while for this current study, the unit of study implied all the selected occasions when drawings were used as unique issues (Stake, 1995).

3.4 Population

A research population is a group of individuals that have one or more characteristics in common that are of interest to the study (Mason, 2002) and on the other hand, research population could be all the "…items in the category of things being researched" (Denscombe, 2010, p. 23). Therefore, in the present study, the research population were all the 120 Grade 11 Life Sciences learners in the school. The population was distributed into three classes, namely, A, B and C which had about forty learners of mixed abilities each. The different classes were done according to the subject selections that the learners took in addition to the Life Sciences. Some of the main differences in the subjects that were taken were, Mathematics Literacy with History for classes A and B while class C had Mathematics and Physical sciences. As a result, Class C was identified as a *science class* for taking more science subjects. Nevertheless, their academic differences were not considered for the current study. It should be known that the practice of making drawings was common in three of their subjects which were Life sciences, Geography, Mathematics or Mathematics Literacy. Therefore, improvement in the use of drawings to stimulate talk as a classroom practice could benefit the learners' understanding of the identified subjects.

Other differences in the population were the learners' mother tongue (MT) languages which were of the following categories three; Afrikaans, Vernacular (could be any of the nine local languages spoken in South Africa) and English, for the different learners as explained earlier under Section

1.1. The Grade 11 learners' participation and their views about the research made the study worthwhile and a manageable sample was necessary to make reasonable observations of the learners' actions.

3.5 Sampling and selection

Sampling is the process of choosing individuals from the identified population who could provide the relevant data for the study (Mason, 2002). The participating learners were selected based on the researcher's general knowledge of their ability to articulate their ideas in the classroom activities. However, the researcher's generalized knowledge of the learners' performance could not be copied onto the current study and therefore, a large initial sample size was targeted to increase diversity to the data. Janice M. Morse suggested starting with a large sample (convenient) when dealing with new areas of research and then reduced to a smaller size as the research advanced and the data showed some understandable patterns (Morse, 2015). In that sense, fifteen learners were targeted from each of the three Grade 11 Life Sciences classes but however, the total increased from 45 to fifty-eight due to some learners who volunteered to join. The total size of the convenient sample became 58 learners, and it was concluded as such. Nevertheless, the convenient sample size was purposively reduced to few members whose data was outstanding and then the members formed the focus group. The focus group members served to discuss and answer questions to clarify the unique issues that emerged from the analysis of the convenient sample's generated data.

Teacher's beliefs and culture values show in his/her classroom actions (Dönmez & Tasar, 2020) and in such instances, an autobiography could help the readers to understand the position and influences of the searcher's interpretation of the learners' interactions (Denscombe, 2010). These teachers' beliefs were categorized as the "espoused*"* and *"i*nferred" depending on whether or not the teacher could talk about them (Bryan, 2012, p. 480-481*).* However, the current study was not an action study and therefore the researcher shared the self-reported beliefs only that were relevant to the present study.

3.6 The researcher's position in the study

3.6.1 Why the researcher took the participant researcher position?

The researcher had often observed that during learning Life Sciences, some learners struggled to understand the abstract biological concepts, especially when drawings were excluded. Therefore,

the researcher, as the subject teacher, was determined to part-take in the study in order to make direct exploration of the observations and interpretations of the learners' verbal and non-verbal actions when drawings and talk were included during learning. The researcher's position as a participant researcher had challenges of the researcher bias some of which were based on personal experiences. These personal experiences had a bearing on the researcher's interpretation of the participants' use of drawings, in particular, were highlighted for the valued readers of this study to understand the researcher's position.

The research report by Jan. K. Nespor (1985) emphasized that the subject teacher's classroom practices were influenced by his/her experiences. Therefore, based on the work from Nespor (1985), the participant- researcher who was also the participants' subject teacher, decided to be transparent to the readers regarding her personal experiences which influenced her interpretations of the learners' actions with drawings.

3.6.2. The researcher's changed teaching approach

The change in the teaching approach called for an equal development in the researcher's teaching strategies. It may help to share that the researcher transcended from the traditional teacher-centered approach era where the teacher was considered the source of information and the scientific facts were transmitted to learners (Rogoff & Lave, 1984, cited in Driver, et al., 2008). The scientific knowledge was regarded as static, the absolute truth which learners had to passively receive (Weimer, 2002; Liu & Liu, 2006) and later regurgitate it during examinations (anecdote experience). Apparently, the new era has technology dominating with the information being dynamic and sourced through formal and informal resources such as school curricula and peers and also, social media respectively.

3.6.3. The researcher's experiences of biology concepts

The researcher's experiences with using drawings were influenced by her Biology subject experiences during her own school days (late 1980s). Making drawings facilitated her understanding of the biological abstract concepts. The researcher valued the role of making drawings for understanding biological concepts which are equated to the classroom practices of Life Sciences learning in the current study.

3.6.4. The researcher's working experiences

The teacher training experiences on teaching Life Sciences prepared the researcher's subject matter. However, the classroom experiences developed new understanding of the subject matter in relation to the changing learners' challenges in the subject. The researcher affirmed the links between Life Sciences and some Biology subject content (Le Grange, 2008) but the abstract concepts in Biology require that some of the Biological skills be implemented in Life Sciences (anecdotal experiences of the researcher). The details of the breadth and depth of the Biology content coverage at FET in Life Sciences curriculum demands that some learners make and use drawings in order to grasp the concepts. The researcher's classroom experiences of some learners' challenges supported the need to make and use drawings (another anecdotal experiences of the researcher). The latter sentiments were supported by other researchers like Dempster and

Stears (2013), Landin (2015) and also, Quillin and Thomas (2014). They observed that the use of drawings in biology/Life Sciences were lagging behind other science subjects such as; Physical science, Mathematics, Engineering and Technology (NRC, 2012; Quillin & Thomas, 2014).

3.6.5. The researcher's previous research findings

The findings from the researcher's Honors Degree research study (2018, anecdotal work) supported that drawings could be used as assessment tools. Some Grade 11 Life Sciences learners who were requested to make drawings on digestion before teaching and some weeks after teaching made a marked improvements on what they revealed. Though the textual/written work could have been compared to the drawings, the learners revealed that even the learners with bilingual challenges succeeded to represent their understanding through drawings. The findings matched those from Dumpsters and Stears' studies with Grade 9s in some South African schools (2013). Dempster and Stears were promoting the need for using drawings as non-textual mode that could help learners in the country where there are diversified languages.

3.6.6. Drawings as the researcher's learning style

The researcher participated in the study because she identified with the skills of making and using drawings to understand biology content during her schooling years (in the late 1990s). Since there is some similarities in the Biology and Life Sciences subject content (Le Grange, 2008) the researcher decided to explore how the Grade learners would perform with using drawings, as it were. The process of making and using drawings interactively involves three sense categories which are visual (use of sight/seeing), auditory (use of hearing/listening) and kinesthetic (use of touching/feeling/doing) (VAK) (Fleming, cited in Jaleel & Thomas, 2019, p. 71). Therefore, rather than just listening, or reading nor viewing information passively, the practice could benefit some learners. The term learning style referred to the way one preferred to effectively perceive, process, store and recall whatever s/he was learning (James & Gardner, 1995 cited in Awla, 2014). The researcher did not intent to diverge into the details of the learners' learning styles, therefore, the concept could be a research area in future studies

3.7. Critical friends

The investigation of some practice that is used in my subject area and the interpretation of my subject learners' actions for professional benefit leads to research bias which threatened the trustworthiness of the study. Therefore, other professionals could be invited, and such other professionals are called critical friends (Costa & Kallick, 1993). The move to involve critical friends was termed, changing,…the focusing lens" (Costa & Kallick, 1993, p. 49) because according to Costa and Kallick, the critical friendship [was] the moment for listening, clarifying ideas to encourage specificity and offering time to understand the case presented (Costa & Kallick, 1993). There were three teachers, including the researcher, who taught Life Sciences in the school where this study was located. And two of these teachers, preferred to be named just as, Mr Peters and Mrs Smiths (not their real names) volunteered to assist as critical friends. Mr Peters and Mrs Smiths had Life Sciences teaching experiences which was over five and twenty years respectively. Mr Peters was registered for Masters' degree in one of the Universities of South Africa and offered to monitor the making of drawings for personal development. On the other hand, Mrs Smiths opted to use her long experience in the subject to conduct interviews with the learners to understand their views about drawings. The natural interest that the two teachers had in the use of drawings practice, created clear roles that each one would play in the study (Costa & Kallick, 1993). The clarification of duties was essential to ensure that the analysis, the critiquing and evaluations that were shared were beneficial to the study. Some studies hinted on the possible conflicts that could erupt from critical friendships when personal interests without professional-development orientation were involved (Özek, Edgren, & Jandér, 2012).

Therefore, the meetings with the critical friends were important for the constructive criticisms raised (Schuck & Russell, 2005) and the researcher considered them in her write-ups (Özek, Edgren, & Jandér, 2012). Thereafter, the three of us frequented the rooms where the learners were busy to take-up the duties for the day (according to the study schedule). When we met later after each session, we shared experiences and views, based on the research questions. The researcher shared her intentions and also considered the critiques that were raised by the critical friends as other lens to see through the study (Costa & Kallick, 1993) and those activities multiplied the study's perspectives.

3.8. Data generation techniques

The case study focused on the use of drawings to stimulate learner talk. And it was embedded in the interpretive paradigm which was now viewed through the socio-constructivist theory lens which were raised in chapter two before. Nonetheless, meanings to social studies differ and so various research tools for data collecting techniques were employed to triangulate the data (Merriam, 1998; Cohen, 2007). The techniques that were employed were the learners' drawings on the research task (as the research documents), classroom observations, questionnaires, and unstructured interviews. The critical friends are popular under the Self-study research, but they were borrowed in the current study to minimize the researcher bias during data generation and to improve on the trustworthiness of the data generated and to provide alternative views to the interpretation of the generated data (Loughlan, 2002). Details on how each research tool was used to generate data followed later in the chapter.

3.8.1 Learners' drawings records

The term document was defined as "'an original or official printed or written paper furnishing information or used as proof of something else" (Guba and Lincoln, 1981, p. 228). Drawings were generated from the research task in the presence of Mr Peters to ensure that it was the learners who authentically created them (Ahmed, 2010). The critical friends, especially Mr Peters, monitored the session as described at section 3.6.1.2 above. The critical friends later assisted to critique the researcher's choices on the unique instances of the drawings. The learner-generated drawings were the original visual data presented which were used to stimulate learner talk in the study. The use of the learner created drawings served the purpose of; 1. revealing the learners' level of interpretation of the research task, 2. displaying the learners' prior knowledge related to the research task and 3. showing the learners' level of realistic visualism (knowledge of seeing how to represent the body organs of the systems involved) (Piaget 1962, Piaget & Inhelder, 1969). All the identified areas added to the measuring the accuracy of the drawings in response to RQ1.

3.8.2. Questionnaires

Questionnaires allow learners to write their facts and opinions about some set questions (Denscombe, 2010). The tool was appropriate for a child-centered environment, where the learners, as the focus of the study, needed some privacy to express their views and opinions. The

advantage of the tool then was that it was administrable in the absence of the researcher and many learners simultaneously responded to the same questionnaire (Denscombe, 2010). In this manner, the tool was less expensive, manageable and time efficient for me contrasted to interviews. Most importantly for the study, the resulting responses offered wide range of the learners' written views and opinions. However, questionnaires tend to limit the learners' responses due to providing controlled writing spaces and time allocation while interviews could be more flexible (Guba & Lincoln, 1981).

The questionnaire for the current study was composed of six questions where four were open-ended questions, for free choice responses and a single closed question, which guided the responses (Denscombe, 2010). The questionnaire comprised of six questions which focused on three areas as follows; the general experiences about making drawings in the Life Sciences subject (Question 1.1), the learners' views about the importance of making drawings (Qns.1.2-1.4), and lastly, the learners' positions about recommending drawings to stimulate talk in the Life Sciences (Qn.1.5 and 1.6).

3.8.3. Observation

Observations were identified as "the systematic description of the events, behaviors, and artifacts of a social setting (Marshall & Rossman, cited in Kawulich, 2012). The observations in the current study were conducted under the interpretive paradigm, by me as the researcher whose main task was to look-out for the learners' interactions and make meanings. The term, participatory-observer was used to describe the researcher who openly presence him/herself at the scene of the phenomenon (Merriam, 2009) and consequently gathering reliable first-hand information. Anyway, observations were prone to suffer from the Hawthorne effect a bias (Oswald, et al., 2014) resulting from the learners' reaction to the presence of their teacher-as-the-researcher, for instance. (However, the problem was minimized as explained earlier under section 3.5.1 and 3.5.2. using the critical friends. Additionally, since participatory observation provided rich qualitative data as the events occurred (Mason, 2002), video recordings were employed to triangulate the generation of data under minimized biases. Observations also provided additional information such as the unscheduled events or backstage activities (DeMunck & Sobo, cited in Kawulich, 2012) that could be missed through other collecting tools. The backstage activities in the present study, referred to activities that learners could engaged in, like the non-verbal communications, which appeared not

related to the investigation. Through participatory observations, the researcher managed to view how the documents were generated by the learners themselves, therefore ensuring that they were authentic (Ahmed, 2010). The authenticity of the documents added credibility/trustworthiness of the drawings as primary sources for the current study.

3.8.4. Learner interactions and talk

The study focused on the use of drawings to stimulate learner talk that implied that the study was promoting social interactivity. During the social interactions, language was used to mediate the communication, ideas were shared with the more knowledgeable others resulting with self-internalization and then knowledge is constructed (Vygotsky, 1978). The identified benefits of learners' interactions and talk were important and so learners were allowed to interact and talk in peer groups and in focus group interviews. The details of the two interaction and talking sessions were discussed below.

3.8.4.1. Peer group class discussions

The talking in groups produced collaborative reasoning that led to inter-psychological and intra-psychological developments (Tanner, 2009; Wegerif & Mercer, 1999). Consequently, learners were divided into groups of five learners so that they could discuss their drawings at intervals. Their discussions formed the first set of the verbal talk recorded in the study. While in the peer groups, learners were free to make audio and visual recordings to capture their talk. The researcher managed to note down some unique incidents that were observed during the peer group discussion which were considered later with the focus group and supervision of Mrs Smiths.

3.8.4.2. Focus group interviews

As stated above, a few instances were picked from the analysis of previous data and were considered for further elaboration with a small number of the owners who would be more knowledgeable of the intended meanings. The interview session was conducted by Mrs Smiths: (who was the critical friend) to reduce researcher bias. The teacher guided by maintaining the morale of the learners as they explained their unique instances to the group. The teacher also probed the individual interviewees for deeper understanding of the identified issues. The researcher sat at a safe distance in the interview room, to note down the non-verbal incidences that she reconsidered during the data analysis with the critical friends. This conversational tool, interviews, was chosen for allowing a one-on-one exchanged of views with private or group

learners (Kvale, 1996, cited in Cohen, 2007). According to research, interviews employed direct means of collecting information from the concerned individuals, thereby improving the reliability of the data. Furthermore, the tool afforded the chance for a rich source of non-verbal talk unlike the questionnaire tool and since the data was audio-recorded, it implied that the researcher could always replay the records to understand the observed actions.

Conversely, interviews tend to intimidate some people, and in that case, a group interview was chosen (Cohen, 2007) because, then the individuals were not alone. The group interview had the added advantage of widening the discussions thereby contributing constructive ideas to each given case (Laing, cited by Cohen, 2007). Subsequently, the group interviews had to be semi-structured, which implied, having open-ended questions that allowed the learners to talk freely about their unique instances. Based on the open-endedness of the questions, the interviewer could probe and ask for clarity whenever needed (Kerlinger, 1970, cited in Cohen, 2007).

The members of the group were part of the convenient sample and that made them to be familiar to each other and aware of the topic under discussion such that each learner engaged naturally to generate ideas faster than if it was a single person interview condition (Morgan, 2013). In that case, the group was termed a *focus group because* the members purposed to clarify specific variant instances (Morgan, 1988, cited in Cohen, 2007). Each learner had some case to talk about and that kept the others anticipating and ready to provided support whenever needed (Cohen, 2007; Taylor-Powell, 2003).

3.9. Data generation Procedure

A convenient sample of fifty-eight Grade 11 Life Sciences learners who had given their written consents made drawings of the human alimentary canal and the urinary systems in response to research task (see Appendix 2 Section A). Then, in the presence of Mr Peters (a critical friend as described in section 3.5.1) who monitored the session, the learners were each issued a human body outline template. And they were instructed to make drawings to show the organs and systems through which the sandwich and the juice pass after they were swallowed. The drawings-making activity was individual work that needed ten minutes to complete. This task activity was conducted during formal lesson times to benefit the other learners who were not participating in the research study, as an ethical measure (see Appendix 6.2: Learners' consent forms). After the drawings session was over, the learners responded individually to the written questionnaire questions. The

task instructions suggested that learners spent five minutes writing their views and experiences about the research study. Thereafter, the learners gathered in random groups of five peers to discuss their drawings for a further five minutes. While it was not necessary to supervise the learners during discussions, Mr Peters moved quietly around the classroom, giving some guidance whenever needed and maintained order during the peer discussions. The learners took turns to make audio recordings of their discussions which were one minute long. Conversely, some learners chose to make visual recordings of their discussions instead. Furthermore, some learners still made group drawings to substitute for the mistakes they identified on their individual drawings. Subsequently, the researcher made quick notes on the unique incidences that she observed from the classroom that were addressed during the data analysis. Eventually when the time allocated for the session ended, the data was taken away for analysis with the critical friends first and then with the supervisors later.

Some two days later, after replaying the recorded data several times to analyze it, and reviewing the drawings data, the researcher selected a few unique data that emerged from the analysis to be discussed and clarified further with the respective individuals concerned. Those selected individuals formed the purposive sample referred to as the focus group. This purposively sample comprised of seven learners who had contributed unique drawings and audio-visual recordings that were termed the emergent issues. The focus group members conducted semi-structured interviews under the supervision of Mrs Smiths: (the critical friend described in section 3.5.1). The group members recorded their talk about the identified issues as requested by the researcher. The critical friend, Mrs Smiths:, facilitated the session by probing and listening as each focus group member talked and clarified his/her case as a unit. Mrs Smiths: also helped to keep the learners on track of the research questions while the researcher continued to write notes on the outstanding incidences. They were also asked to share *their views and opinion about the use of drawings to stimulate talk* which was not part of the questionnaire questions. The researcher saved that part of the question, purposely, for the last few learners who had more time to interact with the study and apparently, those learners were the focus group members. Ultimately, the session ended after 35 minutes. The researcher closed the session by thanking the learners while Mrs Smiths: carried the data away for analysis with the critical friends' team first and later, with the supervisors. The detailed descriptions of the techniques that were used in the study follow below.

3.10. Rigor and validity

The term rigor refers to the trust value or trustworthiness of the qualitative research (Guba & Lincoln, 1981). This study was investigating qualitative practices, non-measurable properties were considered such as credibility, transferability, dependability (Guba, 1981; Guba & Lincoln, 1985, 1989). However, since the study concerns social issues, the listed terms could be replaced by those that are commonly employed in social science which are; reliability, validity and generalizability (Morse, 2015). Reliability, which replaces dependability, concerns the degree of consistency of the results over time when the study is repeated under similar conditions (Denscombe, 2010; Mason, 2002). There was prolonged engagement and establishment of trust (intimacy) with the learners from being their teacher from GET (lower grades, for some of them) in addition to Grade 10 and the then 11. In spite of the long-established trust providing better reliability knowledge of the learners, there were challenges of researcher bias which would limit the reliability of the results. To counter the researcher's bias, two interested Life Sciences colleagues volunteered to act as critical friends and the researcher welcomed them to critique the analysis of the data regularly and one of them facilitated the interviews of the focus group.

3.10.1 Credibility

Credibility correlated to validity, which referred to the data being accurate and appropriate for the study (Denscombe, 2010). The accuracy of the data was considered by involving the learners' voices like through; the peer group discussions, learners' views and opinions (through responding to the written questionnaire questions) and clarity on the data was sought through conducting interviews with the focus group (under the observation of the critical friends). Additionally, the use of a single research tool could not guarantee credibility, given that the study was a particular practice that was performed under conditions suitable for the specific classroom development. In that case, Denscombe (2010) suggested that different research tools could vary the data collection, the process is called triangulation. Triangulation provides a thick rich data collection (Yin, 2002; Merriam, 1998) or thick descriptions (Morse, 2015) which helped to multiply the meaning- making process of the study. The audio recordings were transcribed as they were generated to keep track of the study issues and also to improve the reliability and validity of the study (Yin, 2002). Finally, the samples were changed from being convenient to purposive as the study developed and there

were evidence of some meaningful patterns and the changes improved the appropriateness of the rich data (see section 3.4 on sampling) which was suggested by Morse (2015).

3.10.2 Generalizability

Generalizability replaced transferability and this referred to how representative the study was, such that the findings could be comparable and applicable to a different sample and situation (Denscombe, 2010). Some researchers suggested that where small case studies were involved, then the process of transferability could be "imaginative" since the small size of the sample/s would limit the usability of the findings' (Lincoln & Guba, 1985 cited in Denscombe, 2015, p. 301). The procedure on how the data were generated was described step-after-step, to make it transferable. In some instances, in order to improve the validity of the study, adjustments were implemented according to the unfolded new ideas from the critical friends and supervisors (Morse et al, 2002). Overly, the researcher ensured that there was coherence in the methodology, the sampling, data collection and analysis tools in order to improve the reliability and validity of the study.

Early analysis of the data helped to establish relationships between the generated data and what was still to be collected/known. The practice of verifying and critiquing the data continuously with the critical friends persisted in order to monitor the reliability and validity of the study (Morse et al, 2002)

3.11. Ethical considerations

Ethics is a branch of philosophy that raises matters of how humans should regard other human subjects (Gall, Gall & Borg, 2007). The everyday roles of the teacher and the learners in the study changed to become researcher and learners respectively. In such settings, the presence of the researcher could induce psychological, emotional and or physically feelings to the learners (Merriam, 2009). Therefore, ethical measures followed in the study were explained to ensure that the requirements by the Human Ethics Research Committee (Non-medical) of the University of the Witwatersrand were respected (Ethics protocol number: 2019ECE029M)

3. 11.1 Avoidance of harm

The learners were thoroughly informed about their rights before volunteering to participate and consistently during and after the study. The recorded data (audios and videos) which was stored

on a USB under encrypted password and the hard copies of the data (the drawings) were taken to the locked storerooms of the University of Witwatersrand School of Education (WSoE) so that they could be retrieved only for research purposes.

3.11.2 Informed consent

Informed consents were obtained from the relevant institutions as follows; the ethics clearance was obtained from the University of Witwatersrand's Ethics committee including the written permission from the Government Department of Education (GDE). The approval to conduct the study in the identified school was attained from the principal and the school governing board (SGB) members.

The researcher wrote letters to inform the Grade 11 Life Sciences learners about the study and entertained their questions before inviting them to participate. Letters were written to get the parents or guardians consent for the minor learners' participation (Gall, Gall & Borg, 2007). The learners were informed about the importance of recorded data prior requesting their permission to use audio and video recorders with them.

3.11.3 Voluntary participation (respect for individuals and their autonomy)

The learners (some of which became the learners) were informed about their liberty to leave the study anytime they felt like and that they were not to be penalized or rewarded for participation or non-participation.

3.11.4 Anonymity- respect for their dignity

Numbers were used instead of the learners' real names through-out the research, except whenever real identities were needed temporarily for further references (for discussion of emergent issues). The names were written in pencil and erased before submitting the final report. Video recordings (for the learners willing to make videos) had their faces blurred. The names of the school, its location and all the authorities involved in this study were kept anonymous.

3.11.5 Confidentiality

The responses were only used for research purposes and were not to be divulged to the outside world, except through the research document. The digital data was encrypted and researcher kept on the password-locked laptop during the research study and was finally submitted to the supervisor for storage under a password-protected computer at the Wit's School of Education.

3.11.6 Maximizing benefits for the learners (beneficence)

The drawings of the alimentary canal with the peer discussions were conducted during the Life Sciences lesson to benefit the non-participating learners even if their data did not contribute to the study.

3.12 Data Analysis

Analysis involves making sense of the generated data (Mason, 2002; Merriam, 2009). Therefore, the process involved me and the critical friends looking to the different components of the gathered data seeking to make sense, directed by the research questions as elaborated below;

- Correctness of drawings (see RQ 1)
- Learners' experiences of using drawings (see RQ 2)
- Forms of learner talk stimulated (see RQ 3)

3.12.1. Analysis of Classroom observations

Classroom observations were made under the different activities and the collected data were used to address the relevant research questions. Additional evidence such as learners referring to their drawings during audio recordings showed that drawings were used or not used to stimulate the learners' social talking modes. Then, inductive analysis was employed in each situation.

3.12.2. Analysis of correctness of drawings:

Deductively, the drawings acted as external evidence of the learners' responses to the research question 1 (RQ1). Therefore, each of the generated drawings were scrutinized individually to count the organs represented thereof and twice coding were done for each drawings as follows, 1) for the number of organs represented using the Reiss and Tunnicliffe's (2001) scoring-scale (Table 3.1), and then, 2) for the body systems displayed considering whether or not the displayed body systems satisfied the descriptions of the body systems identified by Reiss and Tunnicliffe (2001) (see Table 3.2). During the analysis, the researcher noted those drawings that were uniquely correct or that needed further elaborations from the owners. The unique drawings were taken up

further with the concerned individuals during the focus group interviews. The research tool for scoring the alimentary canal and urinary system for their biological quality (in terms of the organs represented) was adopted from Reiss and Tunnicliffe (2001) as shown in the table 3.1 below.

Table 3.1: The seven-point scoring tool developed by Reiss and Tunnicliffe (2001)

Level	Descriptions
1	No representation of internal structure
2	One or more internal organs (e.g. bones and blood) placed at random.
3	One internal organ (e.g. brain or heart) in appropriate position
4	Two or more internal organs (e.g. stomach and a bone 'unit' such as the ribs) in appropriate positions but no extensive relationships indicated between them
5	One organ system indicated (e.g. gut connecting head to anus).
6	Two or three major organ systems indicated out of skeletal, gaseous exchange nervous, digestive, endocrine, urinary, muscular and circulatory.
7	Comprehensive representation with four or more organ systems indicated out of skeletal, gaseous exchange, nervous, digestive, endocrine, urinary, muscular and circulatory.

After the learners had identified the organs, the organs ultimately showed as, "…assembled" "functional systems" (Reiss, et al., 2002, p. 6). These functional systems were referred to as the body systems in the current study. Now, according to the current study, the expected body systems were the alimentary canal --→blood circulatory-→urinary system. The body system criterion borrowed from Reiss and Tunnicliffe (2001) shown below was used to analyze the drawings and where the criterion for body system was met, a capital letter was used to denote the system (like; A, C, U, for alimentary canal, circulatory or urinary systems) or otherwise, a small letter such as; a, c, u for the respective body systems, were used when inadequate organ-representation of the body system was displayed.

The body systems representations were analyzed based on the system descriptions given below,

Table 3.2 Body system criteria according to Reiss & Tunnicliffe (2001).

System	Description
Digestive system/Alimentary canal	Through tube from mouth to anus and indication of convolutions and/or compartmentalization.
Gaseous exchange	Two lungs, two bronchi, windpipe system which joins to mouth and/or nose.

Urogenital/kidney/excretory	Two kidneys, two ureters, bladder and urethra or two ovaries, two fallopian tubes and uterus or two testes, two epididymis and penis
Circulatory	Heart, arteries and veins into and/or leaving heart and, at least to some extent, all round the body

3.12.3. Analysis of the learners' experiences with the drawings

Thematic analysis approach was applied to the questionnaire data to understand the patterns in the learners' views and experiences about making and using drawings in the Life Sciences classrooms. The individual learners' responses in the form of their views and opinions to the questionnaire questions were read over many times and then thematically analyzed by the critical friends and me. The questionnaire questions formed the guiding categories following the search for meanings, patterns and themes to the learners' views and opinion about the practice. Those responses with similar theme were quantified as percentages while the sub questions were added and presented as ratio-percentages of the question. A few samples of the learners' responses in verbatim (as is) were included as supporting evidence.

The questionnaire was purposely given to class C whose attendance was more than the other two classes to maximize the data generation. Additionally, based on the researcher's knowledge of the learners (as their subject teacher), there were higher chances of collecting diversified rich data responses to the questionnaire questions. The learners' responses were sorted, and themes were formed based on the questionnaire questions and some extracts of the learners' responses (in verbatim) were shared as evidence. For some themes, the totals of the responses were represented as ratio percentages of the responses were employed to quantify the data.

3.12.4. Analysis of the forms of learner interactions and talk

After the correctness of drawings, there could be issues that needed clarity and for that, then the researcher employed the learner talk to fill the information gaps. The classroom observations (for the non-verbal indicators) and the audio recorded data were replayed several times in order to transcribe the learners' talk forms. During the analysis, the researcher aimed to study the; *what*, *how* and *why* learners talked about their drawings. The type of analysis approach that allowed for such details of particularity was the *inductive within-case* approach (Ayres, et al., 2003; Stake, 1995). The learners were not coached on the scientific talk and so, their forms of talk were not pre-

coded (Stake, 1995) and the possible guides for analysis emanated from thorough replay of their recorded audios and reading over their transcripts for repeated words or phrases or contextual meanings that could be matched to the social modes of talk. Each learner's drawings could be different, then the talk was bound to differ from the peers' and as a result, each learners' individual *drawings* or *issue* would be unique for understanding her/his story. The critical friends assisted to monitor the interviews in order to reduce the researcher-bias and they critiqued the researcher's analysis decisions, which gave way to alternative perspectives. The learner interactions and talk analysis took two dimensions which were;

1. the *scientific ideas* in the talk and the systems of category tool that was developed by Enochson and Redfors (2011, 2012) was adopted. The systems of categories tool analyzed how the learners related their scientific knowledge of the processes to the drawings they had generated from the research instructions. The tool sample was as shared in the table 3.3 below,

Table 3.3: System of categories research tool (Enochson & Redfors, 2011, 2012).

Category	Descriptions of the system
A	No answer, or answer not related to question
B	Non-scientific descriptions based on alternative ideas of the organ system
C	Descriptions following a scientific explanatory model-important parts missing
D	Descriptions following a scientific explanatory model-important parts included

The learners' talk was intended to be explanations of the biological organization or processes of the nutrients as they were transferred between different organs as depicted by their drawings. The learners' scientific ideas were classified as being at *scientific* or *non-scientific* when their descriptions involved the relevant biological terminologies that indicated the processes that were involved such as peristalsis, diffusion, absorption, excretion, and so forth. Schönborn and Bögeholtz (2009) employed the terms like *horizontal* and *vertical level* to refer to the macro-level or micro-level of nutrient transfer respectively. However, the Schönborn and Bögeholtz (2009) concept was dismissed since it was considered to be beyond the scope of the current study.

2. the *social talk forms/modes that* learners were engaged in were analyzed, according to the three types of talk that were adopted from Wegerif and Mercer (1997; 1999) and Mercer (2005). The

characteristics that distinguish each of the three types of talk were given below (Mercer, 2005; Wegerif & Mercer, 1997).

1. Disputational talk, which is characterized by disagreement and individualized decision making. There are few attempts to pool resources, or to offer constructive criticism of suggestions. Disputational talk also has some characteristic discourse features -short exchanges consisting of assertions and challenges or counter assertions.

2. Cumulative talk, in which speakers build positively but uncritically on what the other has said. Partners use talk to construct a 'common knowledge' by accumulation. Cumulative discourse is characterized by repetitions, confirmations and elaborations.

3. Exploratory talk, in which partners engage critically but constructively with each other's ideas. Statements and suggestions are offered for joint consideration. These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered (cf. Barnes and Todd, 1978). Compared with the other two types, in exploratory talk knowledge is made more publicly accountable and reasoning is more visible in the talk.

3.12.4.1. Analysis of Peer groups talk

The recordings were replayed several times to improve the researcher's understanding of the verbal and non-verbal actions that were performed in order to transcribe correctly.

3.12.4.2. Analysis for deepened learner talk forms

The focus group interviews were purposively formed to elaborate on the unique issues that emerged from the analysis of the initial data in Session 3.9.3.1. The emergent issues were different for each learner, and so, each set was treated as *a unit of study*. Then the transcribed data were qualitatively analyzed to establish the forms of talk which were further matched to the

characteristics of the three types of talk that were adopted from Wegerif and Mercer (1997) and were like those by Mercer (2005) too.

3.12.5 Conclusion

The details about what research design was used and how relevant the design was to the study were described in the chapter introduction, including the various research instruments that were implemented. The ethical issues that were implemented were explained. The research employed the qualitative case study approach to interpret how drawings were used to stimulate learner talk in the Grade 11 Life Sciences classrooms.

Under the section on the searcher's position in the study, the researcher shared her beliefs, values and experiences of using drawings which could relate to the investigation. The researcher also included her perspective on how the making and using drawings could be regarded as the learning styles necessary for some of the learners during their teaching and learning of Life Sciences.

Finally, the data collecting procedures were discussed. Some critical friends were included and that approach was borrowed from Self-study research, for the purpose of improving the reliability and validity of the data. The critical friends served to inform the researcher's interpretations through giving alternative perspectives to the analysis of the generated data. Thereafter, the data analysis tools which were considered for the study were discussed in the chapter that followed below.

Chapter Four: Data Analysis and Summaries of the Findings

4.0 Introduction

The analyses that were conducted were based on the data which were generated through the following research tools; learners' documents, which were generally referred to as, the drawings, then the classroom observations followed by questionnaires, peer discussions and focus group interviews as the research tools. The generated data were then processed to understand the meanings. Graphs were employed to represent the quantities of the organs labelled on each of the drawings, while a pie chart was used to show the body systems that were presented. Tables and excerpts samples were added to display some of the learners' written responses to the questionnaire questions. The classroom observations were employed to inform the analysis and to make sense of the learners' interactions. Lastly, the audio recorded data from the peer discussions and focus group interviews were transcribed to consider them for analysis purposes and to inform the researcher's discussions of the findings later in Chapter five. Themes that were drawn from the research questions were used as subtopics to guide the analyses. On the other hand, details about how the analyses were performed were given as summaries of some outstanding findings. An overall summary was given to close the chapter on the data analysis.

4.1 Correctness of drawings

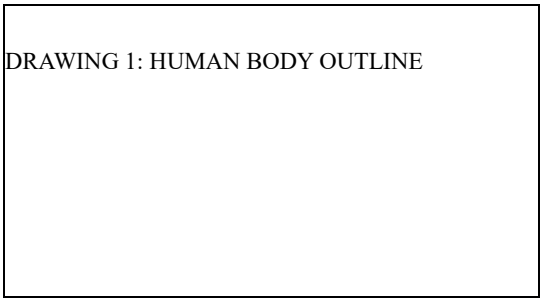
The issue of the correctness of the drawings was responding to the research question 1 (RQ 1) which read as shown below;

RQ1: How correct are the drawings of the human alimentary canal and urinary system that Grade 11 Life Sciences learners make?

After analyzing some of the participants' drawings, the researcher reasoned that there was some pattern where the correctness of the drawings had a bearing on the learners' talk being correct

The correctness of each of the drawings was analyzed based on the following codes: the *organs named*, the *body systems displayed* and the *biological qualities*, just as it was stated in chapter three. That manner of analyzing the learners' drawing was implemented in some studies that were conducted in South Africa using the Grade 9 learners (Dempster & Stears, 2013). Therefore, the procedures of how each of the codes were considered to analyze the correctness of the drawings were described below. The learners used a body outline similar to the one displayed below, to

generate their drawings, just as it was suggested and implemented in most studies that involved learners generating drawings by (Reiss & Tunnicliffe, 2001).



The analysis according to the respective codes were represented in the following sections.

Each one of the 58 learners used a single body outline page that was improvised in the study to generate drawings according to the research instructions. Each drawing was supposed to facilitate the Grade 8 learner to understand what happened to the eaten sandwich and the juice that was drunk. The drawings activity was conducted under the supervision of Mr Peters while the researcher, sat at a safe distance to record the classroom observations which were used later during data analysis to triangulate the data on the correctness of learners' drawings.

The initial analysis of the 58 learners' data revealed that there were some blank body outline pages, other body outline pages that had written responses instead of drawings where the owners had stated that they could not make drawings. Consequently, there were a total of 47 body outlines pages that showed drawings which were then analyzed and captured according to the following two codes; the body organs represented, and the body systems displayed (Dempster & Stears, 2013). The two codes were based on the criteria of the body systems presented and the seven-scoring scales of the biological correctness of the organs displayed that were developed by Reiss and Tunnicliffe (2001) and facilitated to highlight the accuracy of the drawings. Therefore, the details about how the data were sorted for each of the codes were given under the respective subheadings. Some critical friends were invited to the monitor the data collection in order to reduce the researcher bias.

4.1.1. Correctness of organs

The correctness of the drawings started from identifying the organs which were represented according to the criteria obtained from Reiss and Tunnicliffe (2001). The criteria which follow below, helped to list the correct organs that were supposed to be on each body systems as developed by Reiss and Tunnicliffe (2001)

Based on the criteria, the names of the different organs that were represented on each of the drawings were written in a table that follow below and then each time the names appeared on the drawings, ticks were added to the corresponding organ listed on the table. The process was administered to all the drawings and then the overall totals for each of the organs represented were presented in the bar graph as shown below.

Figure 4.1: Bar graph on the organs represented on the drawings.

The bar graph 4.1 above represented many different organs of the alimentary canal compared to the urinary system. The learners' knowledge of the correct organs was different The organs that were commonly identified by all learners for the alimentary canal were; mouth, esophagus, stomach, small and large intestine while a few extras such as; pancreas, liver, gallbladder, appendix, rectum and anus were exclusively named by some few learners. Then in some instances, non-scientific names of organs such as "pee" and words like penis instead of drawings were employed to indicate the urinary system. Ultimately, the urinary system organs that were commonly identified were; the two kidneys, bladder and penis while the ureter and the urethra were omitted by learners. This was considered to denote the differences in the learners' scientific literacy. The results from the three classes displayed how diversified the learners' knowledge of the research instruction was. Then after determining the organs' correctness, further analysis of the drawings was conducted regarding the body systems as detailed below.

4.1.2. Correctness of body systems

The learners' peer talk were mostly about how correct the represented body systems were and in order to analyze the body systems, the criterion suggested and implemented in similar studies were borrowed from Reiss and Tunnicliffe (2001) which was shown in Section 3.12.2 already. The suggested criterion considered the how the drawings matched the body systems. Capital letters

were used to denote the body systems whose criterion was correctly met in the represented drawings such as; A, C, U, for alimentary canal, circulatory or urinary systems. On the other hand, or otherwise, a small letter such as a, c, u for the respective body systems, were used when inadequate organ-representation of the body system was displayed.

Some samples of the drawings were added below to illustrate how the analysis of body systems was implemented, Figure 4.1 shows some of drawings samples see Appendix 4.1.1

All the other drawings showed organs located on the body outline but D47 was unique by displaying a word-flow diagram. However, the word-flow diagram qualified to be a drawing because each word represented an organ while the arrows showed the direction that the nutrients were moved through the organs. Therefore, the drawings could represent a process and organ relationship of the alimentary canal (Quillin & Thomas, 2015). According to the researcher's conceptualized definition of the term drawings cited as follows; "a learner-generated external visual representation depicting any type of content, whether structure, relationship, or process, created in static two dimensions in any medium" (Quillin & Thomas, 2015, p.2). In that circumstance, drawing D47 was a visual representation with the texted names of the organs and arrows depicting the organs' relationship and the direction of the process, (Quillin & Thomas, 2015) qualified to be drawings while in the form of a word-flow diagram and was scored at level 5.

Thereafter, the procedure was used to analyze the data and the different body systems were counted under the identified themes. The totals were added and converted to percentages which were represented as the pie-chart shown below.

Fig 4.2: The pie chart on the body systems represented.

The pie chart displayed the correctness of body system in terms of the seven –point scale (Reiss& Tunnicliffe, 2001) which was given in Table 4.2 above (Section, 3.12.2). There was a high representation of the completed alimentary canal which made a 31% contribution to the body systems represented. Then there were body systems which showed the three required systems and they contributed a 21% of the body systems represented. Therefore, the learners' knowledge of the

alimentary canal alone exceeded that for the expected three body systems' drawings. Additionally, the learners also represented some single organs for the breathing which were scored at level 2.

4.1.3 Summary on the correctness of drawings.

The learners made a variety of representations of drawings intending to respond to the given research scenario. They named organs and displayed body systems with varying levels of organ representation. The analysis followed two areas of focus which were the organs and body systems of the drawings. And the three systems considered were, alimentary canal, blood circulatory and the urinary system, according to the research scenario. It should be noted that because there was a single body outline that was given for generating the drawings on commonly represented were mostly for the alimentary canal, showing the following organs: mouth, esophagus, stomach, small and large intestine and they were scored at level 4 according the seven –point scale (Reiss & Tunnicliffe, 2001). The urinary system organs were represented by the two kidneys and the bladder because there was a single body outline to represent both body systems.

There was a link between the organs representation and the body systems, where the missing organs led to themes such as incomplete alimentary canal, urinary system to be identified for the body systems. However, the whole blood vessels representation for the blood circulatory system could obscure the visibility of all other organs. Therefore, only the heart representation was accepted to indicate the presence of the blood circulatory system. Consequently, because of some missing organs, the body systems were also uncompleted but there was a 21% representation that was made for the expected three body systems showing: the alimentary canal, circulatory system and the urinary system. Ultimately, the 21% represented the level of correctness of the drawings according to the research instructions while the learners' knowledge being biased towards the alimentary canal.

Drawings have been employed in science disciplines (Quillin & Thomas, 2015; RNC, 2012) but not much was recorded about what the learners' experiences of generating drawings were. The current considered the learners as the focus of the study whose experiences with drawings could add value to the study since the drawings themselves could not speak.

4.2 The learners' experiences of using drawings.

The learners' experiences were in response to the RQ2 which read as follows;

What are the Grade 11 Life Sciences learners' experiences of using drawings and talk to build their understanding of the human alimentary canal and the urinary system?

Drawings were practiced employed in other science disciplines including biology (Quillin & Thomas, 2015; RNC, 2012) which was represented as Life Sciences in the current study. However, in the current study, the researcher decided to capture the learners' voices to add to the data. The researcher designed some questions that required the learners' experiences with making and using drawings for teaching and learning and also the learners' experiences or feelings about using the drawings in the present study.

The researcher decided that the contribution of the learners' experiences about making and using drawings for teaching and learning could add rich information to complement the investigation A sample of the questionnaire questions that were given to the learners were added to the appendix. See Appendix 4.2 below

The first three questions, numbers 1.1.1 to 1.1.3, were about the teaching and learning experiences where the researcher wanted to establish if learners were familiar to the use of drawings in Life Sciences. Then the rest of the questions, from number 1.2 to 1.6, required learners to share their experiences about the use of drawings in the current study. Now, the learners' experiences involved their affective component which is a non-cognitive factor but it is a pre-requisite to learning (and the latter factor was ranked high for motivating learners on the amount of time and effort (Bransford et al., 2000) spent on implementing some given work. Drawings are practical skills which required time to practice and if the learners had high affection for the drawings, then the practice could achieve more. The term, affection was also associated with; anxiety, aspiration(s), attitude, interest, locus of control, self-efficacy, self-esteem, and value (Chamberlin, 2010, p. 168; Quillin & Thomas, 2015). Anyway, the future of using drawings as a strategy in the Life Sciences' teaching and learning depended on the learners' *voices* about their experiences in the current study. That was why most of the questionnaire questions asked for the learners' affective experiences.

There were 26 learners who responded to the questionnaire questions under the supervision of the critical friend, . The participating learners were purposely selected from a science class (whose subjects were mathematics, life sciences and physical sciences) and many of them had volunteered to part-take in the study compared to the non-science classes. Furthermore, the researcher was interested in these learners' high experiences with using drawings in other science disciplines such as, mathematics and physical sciences (NRC, 2012). In that circumstance, the learners provided a

rich and relevant source for information on the use of drawings. The thematic analysis approach was applied to the generated data and the responses were read many times to understand the themes involved. Some subsections were out lined based on the findings from the questions and other subheadings that helped to answer the research questions were added. Excerpts were also derived from question number 1.3 and 1.4 which required the learners' enjoyment and or boredom about of the study respectively.

4.2.1. Experiences of using drawings as a Life Sciences strategy

The question was intended to establish what the learners knew about the making and use of drawings in the Life Sciences. The questions reported on the use of drawings in the teaching and learning of the subject and allowed learners to write their thoughts and experiences about the drawings in the current study. The learners were required to cite evidence from named topics where drawings were involved, methods of how the drawings were employed and their thoughts about whether they had benefitted from using the drawings after all. In essence, the questions were targeting to show how much learners were familiar to making and using drawings and how much they appreciated the use of the drawings as a teaching and learning methodology in their subject and as a tool that facilitated their individual understanding of the concepts. The information was necessary to reflect on how relevant the practice of using and making drawings was to the learners. Their responses were sorted according to the respective themes derived from the questions and then managed as percentage ratios which were depicted below.

Figure 4.3: Topics where drawings were used.

The data analysis displayed in the graph above showed that the topic of digestion which represented the alimentary canal in the current study was rated the highest in using drawings, followed by the excretory system/ urinary system and then the photosynthesis topic was lowest. Despite all the topics that learners could identify, some learners still left the question unanswered (shown as blank on the graph) and it was unclear how they could not name even one topic such as the urinary system which they were busy with at the time of the study.

4.2.2. Learners' experiences of Drawings for teaching and learning Life Sciences

The question was intended to view how the learners valued the use of the drawings as a teaching and learning method in the subject. The responses showed descriptions of how drawings were useful such as; *for making illustrations* was highly identified, followed by that drawings *provided information on the structures and processes of concepts better*. However, there was a very small percentage of learners who failed to suggest something. The researcher wondered whether the data implied that the learners did not appreciate using and making drawings.

4.2.3. Experiences of the value of drawings in learning Life Sciences

The question was related to the previous one but at this stage, the learners were intended to reveal their experiences about using and making drawings. The suggested responses were ranked in their decreasing percentages of importance starting from; *helping to understand concepts (39%), aiding to make imaginations (*36%*), giving visual information (*14%) and to offer *clarity during discussions (11%).* This question was well represented and all the learners shared their experiences with drawings.

4.2.4 Learners' thoughts about the impact of using drawings

The learners could have valued the drawings just as a teaching and learning methodology. The current question was meant to bring the study closer to the learners' experiences and their responses were required to open-up for both the positive and negative experiences that the learners had from part-taking in the current study. Some samples of the learners' excerpts were added below.

4.2.4.1: The learners' positive experiences

*The ac*tivity offered positive affection for the learners, D16, D65, and D60 but for the learner D59, the making of drawings was difficult but still s/he benefitted from the importance of revising the concepts that were involved in the scenario. The responses revealed the differences in the learners' learning styles which were audio and hands-on for D16, hands-on and factual for D65 (left cerebral) and D60 was not easy to describe from the VAK by Flemings (1992) and so the learning could fit the active experimentation dimension, according to Kolb's learning styles (1970), after

s/he mentioned 'enjoying trying out things for self-edification'. The term learning styles referred to the learners' most preferred way of comprehending and sorting out instructions (Kolb, cited in McCarthy, 1997). Learners D59 was visual, since s/he learnt through observation of facial expressions, charts (Flemings, as cited by Jaleel, 2019). The details on learning styles were beyond the scope of the current study therefore the data was not discussed further.

The other factor that was considered was the learners' challenges from the current study. The learners' positive and negative experiences were important to inform the discussions that followed later about the study.

4.2.4.2: Learners' negative experiences about using drawings

The learner D65 had suggested earlier under Section 4.2.4.1, that she appreciated drawings since they were illustrative and described events as they occurred. However, now she complained about the scenario being challenging to represent. Her situation revealed how learning styles varied with the type of problems and therefore making learning preferences not to be fixed. "*There is no single right way to learn in a specific situation. Everyone has his/her own style of learning which can also vary from one situation to another"* (Jaleel, 2019, p. 3).

On the other hand, learner D16 suggested to use a textbook for checking the details of the drawings but now, Carvalho, et al (2005) discovered that text books never depicted diagrams in the same way which could mislead learners. Adding to the problem of unreliable information from various textbooks, there was also the issue about textbooks did not representing the biological body systems drawings, well for learners to understand (Carvalho, & Clément, 2007). The researcher then wondered how much the textbook could have help the concerned participant when the scenario was a real life problem which just required one to be creative with the representation.

4.2.5 Summary on the learners' experiences with drawings

The questionnaire revealed the learners' 'written voices' over the making and use of drawings in their Life Sciences and the current study as well. The information was necessary to minimize the

'voice' of the researcher from the discussions that followed in the later chapters. The analyses of the various written responses to the questions showed the following information.

-learners were familiar to the practice of making and using drawings, especially in the topic of digestion, which was associated with the alimentary canal, and a few mentioned the urinary system.

- learners acknowledged how drawings benefited them with visual representation of the imagined concepts and making understanding possible

- some learners enjoyed the research activity processes that were the activity and their reasons ranged from the limited space on the body-outline to being challenged by making drawings, however, they still appreciated using drawings for revising the Life Sciences concepts.

-for those who valued the strategy, they recommended the use of the making drawings frequently and requested for more time to improve the practice.

Some of the written experiences about using drawings were echoed later under the interviews of the focus group that followed in Section 4.3 below.

4.3 Analysis of the learners' talk forms

The learners' interactions were planned to reveal how the generated drawings were used to stimulate learner talk in response to RQ3 which read as follows:

RQ3; *What is the nature of the learner-learner talk that emerges from the drawings of the human alimentary canal and the urinary system of these Grade 11 Life Sciences learners?*

This part of the analysis developed from the previous data analysis where the learners' drawings and their experiences gained from the activities were addressed, (Research question 1 and 2). There were some issues that emerged and the researcher aimed to benefit fully from the rich information by obtaining the elaborations from the 'horse's mouth', the owners. Ultimately the clarities were necessary for the researcher to understand better how learners used their drawings to stimulate talk, as required by the investigation. Therefore, as explained earlier, the learners interacted while

in peer groups and later in interviews as a focus group. Their talk which was audio-recorded was transcribed and later it was replayed while the transcripts were re-read to aid the sorting of the data into codes. The term codes referred to the "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study" (Miles & Huberman, 1994, p. 56).

The learners interacted in peer groups and then later, in a focus group. The compositions of the peer groups and the lengths of their talk were followed as stipulated earlier under Chapter 3 (Section 3.6.2.4.1). The peer interactions and talk were monitored to note *how* they used the drawings to stimulate talk. Their talk was analyzed in terms of the *scientific ideas* shared and according to *the social forms of talk,* given as the *what,* the *how* and *why* based on the three types of talk. The data analysis tools that were employed were System of categories (Enochson & Redfors, 2011, 2012) and the three types of talk (Wegerif & Mercer, 1997, 1998) as stated earlier under Section 3.12.4.

The researcher intended that the learners could use the talk to fill up the missing information from their drawings, especially for those organs or systems that could be obscured by other organs, such as the circulatory system and the urinary system. Now, each learner's talk formed *a unit of analysis*, inspite of the talk being conducted in groups, because each contribution was unique individually as a form of talk. During the analysis, the researcher aimed to study the, *what* and the *how*, of the learners' talk about their drawings and such details required looking at the unique issues of the learners' talk individually (Ayres, et al., 2003). The *inductive within-case* approach (Ayres, et al., 2003) was chosen to provide the required details. In addition, the *within-case analysis* approach allowed more than one case/issue to be analyzed and that implied individuals in a group or different groups (Miles & Huberman, 1994). The other advantage of within-case analysis was its applicability to situations where there were no pre-codes that guided the analysis. The latter position was applicable to the current study participants who lacked prior-coaching on scientific talk which made their forms of talk to be unpredictable to have pre-codes. The audio recordings were replayed several times to understand the talk in order to transcribe and the transcriptions were read line after line (Strauss, 1996; Strauss & Corbin, 1990) to establish the frequent phrases. The frequent phrases were further matched to the elements of the three talk types that were borrowed from Wegerif & Mercer, 1996) shown in Section 3.12.4 #Threetypesoftalk;

The three types of talk were used for analyzing the learners' transcribed responses which answered to the research instructions given below.

Display your drawings to your peers and discuss how each of the drawings could be useful to Nthando. [Hint: consider the organs labeled, their positions, and anything else important you can see in the drawings]. Help Nthando understand fully how the food is passed along and what happens to it.

Therefore, each learner was supposed to talk about how his/her drawings were suitable for Nthando to understand what happened to the sandwich and the juice after they were swallowed.

4.3.1: Analysis of the what, the how and the why of individual talk with peers

The study was exploring the use of drawing to stimulate learner talk and in that instance, the researcher considered the words that the learners used and the implications of the words to understand the learners' forms of talk and the forms of the scientific terms they used. Finally, the researcher chose the transcripts from the learners who were, normally, non-participating learners during the subject's classroom activities. The talk from such a group was of interest to me as their teacher (out of curiousness) and could provide rich information (as the group's participation was rare in the usual class activities). The peer members were identified according to the numbers on their drawings as; D08, D11, D13, D14 and D16. The selected group was important for the researcher, to understand how they engaged in their talk since she was their subject-teacher. The researcher included some samples of the individual drawings and excerpts which were extracted from both the peer and focus group-audio recordings. The samples were displayed below.

The within-case analysis of learner talk in peers groups

The researcher wanted to listen to how the learners' talk progressed from the peer groups. Such forums would reveal how focused or not the learners were by themselves and how their inter-relationship and intra- relationships were. All the details about the learner talk was necessary later in order to comment on the types of talk according to Wegerif & Mercer, 1996) which were discussed earlier in Section 3.12.4

The drawings for the five peer group members were displayed to see if they matched the peers' initial talk. It was interesting to note that all the five drawings had the three body systems

represented showing the major organ such as follows; the heart, for circulatory system; the kidney for the urinary system and the alimentary canal organs. Some of the drawings such as; D08, D11 and D13 showed annotations about the processes that occurred by the kidney. See the five drawings below #Drawingsforintialpeergroup.

4.3.1.1. Extract 1, the peer group's forms of talk and the researcher's comments

The various peer group's initial talk forms were shared in the Extract 1 shown below #Peerintialtalkforms.

The learner D11 was the first to speak as the extract below;

Time	Learner	Talk
000	D11:	*Ok, so I am D11 and firstly I would like to start with the mouth which is the mechanism process where chewing takes place. As the food goes down into the esophagus the food passes through in the form of a bolus*

D11, referred to the digestion in the mouth as mechanism and such talk was not clear if D11 meant the mechanical digestion instead. The concepts of the food being move down the oesophagus as a bolus was correct. Therefore, for that part of information which was scientifically correct and was displayed on the drawings, then D11 could have linked her drawing to the talk.

Learner D08 followed as below.

Time	Learner	Talk
001	D08:	*And I am D08, I will be speaking about the lungs and the kidney. The lungs is a process where gaseous exchange takes place. And mostly the two gases that pass through are carbon dioxide and oxygen. You inhale oxygen and exhale carbon dioxide and in the kidney is where filtration takes place mostly about excreting uuum and excreting and then after that it goes on, yes*

D08's talk was not about the digestion like in the rest of the group members, she talked about the gaseous exchange that were represented by the lungs and then the filtration which occurred in the kidneys. The drawings for learner D08, displayed labels for kidneys which represented the urinary system. Nevertheless, it was not clear if D08 was extending to what the first peer member had shared. On the other hand, the two systems that she described were found on her drawings to illustrate that she had used her drawings to stimulate talk, as it was requested in the research instructions. The information was scientifically corrected and it was shared fluently.

Learner D 14

Time	Learner	Talk
054	D14:	*And I am D14, I will be speaking about the stomach, the digestive system that it digests food into the intestines*

The talk by D14, suggested that the stomach was the digestive system which digested food into the intestine. Now the researcher got the impression that, then the intestine could be a name for the state that food from the stomach was converted to. On the other hand, the learner could have implied that the stomach digests food which would be moved into the intestine. However, inspite of the ambiguity in the statements which needed to be elaboration by the owner, the drawings showed the alimentary canal. Therefore, the researcher noted that the learner's talk lacked correct order and the implications were covered in the chapter that followed later.

There was a pause of over sixty seconds before learner D 13 could talk as shown below;

Time	Learner	Talk
102	D13:	*I am D13… so, the digestive system which is the stomach goes through to the large intestines from the kidney which is the urea and then that's then where all the metabolic wastes is already broken down and absorbed. Then, it goes to the large intestines where it goes to the bladder and the small intestines is where the food and the food is broken down and it goes down to the anus.*

D13, by starting with, "…so…" the researcher got the impression that the statement was linked to the previous concept, which was introduced by D14. The learner, D13, repeated the idea of the food being pushed down to the intestine from the stomach but she got the order wrong. That mistake occurred after suggesting that the wastes from the large intestines were directed to the bladder and the small intestines. Therefore, the learner's facts about the alimentary canal got mixed-up with the urinary system mixed-up despite the organs being correctly represented on the drawing. It therefore showed that the learner consulted her drawings and attempted to talk about the processes such as metabolic wastes and absorption but got the order of their application wrong.

The final speaker took nine seconds' pause before starting on her talk which followed below;

Learner D16's talk was displayed below;

Time	Learner	Talk
139	*D16:*	*(Inaudible) once metabolic waste enters into the anus, it gets excreted so everything that is broken down goes to the waste and everything gets excreted out, so everything comes*

	out, so all the juice and the sandwich then (inaudible)… Nancy's friend Aaah, it all comes out once (unclear).

The learner, D16, started her talk repeating the concepts of the metabolic wastes from the previous speaker but then she added her own terminology which was *excretion which was correct about the metabolic wastes but it got messed-up after suggesting that the juice and the sandwich,* all come out. Therefore, the learner had correct ideas but then she repeated some ideas from the previous peer which then.

4.3.1.2: Discussion of the researcher's interpretations of the peers' talk (Extract 1)

Based on the evidence given above, the peers managed to talk in their groups and they consulted their drawings however, they missed to respond according to the instructions. The learners had the correct terminologies for the digestion and urinary system, but they failed to apply them correctly except for learner D08 who talked fluently about the breathing and urinary system. The drawings, for instance, were supposed to aid their talk but contrarily, many of the learners' talk was a repetition of ideas from previous peers and then they struggled to share fluent presentations. The researcher failed to follow most of the talk in order to understand the learners' talk presentations which did not correspond to their represented individual drawings. The behavior which was displayed where learners repeated terminologies which they failed to implement and such behavior demonstrated what is termed, "group harmony" where elements of repetition of even wrong information is done to protect the group image (Mercer, 1996a, p. 368-369). In terms of the study, the drawings revealed how four of the learners were not confident to talk about the alimentary canal, nor was their scientific facts correct and they lacked fluency or coherency with their presentations. That discovery required follow-up otherwise it could indicate how much the topic was not understood. Contrarily, the learners displayed that they had not followed the instruction to link their drawings to the talk.

After regarding all the reflections from replaying the recordings and re-reading the transcribed data during the analysis of the peer group talk, the researcher reasoned that the learners needed to be guided to *use their drawings to explain what happened to the sandwich and juice after swallowing to a Grade 8 learner,* as it was stated in the instructions. Therefore, the researcher suggested to probed them and see if they could realize their miss-interpretation of the activity instructions.

4.3.2: Elaboration on the peer talk on drawings

Four learners volunteered to discuss their drawings again and so they were given back their drawings to work with. They recorded their audios and then the data were transcribed and analyzed employing thematic synthesis. The four peers who volunteered were identified as; D08, D13, D43 and D65. However, their drawings and their excerpts as Extract 2, were added to the appendix (Appendix 4.3) this was because three of them, D08, D43 and D65 were selected to form the focus group that followed later in the Section 4.3.2. See Extract 2

The except for learner D13 was the only one shown below.

4.3.2.1: Learners' Deepened discussion on correctness of drawings

The learner, D13, was selected from the other four learners who were identified above because she was timid and hesitant to present, took a long pause before she could present her first/initial peer talk (Section 4.3.1.1). Extract 1 and now under the deepened discussion, some peers assisted her before she could talk at Extract 2 (Turn 003 and 239) to reveal that there was some sharing of ideas in the group. It was significant that the time taken while talking by learner D13, was lengthened than in Extract 1 (Time was 003 to 044seconds). All the changes were signs that there were improvements after the interviewer guided the learners to include the research instructions. The talking duration and the choice of words for learner D13 were noted and tabulated in the table below. The new words and expressions that were used to talk by learner, D13, were indicted as **higher font** and in **bold** under column B.

4.3.2.2. Extract 3: D13's talk compared

Time/s	Column A; D13 talk Extract 1 (initial talk)	Time/s	Column B; D13 talk Extract.2 (second talk)
102-128	*I am D13, so the digestive system which is the stomach goes through to the large intestines from the kidney which is the urea and then that's then where all the metabolic wastes is already broken down and absorbed. Then, it goes to the large intestines where it goes to the bladder and the small intestines is where the food and the food is broken down and it goes down to the anus.*	003-044	*Ok, I am D13 and (group members whispering)* ***uuum*** *my drawing to a Grade 8 learner ,* ***I don't think*** *my drawing is at the Grade 8 level because I included all organs and* ***I think****, like the lungs and the kidney, no the lungs and every other organ. It doesn't have to appear it has nothing to do with the digestive system, it's unnecessary and my* ***uuum*** *explanation is not really on Grade 8 level for Ntando to understand, and…* ***yeah.***

D13 talked for 22seconds during Extract 1(Turn 102), the talk started with a, "…so…" to show that it was a continuation to previous idea. The first sentence had some errors about the digestive system being the stomach which goes through to the large intestines from the kidney …. ". In Extract 3 above, D13 was assisted by peers before the talk started (Turn 003-044) and then the talk lasted 41 seconds. Therefore, the talk duration was increased. The focus of the talk was on the Grade 8 learners' standards which was relevant to the research activity instructions given earlier under the introduction. The learner gave supporting reasons for ideas and criticized herself for the inclusion of the kidneys and the lungs on the drawings. The talking pattern of Extract 3 above shows **"uuums"**, "**I don't think"** and "**I think" and " yeah"** displayed in higher font and bolded, which indicated thinking moments unlike when her talk in Extract 1. The ability to criticize one's own work like that, displayed some level of confidence, was absent from Extract 1 and that could be linked to the explorative talk elements (Wegerif & Mercer, 1997).

4.3.2.3: Summary on the peer correctness of drawings

There were improved learner interactions in Extract 2 than there were in Extract 1. The learners critically analyzed their drawings in respect of the Grade 8 learner whom they were expected to address, just as it was stated in the research instructions given in the introduction. Apparently, the learners' performance improved after Mrs Smiths: had asked them to reconsider the research activity instructions. The learners discussed their drawings critically and in contrast to their peers' and they talked for longer times than before. That way of talk displayed some form of reasoning unlike the cumulative talk (Wegerif & Mercer, 1997) at Extract 1.

4.3.3.: Follow-up on the learners' misunderstood issues

Bearing the changes that had been noted from the last part of the peer talk in the previous Section 4.3.1.2, a focus group was created to address some unique data that were misunderstood under Section 4.3.1.2. Some members were selected purposely to conduct some interviews that were supposed to provide rich information about the relevant learners whose talk were unclear from the previous peer talk. The learners that were chosen were the following: D08, D43, D63 and D65 who were the owners of the emergent issues. Their contribution to the study would provide the 'verbal voice' elaborations over the misunderstood issues in order to improve on the researchers'

understanding and interpretation of the study later. The advantages on the use of focus group interviews were shared already in Chapter 3 (Section 3.6.2.4.2)

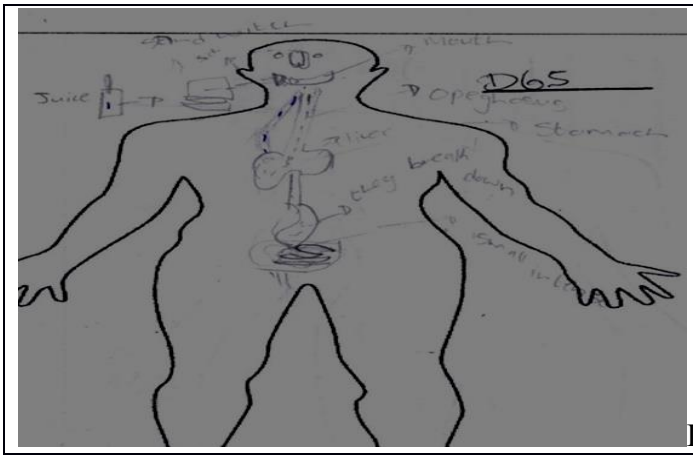
It should be noted that the focus group's members had no rules on how to manage the session nor prior training on how to talk about each of their selected issues besides the reminder to reconsider the research instructions which was done during peer group discussions. On that point, the researcher was curious to listen and learn from the owners of the identified emergent issues. During the interview interactions, the researcher listened and observed the interactions while Mrs Smiths: monitored the session, listened and at times probed the interviewees to understand their talk better. The learners elaborated on their issues, while the other members assisted whenever necessary.

4.3.3.0: Forms of learners' talk in focus group

Under the guidance of Mrs Smiths, various individuals were selected to clarify issues that emanated from the initial data analysis (Section 4.3.2). The within-case analysis allowed some follow-up on individual issues (Stakes, 1995). Therefore, the members who were identified by the numbers on their drawings formed the focus group and details of each individual members' talk were displayed below.

4.3.3.1: A disputational talk

The drawings below were labelled as displaying a misconception by the researcher; however, the owner was given a chance to elaborate.



D65

The learner D65 was selected to join the focus group to explain the two tubes that emerged from below the mouth which the researcher had deduced to be a misconception. Learner D65 was chosen because she was generally, an introvert and nonparticipating learner in class activities. It was interesting to listen to her reasoning about the two tubes. Some selected excerpts of her reasoning were shared below.

4.3.3.1.1. D65's talk about her drawing

The learner D65 defended her drawings by clarifying the misunderstanding that the researcher, had but, however, before the learner D65 could share her reasoning, she needed to build some confidence over the scientific terms. Some peers' voices interjected to help D65 to pronounce the term oesophagus at Turn 006 and later at Turn 009, a peer also scaffolded her, as illustrated in the excerpts added below;

Extract 4.1: Peers scaffolding D65

Time	Learner	Talk
006	*D65:*	*Uuum this is maam this is oesssophagus (**a peer's voice helps to pronounce the word**)*
009	*D65:*	*Yah this one (**again a peer's voice heard from the background continues to support D65**)*

After the scaffolding, learner D65, managed to address the main issue of the two tubes for some minutes. See Mrs Smiths: **Error! Reference source not found.**.

The learner stated that the second tube was "not really for digestion" (Turn 040) but was for the breathing system instead (Turn 043). She described how different colours were used to highlight that; the blue ink showed the breathing tube (trachea) and the penciled parts indicated the oesophagus (Turn 050).

The learners' reasons matched the evidence from the drawings and the responses were convincing. Mrs Smiths: considered another angle of probing, which involved the learner's experiences about using drawings and talk for learning. This set information was an extrapolation to the questionnaire which was discussed under research question 2 (Section 4.2) the focus members felt about their experiences in the study at that point contrasted to when the study started.

4.3.3.1.2. Learner D65' ideas about using drawings and talk in Life Sciences

Mrs Smiths: probed D65 for her views about using drawings and talk in Life Sciences. The question was a repetition from the questionnaire which was done in order to listen to the learner's *voice* about her experiences with the study. The decision to probe for such information was appropriate now than before since learners had been exposed to the research activity long enough to contribute reasonably. The researcher was grateful that Mrs Smiths remembered to probe the learner D65 for that information because the data was vital for the study discussions in the later chapter. Furthermore, learner D65 was known as one of the silent learners in the subject and so hearing her reasoning was valuable for understanding other learners similar to her.

Extract 4.3: D65's 'voice' about the use of drawings

Time	Learner	Talk
117	*D65:*	*My understanding madam* ***I don't think I understand what drawings are for, I feel like…it's better when it's written down in words*** *and then it's more understand better. For me madam if, like if I was a Grade 8 learner and u gave me this madam and there was juice and oesophagus* ***I wouldn't understand what's actually happening****, madam* ***until you explain*** *to me maam. And* ***it's better if I can read it than to draw*** *madam, that's my point of view madam, I feel like drawing doesn't actually help for me*

The position of D65 was similar to what she said under the questionnaire question 1.4 (Section4.2.4.2). She wrote that, she had not understood the drawing for Nthando. In the extract above, learner D65 indicated how she did not understand the purpose of drawings inspite of preferring to comprehend the details of the scenario first before making the drawings. However, after the interviewer asked about the use of talk, the learners had something else to say as shown in the excerpt below.

Extract 4.4: D65's voice about talking

Time	Learner	Talk
151	*Mrs Smiths:*	*But then how about the talking?*

154 *D65:* *The talking* ***when somebody explains*** *to you actually,* ***maybe if I draw it*** *maam* ***and explain what is going on it*** *actually* ***helps to understand better*** *than to actually see a drawing just like this maam*

235 *D65:* *No, I* ***could, like have a mind map to remember*** ***what I am talking about*** *so they can know.* ***I could like draw here, like this is*** *the mouth and* ***could label this comes in and this comes in*** *and this comes in (going over her drawing and illustrating with her fingers).*

The excerpt revealed that D65 needed someone to elaborate in detail what was needed to be done. Learner D65's key worries were bolded in the excerpts shared above and these were; needed explanations from someone (maybe she was challenged by the scientific language) to know what was required, then she needed to make the drawings herself to understand better. She also needed to make a mind map to reassure her of what she would talk about. Lastly she would need to add annotations to her drawing. Concisely, learner D65 wanted to share that she would prefer that the instructions were elaborated to her understanding and then she would also prefer to make the drawings according to her preferred understanding. This was a great discovery about the learner's challenges with instructions and how not all drawings were easy for her to understand. That explained why for her drawing, she had indicated some drawings of the sandwich and juice besides the drawing which were meant to facilitate her understanding and the generation of the drawing later. The implications of this discovery were discussed further in chapter five.

Then, Mrs Smiths: noticed that D65 had suggested that she would need to draw, and so the teacher rephrased the question directly to see if the learner, D65 could notice. Ultimately D65 realized that she needed some drawings after all (Turn 255). She, however hinted that she preferred drawings that had annotations which aided her explanations. She stressed that she preferred that she could make the drawings herself and that there could be explanations in point which be simpler to understand.

The Extract 4.5: D65 needed drawings after all

Time	Learner	Talk
	Mrs Smiths:	*Umm. Ok fine, so in that case would drawing be important for you to talk? Would the drawing, would you need to have a drawing nearby?*

255 D65: Ohh, Yaah,… (Pausing to think), yes madam (smiling) but just ahh, ahh, ahh, yes madam I think, ..I think I do need a drawing to actually help me madam… but not this kind of drawing madam.

Mrs Smiths:: Ok Ahh wwwhat (disruption by D65)

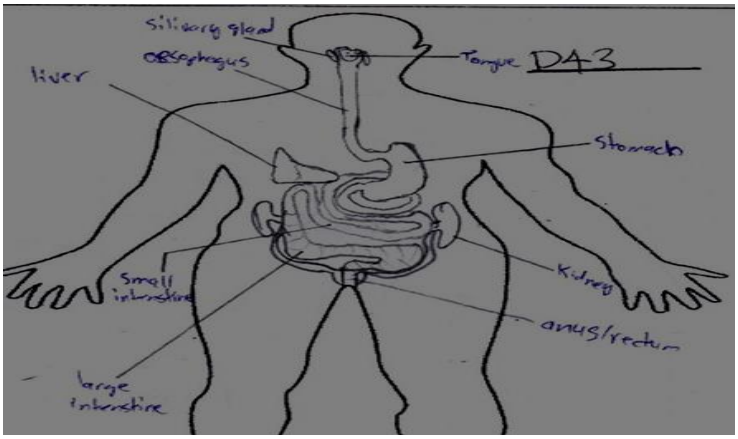
308 D65: .Like points… (she added to specify her preference).

4.3.3.1.3: Summary on learner D65

The learner D65, was generally a non-learner in Life Sciences but after some peer-scaffolding, she managed to dispute over her drawing which had been mistaken to represent misconceptions. The learner reasoned out how making drawings and talking could help her to understand. Therefore, the learner used her drawings, which the researcher had ruled-out as being wrong, to talk about the drawings she preferred.

4.3.3.2: Learner's talk about his own drawings

Learner D43 defended his drawings claiming that the parts represented were compliant to the standards that the Grade 8 learner could understand. Mrs Smiths: probed to hear his voice about his claims and D43 justified the inclusion of the bladder to the alimentary canal drawing. The drawings from learner D43 were added below so even my readers could see why the owner was contented that the figure was simple for the Grade 8 learner to understand.



D43

4.3.3.2.1 Learner's talk about their own drawings

Extract 5.1: Learner D43's basis of the argument

Time	Learner	Talk
003-058	D43:	*I just added Ehh bladder and urethra maam, for the issue of the fluid. My drawing will be suitable for a Grade 8 learner because it has both the digestive system which sort out solid waste and liquid and separate them from the stomach and intestines and the solid waste will be stored in the rectum before excretion where they are removed from the system and then they are removed from the system, and liquid will be stored in the bladder before they are removed from the system. It will be easy to understand as it shows all the components of the digestive system.*

The reasoning was accurate, and it demonstrated that the speaker had understood the research activity instructions requirements. He added the statement that the drawings were Grade 8 compliant which affirmed his unchanging position from the previous talk under Extract 2. In Turn 258-318. Nevertheless, a terminology error occurred when D43 used the term excretion instead of egested by line 5 of the excerpt above.

Measuring by the responses given by D43, Mrs Smiths extended the prompt questions to the excretory organs in Turn 234, which D43, responded to by explaining how systems could be dysfunctional and later damaged when excretory material were not released (Turn 240). That level of the response was beyond Mrs Smiths' expectation (she confirmed later during the analysis discussions). Therefore, D43 demonstrated that he was critically reasoning and not just regurgitating information. See the Extract 5.2 that follow below,

4.3.3.2.2: Learner D43's experiences of the study

Extract 5.2 on D43's ideas about the study

Time	Learner	Talk
217	D43:	*Of cause I realized that Ehh for the fluid…the system that deals with the fluids that was incomplete then it comes to the removal section down the pathway but not excrete unwanted waste.*
234	Mrs Smiths:	*What would happen if you had left it like that?*
237		*Pause*
240	D43:	*It would have negative effects on the system and diseases could occur... (Pause)… like some organs will start failing and others will rot away because of the waste in the system.*

4.3.3.3: Focus groups members' critique of the correctness of peers' drawings

The opportunity to compare the learners' drawings was offered to two learners who were, D08 and D43, who seemed to be more knowledgeable about the research activity instruction requirements and their drawings revealed some different evident. The study was on the use of drawings to stimulate learners talk and so, the researcher decided to listen explicitly from what the two top class learners' thoughts were about the study. Their drawings and excerpts were added below to the appendix (Figure 4.3.3) peers critique correctness of each other's drawings.

4.3.3.3.1. Learner D08's talk about the two drawings

Extract 6.1;

Time	Learner	Talk
405	D08:	*For me I would say that uum, as the DO8 and the D43 has the more like the digestive system and I have different,… like, I got the (inaudible) and I got the digestive system which is clear in some way because you can feel (inaudible) to the stomach part not actually uuum,… showing the uuum,… small intestines with the large intestines but D43 showed the digestive system perfectly where he actually showed us how filtration will happen through the kidney and the excretion of… would, will go through and then filtration will happen.*

4.3.3.3.2: How the learners use the drawings to address each other's drawings

Learner D08 was one of the top learners and she was given a chance to compare her drawings to that of learner D43. This was the first time to listen to her ideas about the drawings by learner D43. The excerpt extract revealed how learner D08 started by *defending* her drawings as being clear in some way *but later, she admitted that* the drawings for learnerD43 showed the digestive system/alimentary canal *better t*han hers and justified her opinion (Turn 405). Even though the tone of the learner started off being competitive and defensive "…*For me I would say that uum…and I got the digestive system which is clear in some way…"* (Turn 405, at the beginning). However, towards the end the tone changed, and she could appreciate the efforts of her peer on the drawings *"…but D43 showed the digestive system perfectly where he actually showed us how filtration will happen…"* (Turn 405 at the end)

4.3.3.3.3. Learner D43's ideas about the two drawings

Extract 6.2

Time	Learner	Talk
454	Mrs Smiths:	*What do you say D43 about the two drawings?*
500	D43:	*Well, D43 has the respiratory system, Ohh D08, has the respiratory system which is also important when it comes to… digestion. Some organs cannot operate without oxygen because the… respiratory also excretes carbon dioxide so that organs in the body can function perfectly.*

4.3.3.3.3. The learners' views of drawings and talk?

The contribution from the two learners on how they felt about using drawings to stimulate talk was important for the researcher's understanding the study and she, the researcher, was grateful that Mrs Smiths remembered again to probe the for the learners' ideas. The excerpt from their talk were added SeeAredrawingsnecessary? .

4.3.3.3.4: Learners' experience of talk in sciences

Mrs Smiths: changed the question by asking what could start between making drawings and talk. In response, D43 and D (Neutral) both suggested that talk should follow after the drawings. That idea was opposed by D08 who preferred talking first before drawings because after talk or elaboration, would help her to understand about the drawing.

4.3.3.3.4.1 Learner D08 and D43 closure to the role of talk in the classroom

Extract 6.7

Time	Learner	Talk
1325	D08:	*Maam I say actually the opposite. I say talk then draw so the pupil can first get a picture of what you are saying and then when you draw (inaudible). You first goanna visualize what you goanna draw and then draw it, so talk first is better than drawing*.

Learner, D43 reasoned from the position of the Grade8 learner and suggested that visual representations could be easier to understand than the verbal, which would be an abstract mode.

2017 D43: *Well like I said the drawing will be the talk but in a visual way but with the talk it will be a drawing in a verbal way. So, they have to be more or less the same because they have to explain each other in other words*

4.3.3.3.4.2: My comments about the learners' perspective of drawings and talk

There were two focus group members, D08 and D43 who were asked to respond to the probes on the use of drawings and talk. This question was a follow-up on the written experiences that learners had shared earlier in Section 4.2 with the component of the talk which could not be shared during that section because it learners had not engaged with the study long enough. The two learners were asked to share their ideas to add to what the other learner D65 had shared. The extracts from the two learners' transcribed excerpts were added to the appendix as indicated already. Learner, D43 reasoned beyond Mrs Smiths' expectation and the researcher was equally surprised by such reasoning level on the roles of drawings and talk. Well, the learner generated his own contextualized meaning for talk and drawing where he stated that, a drawing was a "*visual talk* while the real talk was "*verbal drawings".* My critical friends could not simplify what D43 meant, however, the researcher decided that the implication was similar to the dual code theory where talk is a verbal mode and drawings, which are non-verbal were visual modes of learning (Paivio, 2013) The perspective that D43 revealed was similar to the concept of the 'thought language' which was shared by (Asoulin, 2016), where language was a transmission version of thoughts.

4.3.3.4: Summary on the focus group peers' critiques of their drawings and talk

The excerpts revealed that the owner of the drawings could understand and iterate on some aspects that might be missing from the representation depending on what the owner's decision on what should be visually represented. This was supported by learner D08 who claimed to understand her drawings inspite of the challenges from the other members. The neutral learner, D Neutral also got stuck when he tried to elaborate on the drawings for D43 until the owner rescued him. That position had been suggested by learner D65 earlier who also iterated on her drawing which the researcher had pronounced as a misconception. Nevertheless, while many learners struggled to talk about their drawings, it was easy for the learner D43 to understand the drawings from his peers, maybe due to his status as a top-learner, which was quite impressive. Ultimately, all the learners revealed that they appreciated the use of drawings for talking for different reasons but D43 shared a special version where both drawing (imagery mode) and talk (verbal mode) were some forms of talk which supported the theory of *language of thought* (Asoulin, 2016).

4.3.2.5. Cultural factors with drawings and talk

Learner D63 who was quiet through most of the interviews joined to talking about his drawings. He was generally, a respectful learner that was avoided using scientific terms.

Time Learner Talk

2411 Mrs Smiths: *Right, fine. So how would you use your drawing to explain to this child the path that is taken by your food?*

2419 D63: *(smiling) madam since uuum, some kids maam, they understand, they don't understand with verbal, verbal, they understand visual maam. So using this it is easy maam (inaudible),*

2434 (an intruder disruption)

2438 D63 (laughs) so maam it's easy maam (inaudible) it's easy to draw the structure (inaudible)

According to D63, drawings were necessary since some learners required *visual* modes other than *verbal* modes to understand (Turn 2419). Learner D63 borrowed the words; verbal and visual modes, that were shared earlier by D43 (Turn 1942). It showed that he had been listening to the earlier conversation from D43.

Mrs Smiths: then decided to talk about the urination system represented on D63's drawings. The learner D63 went in circles, being inaudible, murmuring "ma'am", pausing, giggling while struggling to answer about the organs for urine flow from the kidney, and the bladder (Turn 2529-till Turn 2617).

Extract 7.2

2529 D63: *so ma'am as we said that this girl (inaudible), so mama, (laughter), so mam, mam, kidney's function is to excrete urine, things like water, (inaudible)…so when he drank, (inaudible), so urea from the liver and from the liver it goes to the kidney (inaudible).*

2604 Mrs Smiths: Right you are talking about the kidney, where does this, the waste from the kidney go to?

2611 D63: *Ma'am?*

2612 Mrs Smiths: *Where do they go to from the kidney according to your drawing?*

2617 D63: Ma'am, are you talking about the juice *(laughs)… to the bladder ma'am,*

2625 D 43: can I help (in a whisper)

Another learner, D43 offered to assist but Mrs Smiths: insisted that D63 should respond (Turn 2625).

However, Mrs Smiths: then eased the questioning by asking about the bladder which was also missing in order to establish what D63 knew about the location of the bladder even if it was not shown (Turn 2636 and Turn 2643). D63 pointed correctly to his drawing to indicate the position of the bladder (Turn 2640).

Extract 7.3

Time	Learner	Talk
2636	Mrs Smiths:	*Where is the bladder?*
2640	D63:	*The bladder is here, there (pointing to the drawing) maam*
2643	Mrs Smiths:	*There… where, I can't see… but it is there?*
2645	D63:	*Yes maam*

After Mrs Smiths: was satisfied that D63 knew about the location of the bladder, she decided that D63 could talk about the rest of the urinary organs as shown below. D63 uttered an, "Uum, paused, giggled", until Mrs Smiths: encouraged him to speak freely (Turn2714).

Extract 7.4

Time	Learner	Talk
2700	Mrs Smiths:	*Ok… fine and how did it go out of the body?*
2708	D63:	*Uuum, through your… (Laughs)*
2714	Mrs Smiths:	*No, you are free, be free, speak freely (encouraging him to speak)*

Nonetheless, D63 still stammered and repeated the word 'sexual organ' three times. But again, this sexual organ was not represented in the drawings and for that, D63 laughed, was inaudible again, then gave an excuse that he had drawn a lady (Turn 2722) and continued to utter expressions such as;"… **Aaah, Eiish,** and pausing before he busted that it was, "… sensitive for a kid" (Turn 2738).

Extract 7.5

Time	Learner	Talk

2715 D63: *The sexual… the sexual… the sexual organ, maam*

2720 Mrs Smiths: *Ok, fine, but it's not there here, why didn't you draw it?*

2722 D63**:** **Aaah, Nooh**… (Laughs) (Inaudible), because maam…ok ma'am, I have drawn a lady… (Inaudible)

2730 Mrs Smiths: Yes, but yes you are not showing it there. The Grade 8 would want to know what happened to the fluid, how it goes out of the body

2738 D63: **Aaah maam Eish**… that would be too sensitive for a kid maam

Then Mrs Smiths: interpreted it as to imply that, drawing the urethra for the Grade 8 learner would be embarrassing for learner D63 and so, in respect of the learner, she dropped the issue. However, the learner D63 further suggested that he could not talk about the missing organ because it was unnecessary to draw the female urethra because,"…we already know about the structure of the girl thing, the boy thing" (Turn 2808). It was unclear whether D63 was referring to his *cultural system* when he used the plural noun,"…**we** already…" Additionally, the learner seemed satisfied that Mrs Smiths: had understood about the, "**girl thing and boy thing**" and he then hinted that he did not want to be "**harsh"** (Turn 2817).

Extract 7.6

2808 D63: *Then **we already** know maam (inaudible) already know the structure of the…of the **girl thing**, **the boy thing***

Mrs Smiths: *The girl thing and the boy thing (echoing D63's phrase)*

2817 D63: *Yes maam so I will try to not **be harsh** (inaudible)*

The other male focus group members (D43, D17 and D19) joined to backup D63 on this issue while the female members (D08 and D65) asked to be excused. The learner observer, noted that move for discussion with the critical friends. See the Appendix 3 for the rest of the transcription of this talk Extract 4.10.7. Another learner, D 17 opened –up on the sensitive issue in Turn3408 and gave the reason for avoiding the names of the reproductive organs in Turn 3430

*3400 D17**:** **Hayii** (vernacular), Nooh, She is saying through the thing there…it has to…your thing there, Ohh…*

3405 D17: should we say the name of it?

3407 Mrs Smiths: You are scientists

3408 D17: Ohh,..Yes maam the penis or the vagina

4.3.4: Summary on cultural factors with the making drawings

Inspite of the drawings of learner D63 representing the two systems, the alimentary canal and the urinary system, it took a long time to name the urinary organs that he has omitted. The learner used expressions such as; **Aaah, Eiish, Uuum, Ohh**, to show how much he was trying to talk fluently scientifically due to bilingual barrier. It took long for the learner to talk about the bladder since he was avoiding mentioning the scientific names for the urinary system. However, with learner D63, he managed to talk about his drawings and explained for the missing organ as being a cultural factor and he claimed that it was disrespectful to show and talk about the reproductive organs to younger learners. Consequently, learner D63 referred to the organs as; "girl ***thing****"* and *"* ***boy thing"*** however, another learner, D17, identified the structures as *vagina* and *penis,* after he asked for permission from Mrs Smiths to say the terms (Turn 3405) and the teacher reminded them that they were scientists (Turn 3407*).* The learner D17 shared similar bilingual challenges to learner D63 since he also used expressions like; Hayii (vernacular for No) and he tried to avoid the scientific terms by using the "***thing***" and "***your thing there***", (Turn 3400). The talk patterns displayed a form of cumulative talk elements (Wegerif & Mercer, 1997) whereas a group the learners respected their cultural factors and kept a "**we *already", (***Turn 2808) attitude which denoted a group harmony.

4.4.: Summary on the forms of learner-learner talk

The general summary of the findings from the research question 4.3, which was about the revelation of the learner-learner talk forms that transpired. The learners discussed their drawings in peer groups and later as they elaborated on issues which the researcher had found to be unique and capable of adding some value to the understanding of the study. The discussions of the study's findings followed later in chapter five. The learners were instructed to show how their drawings could help Nthando, who was a Grade 8 learners in the study scenario what happened to the sandwich and juice that had been swallowed. The learners made audio recorded data which were

transcribed and in order to analyze the extracts from the peer groups and the focus group interviews, the three types of talk from Wegerif and Mercer (1997) were used.

The learners talked from their peer groups and some members were hesitant to talk at first. Consequently, some learners shared erroneous information without someone correcting them and they did not follow the activity instructions as was expected and. That kind of talk resembled the cumulative type (Wegerif & Mercer, 1997) where group harmony would prevent the members from confronting those contributing the wrong responses. However, after Mrs Smiths reminded the learners to consider the research activity instructions during the discussions of their drawings. Learners started to give reasonable ideas to support and even critique their representations.

Most of the focus group members managed to reason about how their drawings were inappropriate for the Grade 8 learner whom they were supposed to facilitate. The reasons that they shared ranged from the drawings having misrepresented organs, wrong size of organs and some organs that were missing from the represented systems. The learners' ability to reason and support their talk in their groups like that, was a demonstration of how they could use the explorative talk elements according to Wegerif and Mercer (1997).

There were few disputational talk from one of the learners in the focus group and the form of talk worked to clarify the error that the researcher had made about the drawings of D65 displaying some misconceptions. The owner of the drawings, D65, disputed and gave convincing reasons to prove that the drawing was accurate, in section.

Another form of talk emerged where learners suggested that it was against their cultural to represent and talk about the reproductive organs to younger learners like the Grade 8 who was in the study. In that situation the learner tried hard to avoid labelling and using the scientific term for the urinary system. The researcher and Mrs Smiths, refrained from the issue as sensitive after the other members of the focus group learners confirmed the matter. The researcher concluded that there was something about the learners' culture and the use of drawings to learn Life Sciences in Grade 11 which required further investigation in future.

4.5: Conclusion

The chapter covered the analysis of the data that were collected using the research tools which were identified as; learner documents, classroom observations, questionnaire, peer group discussions and focus group interviews. The general findings were as shown below;

The findings revealed that, while the correctness of the drawings was intended to refer to the representation of the expected three body systems, due to contextual factors like the size of the body outline provided, the single page where the three systems which were; alimentary canal, blood circulatory and urinary system, were supposed to be represented, then not all organs could be displayed. In that situation, there was a 21% of the drawings that displayed the expected body systems while 31% of the visual representations displayed the alimentary canal than the urinary system or the blood circulatory system. Now it was not clear whether such drawings were generated because the learners wanted the organs for the two systems to be visible, or they failed to interpret the research instructions and or that the learners could not imagine how the two systems' organs could be represented, which was their level of visual literacy.

The questionnaire questions were meant to reveal the leaners' experiences with the drawings, within and outside of the study. The learners admitted to be familiar to the use and making of drawings in the Life Sciences and they revealed that drawings were employed in the topic of digestion/the alimentary canal more than the urinary system. However, the researcher was not clear if the learners were not just asserting that they preferred the topic of digestion to all the others that had been covered. The questions which enquired about what the learners had enjoyed or not enjoyed from the study did not provide all the answers to the researcher's worries. Nonetheless, some learners revealed that they enjoyed the use of audio-recording or talk and drawings which was a-hands-on activity. On the other hand, there were some who did not enjoy the research activity because they could not make drawings and so, they preferred to use text books for referencing. Lastly, there were those learners who found the research scenario difficulty to understand such that making the drawings was a challenge. The shared feelings were eye-openers to some of the worries that the researcher had over why few drawings represented the two body systems.

The last part of the study was saved to clear off the queries that the researcher had about some of the drawings, about some observations including what the learners thought about using drawings

and talk in Life Sciences class activities. It was helpful therefore, to employ a small group of the learners who were directly associated with the areas of concern. In that way, the researcher managed to listen and observe as answers and reasons were shared by the original sources, the concerned learners. The learners talked naturally about how they preferred certain ways of representing drawings and also about whether they preferred to talk first before making drawings. However, drawings and talk were both forms of talk, as shared by one of the learners, D48, who suggested that drawings were *visual talk* while talking was *verbal drawings*. That way of regarding the two strategies was novelty to both the researcher and the critical friends and there were no further comments on the idea. After the presentations from the focus group, the interviews ended in order to wrap up the study.

Chapter Five: Discussions, Conclusions, Personal Reflections, Implications and Recommendations

5.0 Introductions.

The findings were discussed as summarized from the previous chapter based on the research questions and then the conclusions were drawn from, the research questions and in relation to other similar studies. The researcher also shared the personal impressions she had about of the study, as a teacher-researcher. Finally the researcher identified the implications of the study outcomes to the other learners, to the teaching and learning in Life Sciences and to the teachers who use drawings in the subject. Finally, the researcher imparted some recommendations for further studies.

5.1 The correctness of the drawings

The topic on the correctness of the drawings was responding to the research question 1 (RQ 1) which read as shown below;

RQ1: How correct are the drawings of the human alimentary canal and urinary system that Grade 11 Life Sciences learners make?

The correctness of the drawings implied displaying the required body systems according to the research scenario which enquired about what happened to the swallowed sandwich and juice. However, since there were three body systems to represent on one body outline, the learners were challenged to decide on which organs to represent without digressing from the instructions. Some 31% of the drawings displayed the alimentary canal which were completed, labelled beyond the small intestines and that implied the digestion of the sandwich and juice ended by being egested through the anus. However, there were only 21% of the drawings that represented two of the three required body systems. The findings from the generated drawings revealed that learners' knowledge was inclined to the alimentary canal/digestive system more than the urinary system. In that respect, the value obtained from the Grade 11s implied that the challenges about representing the urinary system were still persistent as reported from similar studies (Aydin, 2016; Enochson et al., 2015). On another note, some learners in the current study employed word-flow diagrams and

mind maps as alternatives to the problem of limited space on the body-outline provided and such cleverness was not reported from the related studies with Grade 9s (Enochson et al (2015; Dempster, et al., 2014). Therefore, it showed that the Grade 11learners, as mature participants, utilized alternative didactic knowledge to their advantage (Carvalho, et al., 2004).

5.2 Learners' experiences with the drawings.

The learners' experiences were addressed in response to the RQ2 which read as follows;

What are the Grade 11 Life Sciences learners' experiences of using drawings and talk to build their understanding of the human alimentary canal and the urinary system?

In some ways, the learners' written responses added meanings to the visually represented responses given earlier. The textual responses filled in the gaps that drawings alone could not have explained nor described regarding the impact that drawings, as a practice, had made to enhance the teaching and learning of concepts in Life Sciences.

5.2.1 The findings from the study were that:

- the making and use of drawings in Life Sciences was a familiar practice especially in the topic of digestion/the alimentary canal. The observation incurred to the conclusions about the digestive system/alimentary canal being the commonly understood body system (Enochson & Redfors, 2011, 2012; Dempster & Stears, 2013; Reiss & Tunnicliffe, 2001, 2002).

-the drawings were complimented for promoting visualization of the imagined biological concepts and therefore, enhancing the understanding of the topics in Life Sciences. However, challenges were experienced from making accurate drawings due to inconsistency in the making of individual drawings in the subject. The issue of inconsistency with drawings was identified with other studies and series of factors which included the large classroom sizes, were given as the excuses for not using drawings frequently in biological classes (Quillin & Thomas, 2015).

- more experiences on the importance of talk and drawings were revisited later under the focus group interviews.

--the drawings revealed how much learners understood the concepts in question. As the learners iterated on their mistakes, they reasoned scientifically and consolidated their understanding through the justifications they gave to support their drawings. Unknown to the learners, the revelations of their appreciation and challenges with drawings were the needed information on how drawings were used to stimulate talk. Therefore, the researcher, as the participating researcher, learnt more about the learners' gaps in the given scenario's concepts. Nonetheless, talk was necessary since some learners failed to reiterate their understanding and experiences through written texts due to their bilingual barriers.

5.3 Forms of learner-learner talk

The topic on the learners' interactions were planned to reveal how much the generated drawings were used to stimulate learner talk in response to RQ3 which read as follows:

RQ3; *What is the nature of the learner-learner talk that emerges from the drawings of the human alimentary canal and the urinary system of these Grade 11 Life Sciences learners?*

The research question for this section was intended to show, the *what* and *how* part of what transpired when learners shared ideas about their drawings in the peer groups and later when they were in the focus group interviews. The learners applied some elements of the three types of social talk modes (Barnes & Todd, 1997; Wegerif & Mercer, 1996) and other social modes in the following manners.

The learners struggled to follow the instructions which required them to use their drawings to explain what happened to the sandwich and the juice after swallowing. The problem resulted from the instruction being open and not closed questions such that the learners could decide on how much answer to give in their responses. The findings supported what was suggested concerning the differences in making explicit and implicit instructions. The researcher had chosen to employ the implicit instructions because they were recommended for revealing more variances in the learners' understanding compared to explicit instruction (Prokop, Fančovičová & Tunnicliffe, 2009). The outcomes showed that the learners talked about the digestion in the manner they understood it from their prior knowledge other than from the research instructions. The latter action supported what was claimed about the learners bringing their prior knowledge to the classroom

(Vygotsky, 1978). Some of the selected peer group members employed cumulative talk where they attempted to build a common talk where some words and ideas about the alimentary canal were repeated. Furthermore, inspite of using some relevant terms for the alimentary canal and urinary system, four of the learners mixed the terminologies in manners which were confusing to the researcher while no one bothered to correct, and such actions were characteristic of the cumulative talk (Wegerif & Mercer, 1996)

Another learner, D65 used disputation to talk and defended her drawings from being disqualified for displaying two tubes that emerged from below the mouth. The learner argued for the displayed manner as being her preferred way of remembering the concerned body systems. The concepts of preferences was equivalent to learning styles differences, which implied the modes of teaching that worked for the learner to understand (Jaleel & Thomas, 2019) however, scope of learning styles were beyond the current study and therefore the issue could not be pursued further.

During the last form of talk, learners shared their reasons for presenting their drawings in the manners shown. For instance, learner D08 explained how representing few organs on her drawings allowed visibility to the other organs displayed. The reasons were convincing, and it was the same with learner D43 who was contented that his drawings were appropriate for a Grade 8 learner to understand based on the few organs and neat labels which were evidenced from the generated figure D43.

Additionally, the learners shared their feelings about using drawings and talking. The issue was added at this point because the learners had interacted in the study long enough for them to provide reasonable responses about the drawings and talk. The summary about drawings and talk being forms of talk were outstanding. According to the contribution of learner, D43, drawings which are an imagery mode were identified as *visual talk* while speaking which is a verbal mode was termed *verbal drawing*. Such reasoning capacity of the learner was amazing contribution to the study.

Then finally, there was an issue of cultural factor which limited another learner from making drawings nor using scientific names of human reproductive organs. The learner, D63, referred to the organs as *boy thing* (for penis or boy reproductive organs) and *girl thing* (for vagina or female reproductive organs) instead. The learner showed his drawings without the reproductive organs as missing on his drawings in respect of his culture. The researcher then regarded the cultural

information as sensitive and respected the cultural differences according to the curriculum requirements (DBE, 2011). However, the issue was noted for further investigations under mega-studies.

5.4 The theoretical findings

The drawings enabled social and individual interactions to occur over some emergent issues as was anticipated would happen under the socio-constructivists approach (Vygotsky, 1978). The social tools which were employed were the following: cumulative (in the peer group), disputational (D65) and exploratory (D08, D43, D63) talk forms and non-scientific terms such as facilitated to communicate ideas. The natural use of multimodalities benefited the learners with bilingual barriers who could have been disadvantaged under the pen and paper tests just as was disapproved by Dempster and Stears (2013). Furthermore, given the real-life context (Yin, 2002) of the social interactions in the focus group, some learners like, D08 and D43, positioned themselves as tutors who provided support to the group members as peer scaffolding (Bruner, 1978). Learners were able to collaboratively share their mental models and they used their social tools (Vygotsky, 1978) to iterate their meanings and new meanings were discovered, especially with learner D65 from Extract 4 Section 4.3.4.1 and with more members of the focus group like, D08 and D43, Section 4.3.4.3. This then confirmed that knowledge could be constructed during active social interactions in support of the socio-constructivist theory (Vygotsky, 1962, 1978).

5.5 Summary on the study

Ultimately, the findings from the study revealed that the Grade 11 Life Sciences learners could generated drawings which depicted different levels of correctness after using implicit research instructions. Many of the drawings represented alimentary canals without the urinary systems which showed how much the learners' understanding was biased towards the alimentary canal than the urinary system. The experiences with making and using drawings revealed that drawings were appreciated for facilitating the understanding of the abstract biological concepts in Life Sciences. On the other hand, drawings were not easy to represent since teachers did not employ them consistently in biological classes unlike in other STEM subjects.

Drawings stimulated talk among peers who employed some relevant terminologies such as; mechanical digestion, bolus, absorption, metabolic wastes, excretion, inspite of mixing the terminologies in some confusing manner. The researcher attributed the mix-up of terminology to the irregular use of social talk similar to the one in the current study. The group displayed characteristics of the cumulative talk. Nevertheless, the forms of talk changed after the learners were reminded to consider the research instructions by the interviewer. Thereafter, the forms of talk which were presented by the focus group interviewees and the lessons attained were summarized below.

Despite appreciating drawings, not all drawings appealed to the learners the same way such that, allowing learners to reiterate on their drawings helped to understand what their preferences about drawings were.

Group talk could allow the capable learners to scaffold the less knowledgeable, though teacher's guidance could be necessary to ensure that accurate information was shared.

Learners could critically reason and dispute in support of their drawings as well as appreciate their peers' drawings in such ways that new knowledge could be developed. The learners employed exploratory talk characteristics in their small groups and elaborated on why drawings and talk could be preferred. Ultimately, the Grade 11 Life Sciences learners could use drawings to stimulate talk even without prior coaching on exploratory talk rules after all.

5.6. Implications

The research findings showed how the use of drawings with the Grade 11 Life Sciences learners could reveal both the challenges and strengths of the learners' understanding levels of certain topics.

5.7 Recommendations for the classroom development.

The application of more real-life scenarios could help the learners to relate to their school science knowledge. However, the teachers need to be thorough with subject content mastery and correct application of terminologies through frequent use of drawings to talk which would assist the learners to articulate their ideas and train them better for the science debates after school (DBE,

2011). Furthermore, talk could improve the learners' scientific literacy, self-efficacy, including the inter-psychologically and intra-psychological development as well.

5.8. Limitations

The accuracy of the science information shared was not part of the research questions but it could be considered with future studies. However, it was evident that the three types of talk tool (Wegerif & Mercer, 1996; Mercer, 2008), did not consider the levels of accuracy of the scientific information shared such that the learners could offer some convincing disputation or explorative talk based on incorrect information. The study was on a small scale to generalize the findings, therefore further studies with larger population samples could be necessary.

5.9. Personal Growth

5.9.1: Observing new potentials of the learners

The researcher started the study without clues on how the participants would take it and feared that the study would not provide useful data to respond to the research questions, since the learners had no prior coaching on explorative talk like it was in similar studies (Enochson, et al., 2015; Webb & Treagust, 2006). However, after the initial data analysis, new understanding was motivated. Listening to the experiences of both the top-class performing learners such as D43 and D08 and the introverts, non-participating learners like, D65 and D63, was intriguing to the researcher as their subject teacher. The learners' questionnaire responses and their focus group interviews were compared to understand the study better. In the end, the contributions from the diversified performing learners, made the focus group a worthwhile sample to listen to and their ideas improved the understanding of the study. Then, there were the constructive ideas that were gained from the interactive learner, D43, which was shared below revealed the unimagined thinking capacity of the learner.

> *The drawing will be the talk in a visual way but with the talk it will be a drawing in a verbal way. So they have to be more or less the same because they have to explain each other in other words, (D43, Turn, 2017)*

The words echoed the link between *the thought and language* which was shared by Asoulin (2016). The words displayed a high level of the learner's contextualization of drawings as a form of language or talk which the researcher did not expect to come from the learners.

5.9.2: Learning about the learners' challenges

The researcher's perspective of the learners' struggles when generating drawings shifted after listening to the introvert and formerly, non-interactive learner, D65, who shared that not all drawings were understood by the learners, some required certain specification in their drawings. Furthermore, the use of drawings on human organs revealed that some cultural factors were limiting learners from representing nor talk about the reproductive organs like, D63. The findings were similar to the studies conducted by Dempster and Stears (2013) in some Kwa-Zulu- Natal communities in of South Africa and also with some English undergraduate male students from studies by Reiss and Tunnicliffe (2001) shared in Section 2.1.7. Then the researcher wondered if the cultural factors could a potential barrier in the use of drawings in that matter.

However, the issue required further investigation in future studies.

5.9.3: Implicit instructions revealed diversified drawings

The use of implicit instructions revealed a variety of drawings which were, in some way, difficult to analyze using the tools that were tried in similar investigations such as for the system of categories (Enochson et al, 2012, 2015). This was because, there were many organs to represent on one body outline unlike when separate body outlines were used, such as was in the investigation by Enochson et al (2012, 2015). However, since the scenario that was involved in the current study was a real-life application of the taught body systems, the researcher wanted to see how the Grade 11Life Sciences learners, as senior learners, would reason and employ their visual literacy. Consequently, a 21% of the learners' drawings represented the alimentary canal and the urinary system in the expected manner which supported the findings that visual literacy improved with maturity. On the other hand, many of the learners resorted to representing one system which was the alimentary canal and thereby supported the conclusion that learners understood the alimentary canal (digestive system) more than other human systems (Dempster & Stears, 2013; Enochson, et al., 2015; Reiss & Tunnicliffe, 2001, 2002; Prokop, Fančovičová & Tunnicliffe, 2009).

5.9.4: Limitations from analytical tools

The diversified drawings proved to be difficult to analyze using the published analytical tools, especially when the instructions shifted from previous studies such as was the issue in the current investigation where a single body outline was provided or when a word-flow-diagram was drawn instead of the organs.

The researcher experienced challenges with employing the three social mode tools from Mercer (2005) which was designed for learners with the background rules of the explorative talk since her learners lacked prior coaching. However, the challenge was counteracted by replaying the audio recordings and reading over the transcriptions several times to check for repeated words or phrases that matched or had similar contextual meanings to the elements of the three types of talk as was suggested by Wegerif and Mercer (1996). Ultimately, drawings were used to stimulate talk inspite of lacking prior coaching on the three types of talk (Wegerif & Mercer, 1996) after-all.

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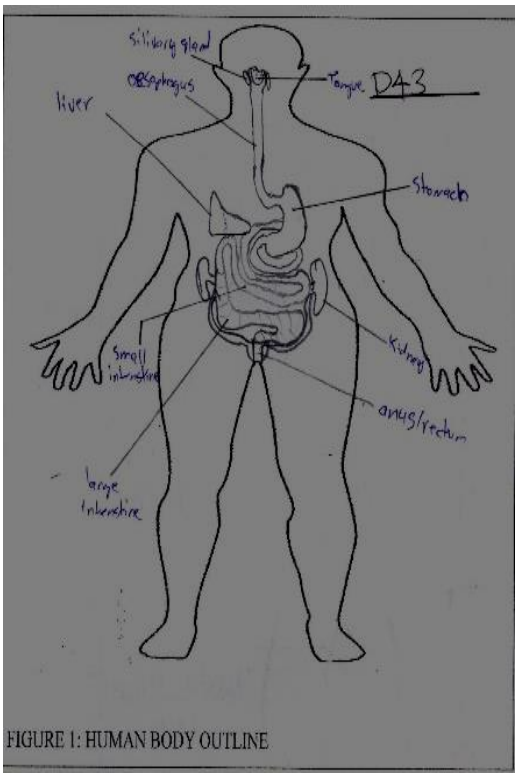
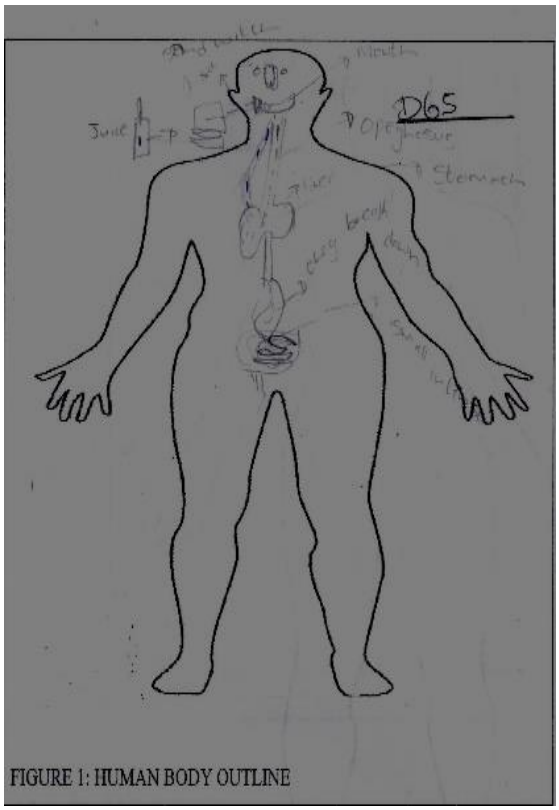
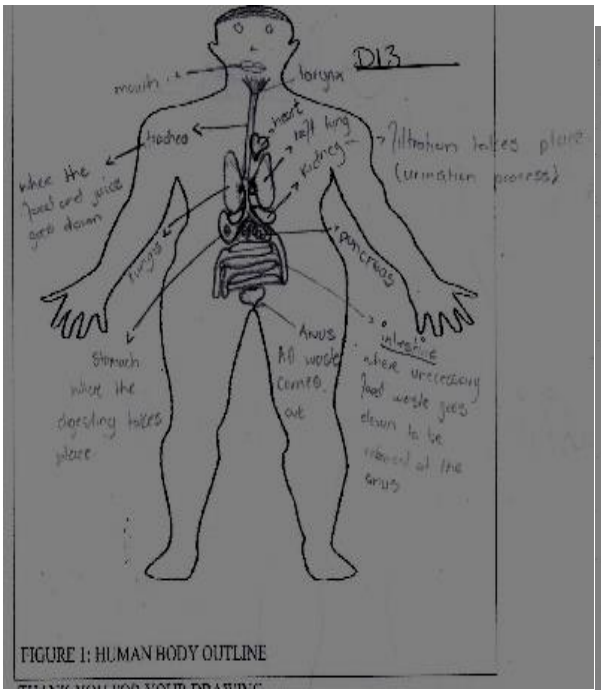
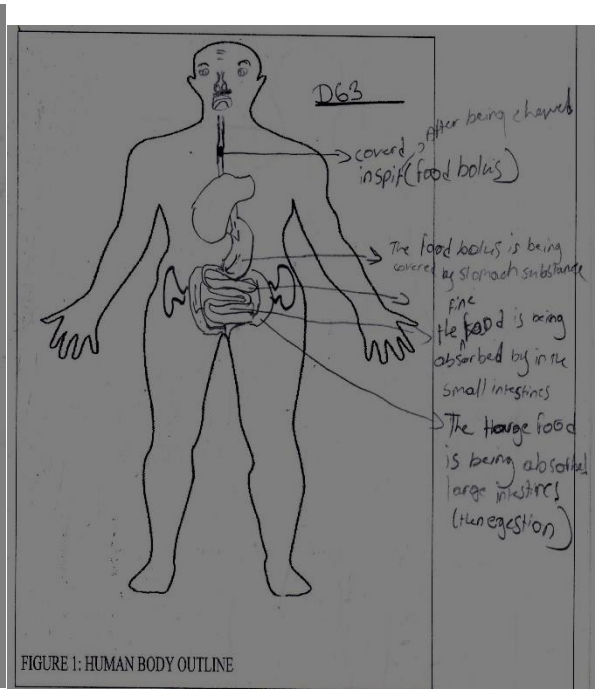
Appendices

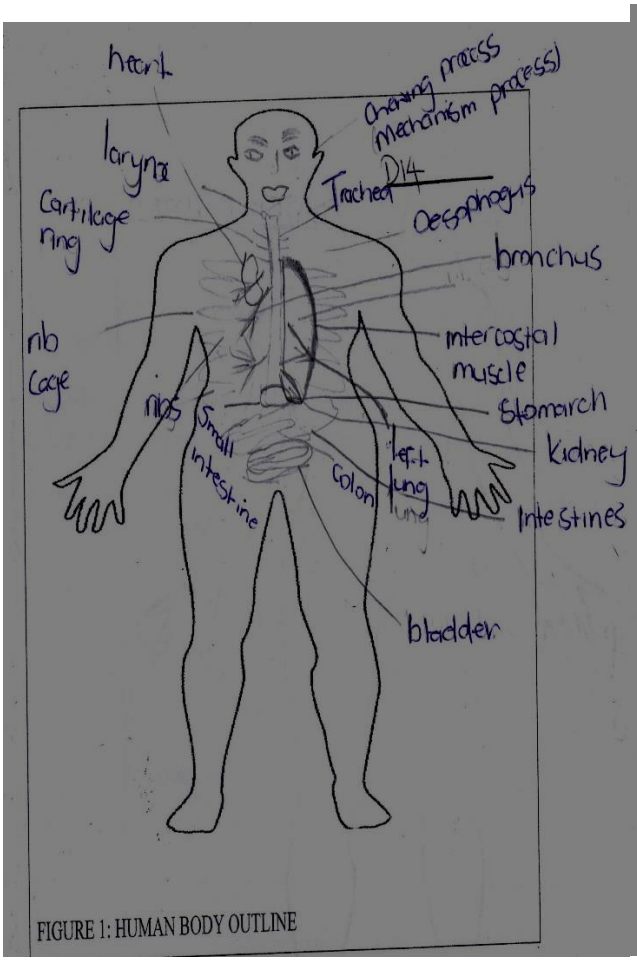
Appendix 4.1.1: Drawing samples of the some participants

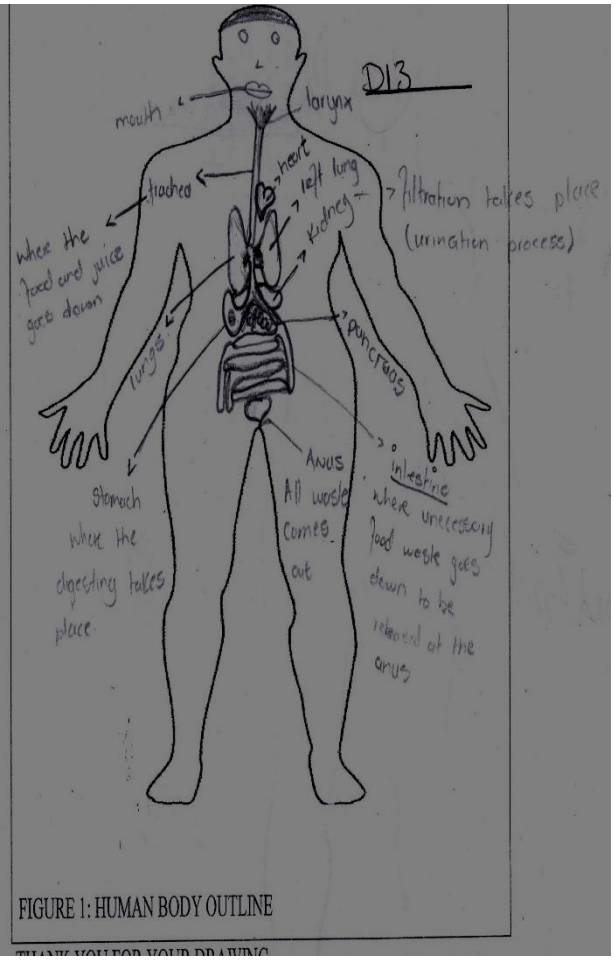





D13
mouth
larynx
trachea
heart
left lung
kidney
where the food and juice goes down
filtration takes place (urination process)
lungs
pancreas
stomach where the digesting takes place
Anus All waste comes out
intestine where unnecessary food waste goes down to be released at the anus
FIGURE 1: HUMAN BODY OUTLINE


D63
covered in spit (food bolus) after being chewed
The food bolus is being covered by stomach substance fine
the food is being absorbed by in the small intestines
The large food is being absorbed large intestines (Huneegestion)
FIGURE 1: HUMAN BODY OUTLINE


heart
larynx
Cartilage ring
rib cage
ribs
Small intestine
Colon
left lung
bladder
Breathing process Mechanism process)
Trachea D14
Oesophagus
bronchus
intercostal muscle
stomarch
kidney
Intestines
FIGURE 1: HUMAN BODY OUTLINE


D13
mouth
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filtration takes place (urination process)
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stomach where the digesting takes place
Anus All waste comes out
intestine where unnecessary food waste goes down to be released at the anus
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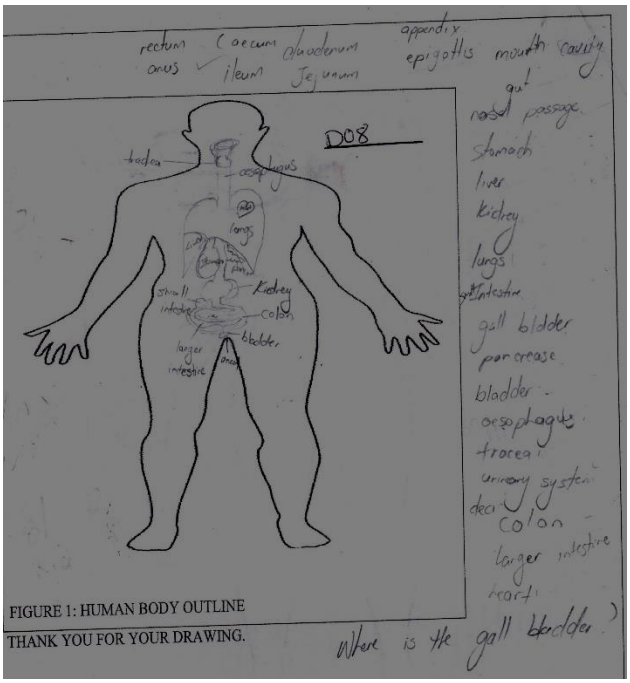


Appendix 4. 1.1: Table 4.1. : The types of organs represented;

	Class A N=15	Class B N=15	Class C N= 25	Sum-55	%
Mouth	13	13	21	47	85
Esophagus	13	13	21	47	85
Stomach	6	6	21	31	56
Pancreas	1	0	7	8	15
Small Intestine	7	10	25	42	76
Appendix	0	0	5	5	9
Large Intestine	8	10	22	40	73
Rectum	0	0	5	5	9
Anus	0	0	15	15	27
Liver	1	5	15	47	47
Gall bladder	0	0	3	3	5
Lungs	0	2	8	10	18
Heart	2	3	10	15	27
Two kidneys	3	1	5	9	16
Bladder	1	2	3	6	11
Ureter	0	0	0	0	0
Penis & word penis	2	0	0	4	4
Wrote the word ‘pee’	1	3	0	4	7

Body system

Body system descriptions	%
Breathing systems & circulatory (b c)	8
Uncompleted alimentary canal (a)	25
Completed alimentary canal (A)	31
Uncompleted urinary system & alimentary canal (u A)	15
Satisfactory urinary, circulatory & alimentary canal (UCA)	21

Appendix 4.2: Sample of the Learners' experiences

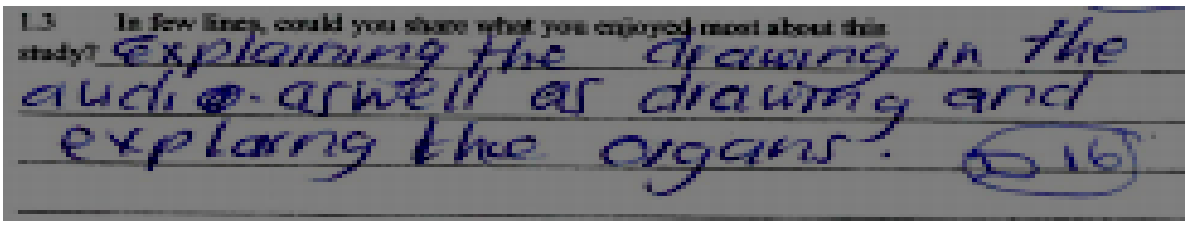
Table 4.3: Analysis of the Individual participants' responses from the questionnaires

Qn. No.	**The Question**	**The Response/s**	**Response Totals/N=28**	**% Ratios**
1.1.1	Do you use drawings in your leaning of Life Sciences?	-Yes	28	100
1.1.2	If Yes, in which topics have you used them most?	-On Digestive System	17	58
		-On the Excretory system	7	24
		-About Photosynthesis	5	17
1.1..3	How have drawings been used in your learning of Life Sciences?	-For illustrative purposes	7	58
		-Provide information	5	41
1.2	Do you think drawings are important for learning sciences?	-Yes	24	85.7
	Explain your answer briefly	-For understanding concepts	11	39
		-Aid to make imaginations	10	36
		-Give visual information	4	14
		-Clarity during discussions	3	11
1.3	In few lines, could you share what you enjoyed most from this study?	-The explanations shared	3	43
		-It allowed for interactions	1	14
		-Blank spaces	3	43
1.4	May you share information about the activity of making drawings using the following questions:			
	1. What did not work about making the alimentary canal drawings?	-Didn't understand the analogy	5	71
		-Cannot draw	2	29
	2. Why did it not work?	-Cannot draw	4	15
	3. How could you make it work next time?	-More drawing space needed	2	50
		- Learn to make drawings	2	50
1.5	Would you recommend having this approach of teaching and learning	-Agree to make recommendations	4	67

	of the alimentary canal in your Life Sciences classroom?			
		-Never recommend	2	33
1.6	Explain briefly, why you would make the suggestion from question 1.5 above	-For visual comprehension	8	73
		-Making drawings consume time	3	27

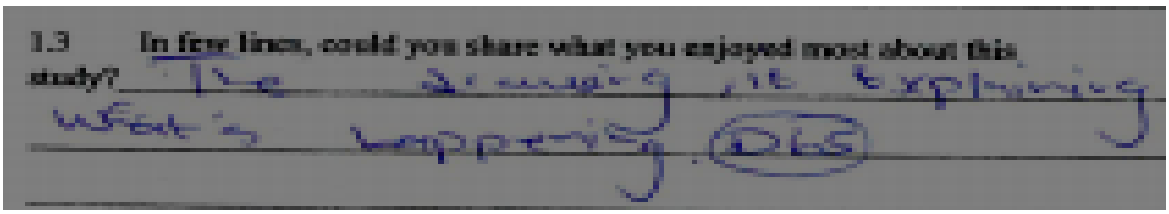
Appendix 4.2.4.1: Learners' positive experiences

Learner D16



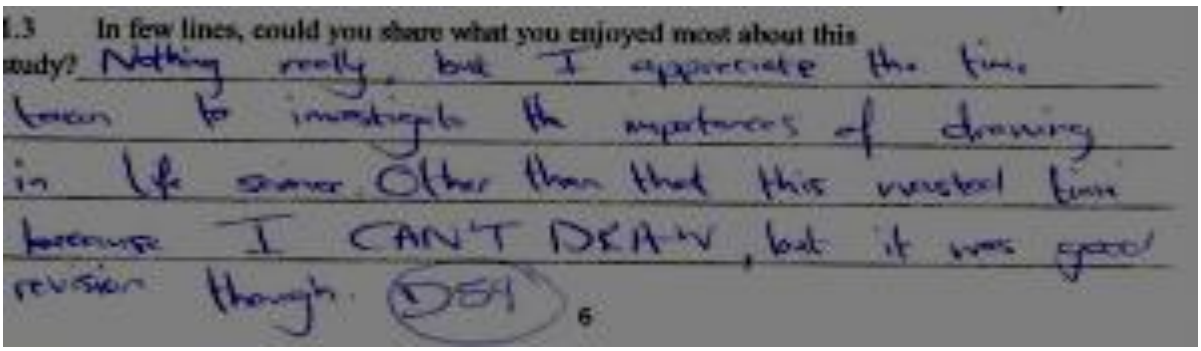
Enjoyed the audio-recording, & making drawings

Learner D65



Enjoyed testing his/her prior knowledge & the challenge to displayed the scenario

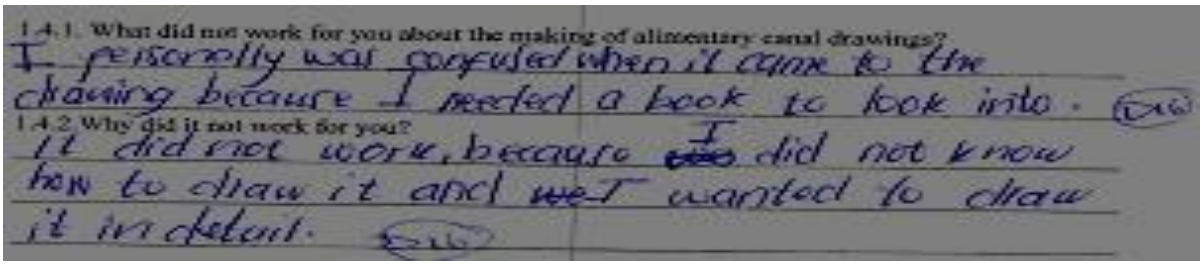
Learner D59



Not enjoyed since s/he could not draw, but benefited from the revisions of the concepts involved thereof

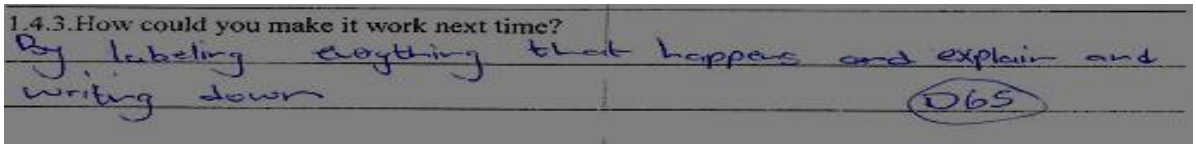
Appendix 4.2.4.2 Learners' negative experiences

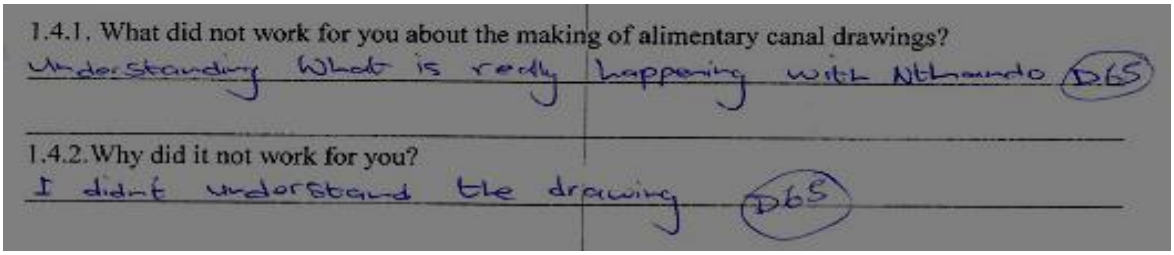
Learner D16


1.4.1. What did not work for you about the making of alimentary canal drawings?
I personally was confused when it came to the drawing because I needed a book to look into. D16
1.4.2 Why did it not work for you?
It did not work, because I did not know how to draw it and I wanted to draw it in detail. D16

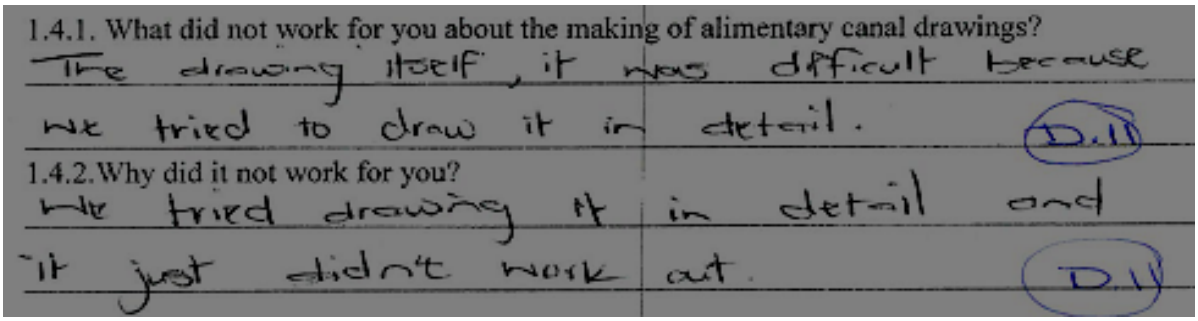
D16 was confused, needed a textbook to refer to give details

Learner D65


1.4.3. How could you make it work next time?
By labeling everything that happens and explain and writing down
D65


1.4.1. What did not work for you about the making of alimentary canal drawings?
understanding what is really happening with Nthando D65
1.4.2. Why did it not work for you?
I didn't understand the drawing D65

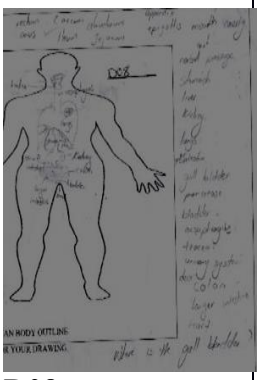
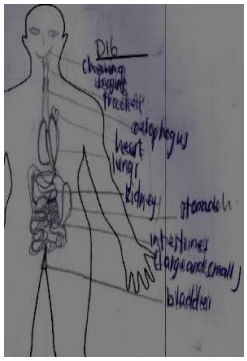
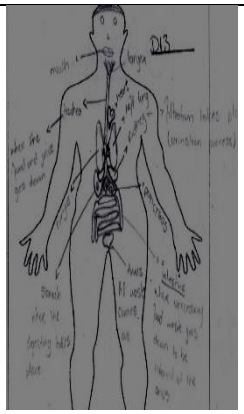
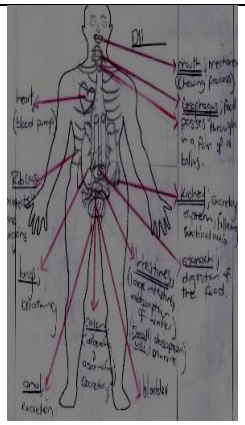
D65 enjoyed that drawings were illustrative but this time, the Nthando scenario was difficult to understand, because D65 preferred drawings and explaining and writing.


1.4.1. What did not work for you about the making of alimentary canal drawings?
The drawing itself, it was difficult because we tried to draw it in detail. D.11
1.4.2. Why did it not work for you?
We tried drawing it in detail and it just didn't work out. D.11

Learner D11 indicated that they worked as a group, to represent the details of the drawings just like learner D65 and still they found the task being challengeful

Appendix 4.3: Learner's talk

4.3.1: The drawings for the initial Peer group

 D08	 D16	 D13	 D14	 D11

4.3.2.1: Extract 1: Peer group initial talk forms

First talk form		
000	D11:	*Ok, so I am D11 and firstly I would like to start with the mouth which is the mechanism process where chewing takes place. As the food goes down into the oesophagus the food passes through in the form of a bolus*

Second talk form		
001	D08:	*And I am D08, I will be speaking about the lungs and the kidney. The lungs is a process where gaseous exchange take place. And mostly the two gases that pass through are carbon dioxide and oxygen. You inhale oxygen and exhale carbon dioxide and in the kidney is where filtration takes place mostly about excreting uuum and excreting and then after that it goes on, yes*

054	D14:	*And I am D14, I will be speaking about the stomach, the digestive system that it digests food into the intestines*

058 *Pause*

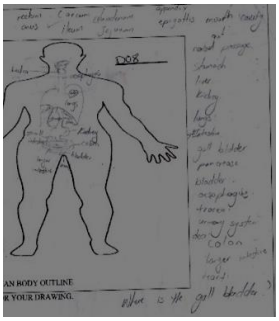
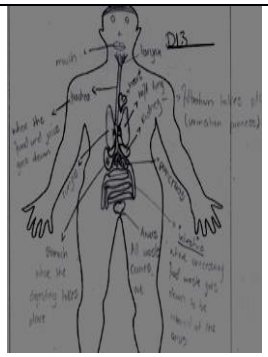
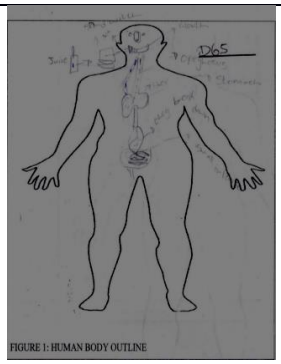
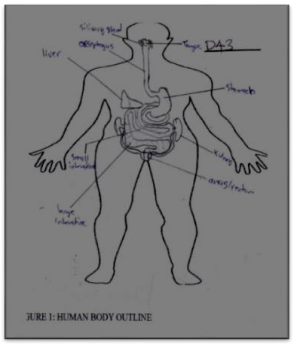
Third talk form		
102	D13:	*I am D13, so the digestive system which is the stomach goes through to the large intestines from the kidney which is the urea and then that's then where all the metabolic wastes is already broken down and absorbed. Then, it goes to the large intestines where it goes to the bladder and the small intestines is where the food and the food is broken down and it goes down to the anus.*

129 *Pause*

Fourth talk form		
139		*D16: (Inaudible) once metabolic waste enters into the anus, it gets excreted so everything that is broken down goes to the waste and everything gets excreted out, so everything comes out, so all the juice and the sandwich then (inaudible)… Nancy's friend Aaah, it all comes out once (unclear).*

4.3.2.2. **Deepened peer talk forms;** Extract 2; the second peer group talk forms

The talk recording was conducted prior the focus group formation and the reasons were part of the features that the researcher followed-up through the focus group**.**

			
D08	**D13**	**D43**	**D65**

003-044 *D13: Ok I am D13 and (group members whispering) uuum my drawing to a grade 8 learner, I don't think my drawing is at the grade 8 level because I included all organs and I think, like the lungs and the kidney, no the lungs and every other organ. It doesn't have to appear it has nothing to do with the digestive system, it's unnecessary and my, uuum… explanation is not really on grade 8 level for Ntando to understand, and… yeah.*

047-136 *D08: Hi I am D08 and I think that my drawing is not accurately right but I do know what goes where but for a grade 8 learner she would figure out that this is some body parts and it wouldn't be right as it is in the body. And for aaa the way it is drawn I don't think it's accurately right because of all the (inaudible) organs and everything that does not look as the organ really look but generally, it's fine for one to understand but it's not right, yeah accurately right.*

145-209 *D65: Hi I am D65, uuum my drawing it's not actually accurate to an extend a (inaudible) organs they are not there, and I also don't think a grade 8 learner will understand what is going on because my drawing is very complicated. There are some parts where I don't actually explain what's going on. The only thing that you can see is the mouth and… yeah.*

214 *D43: I am D43 and I will be talking about the digestive system. After chewing the food it goes down the oesophagus and then to the stomach where it will be broken down by the enzymes in the stomach. And then from there it goes into the small intestines where the nutrients will be absorbed*

239 (*Peers interject to remind him on the task): You are supposed to explain whether your (inaudible) will be able to understand what is portrayed*.

258-318 *D43: Well my drawing is about the digestive system uuum will be easy for Ntando to understand because it has got all the components needed for the digestive system as well as the filtration system which deals with the liquids of the body. Thank you very much.*

Appendix 4. 3:3: Focus Group's Talk Forms Transcript

4.3.3.1 Disputational talk, D65

000 MRS SMITHS: Do (inaudible) uhh routes or pipes?

006 D65: Uuum this is maam this is oesssophagus (a peer's voice helps with the word)

009 D65: Yah this one (again a peer's voice continues for reassurance)

013 D65: And (peer disruption again) no the trachea is for breathing but for eating it is the oesophagus maam (responding to the peer's challenge and the researcher as well). Then it gets to a certain point maam where this is the stomach madam and after the stomach it breaks down and some chemical things that happen, and then it goes through the small intestines. This is what I know maam.

034 MRS SMITHS: And then this tube what is it, is it part of the digestive system?

040 D65: No maam, it isn't really part of the system – it is but not really

MRS SMITHS: What would it be for?

043 D65: It's for the breathing system madam

MRS SMITHS: Oh it's fine, because when you have it like that then it wasn't so clear

050 D65: No, that's why madam I did it with blue and the one that we are actually using is actually with pencil madam

MRS SMITHS: Oh ok

100 D65: Ma'am usually it's pencil and then it only have blue on the sides (showing satisfaction over her response)

106 MRS SMITHS: Ok fine so uuum generally/overly what would you think about using drawings to explain your facts?

117 D65: My understanding madam I don't think I understand what drawings are for, I feel like it's better when it's written down in words and then it's more understand

better. For me madam if, like if I was a grade 8 learner and u gave me this madam and there was juice and oesophagus I wouldn't understand what's actually happening madam until you explain to me maam. And it's better if I can read it than to draw madam, that's my point of view madam, I feel like drawing doesn't actually help for me

151 *MRS SMITHS: But then how about the talking?*

154 *D65: The talking when somebody explains to you actually, maybe if I draw it maam and explain what is going on it actually helps to understand better than to actually see a drawing just like this maam*

208 *MRS SMITHS: Ok, sooo… well… would you, maybe let's say – remember this would be your drawing, would you prefer just to talk about a question or you would rather prefer you draw and put the points down. It could be, let's say maybe a mind-map, right. So you are showing the different organs and then you use it to talk or you just don't want to have a drawing you can just talk straight away?*

235 *D65: No, I could, like have a mind map to remember what I am talking about so they can know. I could like draw here, like this is the mouth and could label this comes in and this comes in and this comes in (going over her drawings and illustrating with her fingers).*

MRS SMITHS: Umm. Ok fine, so in that case would drawing be important for you to talk. Would the drawing, would you need to have a drawing near?

255 *D65: Ohh, Yah yes madam (smiling) but just ahh, ahh, ahh, yes madam I think,..I think I do need a drawing to actually help me madam… but not this kind of drawing madam.*

MRS SMITHS: Ok Ahh wwwhat (disruption by D65)

308 *D65:..Like points (she added to specify her preference).*

MRS SMITHS:… so you wouldn't like to have like a human body outline?

D65: Yes madam

MRS SMITHS: But you understand why there was a human body outline?

319 *D65: Yes maam, because so that you can actually tell the different organism, it actually tells the process how we eat and actually what goes down in our bodies (inaudible)*

MRS SMITHS*: Ok thanks and you are D?*

335 *D65: D65 maam*

MRS SMITHS: Thank you so much. Right uuum (sighs)

(Turn 000-339-Disputational talk on preferring talk to drawings)

4.3.3.2.0 Three individual learners' talk: Are drawings necessary

There were a variety of emergent issues that were addressed by individuals from this focus group. The talk typologies changed relative to the participants' personalities and their reaction to peer influence, especially to the introverts

4.3.3.2.1: Correctness of drawings

000 *MRS SMITHS: Go on*

003 *D43: I just added Ehh bladder and urethra maam, for the issue of the fluid. My drawing will be suitable for a grade 8 learner because it has both the digestive system which sort out solid waste and liquid and separate them from the stomach and intestines and the solid waste will be stored in the rectum before excretion where they are removed from the system and then they are removed from the system, and liquid will be stored in the bladder before they are removed from the system. It will be easy to understand as it shows all the components of the digestive system.*

059 *MRS SMITHS: Ok Aah Assuming I am a grade 8 learner, I would like to understand where the link is between your digestive system and the system that takes the fluids. Where are they linked, where do they come together?*

120 *D43: Aah, Where they come together is by the intestines, the small intestines. The solid particles are in the intestines and the liquids are absorbed in the intestines through diffusion into the blood system then to the kidneys where it will be filtered then they remove the liquid that comes from the blood, then the nutrients (inaudible).*

152 *Pause*

154 *MRS SMITHS: Ok, Fine So,….It might not really show here but it's the digestive system first then fluids secreting or separating system comes last and that is what you call the bladder. Now Ahh, you, you said you added those other systems, Aah, what made you do that?*

217 *D43: Of cause I realized that Ehh for the fluid…the system that deals with the fluids that was incomplete then it comes to the removal section down the pathway but not excrete unwanted waste.*

234 *MRS SMITHS: What would happen if you had left it like that?*

237 *Pause*

240 *P: It would have negative effects on the system and diseases could occur,... (Pause)… like some organs will start failing and others will rot away because of the waste in the system.*

300 *MRS SMITHS: Thank you so much for putting so much effort to answer that question. It wasn't necessarily part of the question but I just wanted to see if you could see this system beyond what you have done and what you have learnt. Every system needs its outlet. In that case you are trying to suggest the system had no outlet and that would have meant the waste would just collect in the body and nobody can function with a lot of waste. Either it can burst or it can become dysfunctional. Right, now…Ok Who are you by the way?*

344 *P: D43 (disruption by D08)*

MRS SMITHS: Ok, I want to look at the two drawings D08 and compare with D45. When you look at the two drawings I don't know what you could say about the two drawings?

405 *D08: For me I would say that uuum, as the DO8 and the D43 has the more like the digestive system and I have different like I got the (inaudible) and I got the digestive system which is clear in some way because you can feel (inaudible) to the stomach part not actually uuum showing the uuum small intestines with the large intestines but D43 showed the digestive system perfectly where he actually showed us how filtration will happen through the kidney and the excretion of would, will go through and then filtration will happen.*

454 *MRS SMITHS: What do you say D43 about the two drawings?*

500 *D43: Well, D43 has the respiratory system ohm D08 has the respiratory system which is also important when it comes to… digestion. Some organs cannot operate without oxygen because the… respiratory also excretes carbon dioxide so that organs in the body can function perfectly.*

MRS SMITHS: In that case do you think the respiratory system could be part of the answer to this child's question?

D43: Yes maam because every organ in the body work together to functions as a unit.

MRS SMITHS: Ok, and then which drawing better answers or answers better that child's question between the two and if possible, what could you say?... Let's give a neutral person. (Disruption by D08) From your own perspective which drawing do you think would explain this task, a task where a child observed a friend eating

food, chewing the food and swallowing it and then taking juice. Which of these drawings would explain better that observation?

629 *P (neutral): Madam, I would say D08 maam because (inaudible) the respiratory system is important for some organs which use oxygen madam and uuum what else, like when you eat madam after you have chewed everything the food pass down the esophagus to stomach, ma'am, where some of it could be burnt by the acid and then uuum (inaudible) small intestines where it uuum, but solid and then the liquid, the fluid will pass through the large intestines madam. And some of it goes into the kidney madam, it will be filtered and reabsorbed and then excreted madam*

715 *MRS SMITHS: From what this child observed, which part will go to the kidney? (Disruption by P: Neutral, Excuse madam) The child observed a friend chewing food, swallow it and then took some juice. So out of these two sets, he had the solid food and the liquid food, which one will go to the uuum ah kidney?*

736 *P (neutral): The liquid madam*

MRS SMITHS: Ok, now when you look at D08, uuum I seem not to see the part, the part of the system that takes the liquid

750 *P (neutral): Madam it's not clear as D43 madam but it has more description madam. Like it shows uuum every organ maam. It's not the drawing, the drawing is not as clear but it's showing every organ.*

MRS SMITHS: And then D08, does the drawing look clear to you?

813 *P (neutral): No madam, it's not as clear as D43 madam.*

MRS SMITHS: According to your observation or perception D08 is not so clear, we now going back to the owner of the drawing. Does D08 look clear to you?

827 *D08: Maam for me the… (Pause) the drawing will look… I could say clear for me maam (disruption by researcher as she asked D08 to explain further)… because uuum I understand what I drew (laughing), so basically uuum if I uuum look at this drawing I will know that the lung is on top of the oesophagus and if someone looks at it they would think that the oesophagus is with the lungs. So if, if for me it's clear but for someone else's view will be different because they won't know...*

902 *MRS SMITHS: Which is why I also came because I couldn't explain it clearly. Right, yes, uhhmm*

907 *D (neutral): Another thing, Madam, the drawing is not clear, the grade 8 learner wouldn't understand.*

912 *MRS SMITHS: Uhuu, What do you think, how do you see with… the grade 8, what exactly do you think could be uuum confusing to him/her unlike with D43?*

923 *D(neutral): The drawing is not clear, clear madam, so if you like try to point out like some organs madam, or the part that some organs join like the oesophagus, you can't really see where they join, so that will, it also be like one problem.*

938 *MRS SMITHS: How about with D43?*

940 *P (neutral): You can see madam (inaudible) the oesophagus goes right into the stomach, it shows a path.*

947 *MRS SMITHS: So for a grade 8 learner what exactly would you need to, to put down so that it's clear? She says this will be fine she says she would then talk about it (P: Neutral, Yes), and then in your case you are saying this would be quite useful, I what way,… you mentioned clarity?*

1004 *D (neutral): It's just…it just shows the digestive system madam, like the part that it is needed because it is talking about the food that is uuum swallowed by the one child and also that the child also takes juice madam. So it's just gonna show that digestive like where the solid food goes to madam, like the fluid would go to the kidney madam (inaudible), reabsorbed and excreted and then the solid madam it will stay in the small intestines where some proteins (inaudible) be broken down like amino acids because they use uuum (inaudible) madam and therefore (inaudible).*

1056 *MRS SMITHS: Ok fine. Now what I also want to know is uuum, you have just shown me that a drawing on its own (inaudible). She feels the drawing is very necessary, she might not put it clearly to everyone else, in that case if she, her drawing has to be understood she must be there to talk about it. (D Neutral: Yes) …So in that case the drawing and the talk are very important for that drawing of hers to be understood. And then when it comes to this one, (pointing to D43 drawings) you were saying it's clear? ((neutral): Yes madam)… It's easy to see some of the parts (disruption by D. Neutral: Yes)... (Continues) but then I even asked how… I see these… what do you call these?*

1136 *D (neutral): Kidneys*

1138 *MRS SMITHS: And then there is that little piece here, what is it supposed to be, is that a tube of the kidney?*

1145 *D (neutral): Yes*

1147 *MRS SMITHS: Ok fine, (disruption by D (Neutral: Ohh) and then I don't see where it is linked there. How would you say that to the grade 8 because the grade 8 will think this is joined to that? (Pause)… I am talking like a grade 8, honestly, so how*

would you do it so that I get to understand... (Pause) Turn: 1200 Commotion and laughter Turn: 1208. Where does the kidney go to?

1206 *D Neutral: Madam… (Stuck since the drawing is not his)*

1212 *D43: (just takes over to rescue P. Neutral) The kidneys are just Ahh behind the intestines maam, and then how the fluid is extracted from the intestines into the kidneys through diffusion maam, and I had to make the kidneys visible on the side so that they could indicate that the intestines alone don't (inaudible) the digestive system and the excretory system.*

1241 *MRS SMITHS: I understand that. So in that case would it be necessary for you to talk about your drawing to this learner?*

1248 *D43: Yes maam*

1250 *MRS SMITHS: And why would you do that?*

1252 *D43: Because it has all the components that are needed for the digestive system, which include the solid and the liquid part.*

1300 *MRS SMITHS: Why wouldn't you just give a drawing on its own?*

1304 *D (neutral): (just popped in, refreshed now) Madam because the talk is just as important as the drawing madam, if the learner just looks at the drawing alone, won't understand unless it is explained (inaudible).*

1314 *MRS SMITHS: Ok fine. Maybe if I could ask, what should start… the talk and then the drawing or you'll start with the drawing then you talk about the drawing?*

1323 *D: Neutral and D43 (together) Drawing maam, then talk, madam*

MRS SMITHS: Ok you say…

1325 *D08: Maam I say actually the opposite. I say talk then draw so the pupil can first get a picture of what you are saying and then when you draw (inaudible). You first goanna visualize what you goanna draw and then draw it, so talk first is better than drawing.*

1341 *MRS SMITHS: Ok, D48… that was… D08*

1346 *D43: I prefer that the learner sees the drawing first before the (inaudible) so that he has an idea of what he is looking at and then if he has any question he asks. If he doesn't understand then (inaudible) because (inaudible) If he talk, to talk first and the learner gets confused about the parts and he may not know the labels of the diagram*

MRS SMITHS: Ok, Yes,

1414 *D (neutral): Madam (inaudible) the drawing has (inaudible and interference by D08) D43 madam because When you draw madam, the child will have an idea of what he is looking at then afterwards you explain, then once you explain they know where each organ is and which organ links with which organ madam and which where the (inaudible) madam the fluid go madam.*

1440 *MRS SMITHS: Ok fine. D08 you wanted to say something*

1444 *D08: Yes, uuum, for me why I say talk first and then draw so when you talk for instance let's say uuum I am describing the way home well and someone wants to (inaudible) first tell them before I show them, it's better because people have to know certain things about the body. Some people will know the oesophagus as the throat so we have to correct the terminology on what is the right term and then draw because okay there is some part they won't specifically know about, like perhaps they won't know the different types of uuum large intestines (inaudible), lungs and the throat and they uuum and yes and our (laughs) inaudible. So they will know before and then when you draw you make everything clear*

1547 *D43: I D43 why I prefer the drawing before the discussion is that the learner has not reached the stage where he can draft information without visual uuum clarification (inaudible). So firstly grade 8 learners from primary school they are used to colorful things and visual diagram so yes when they look at the diagram at least they can have an understanding of what they didn't than if you talk to them first. Like some then they are not good at uuum paying attention, first you goanna teach them how to what (inaudible) unlike when they have diagrams before then they can understand, and the teacher explains (inaudible).*

1635 *MRS SMITHS: Eishh, Thank you so much for your contribution D43. Now I just want to wrap it up. From your experience now, what were maybe your challenges when it comes to the drawing (pause) D43?*

1652 *D43: I didn't have a lot of challenges, it's just that I've given complete (inaudible) and I only realized later but the drawing part not difficult, that actually easy especially if you know what you are dealing with then everything just flows*

1717 *MRS SMITHS: If you were to, to have done that, well what would have been your challenges with the process (motioning D Neutral to speak)*

1724 *D (neutral): Umm, My challenge would be madam, like if you feel you've miss some,…you'll have done (inaudible) like if you saw madam by the kidney to complete the renal artery, renal vein madam and Ahh urethra if (inaudible), urine to the bladder… some things like that madam are very important so if you miss some*

of those important aspects like madam, you'll like confuse the learner further madam, cause he'll have question as where the urinary go, stuff like that madam, how blood pass through (inaudible)…

1759 *R : So in other words you are talking about accuracy, say since this is like a body outline, you had to be accurate over where over exactly to maybe draw or place a particular organ all righty?*

1813 *D08: Well for me as D08, I feel like that in our human body we have different systems, so if uuum if took those systems and like just place it on each other but having your like uuum (inaudible) accuracy of how you put it on uuum then you will understand the drawing more than just drawing what you think is right.*

1840 *MRS SMITHS: Well… so that you say that's what you say about the drawing part, how about with the talk now. You had done the drawing and then now we are using the drawing to talk. What was the challenge that you met?*

1859 *D08: Ok so uuum, the challenge was the talk and drawing together. Uuum, well for me I know more they (inaudible) so then (inaudible) in a mark-wise I think I will get less for my drawing but more for my talk because uuum there is more information I know than the drawing is more displaying and showing. And the talk would actually help uh (inaudible) grade 8 learner to understand that it's not confusing if you look at the system directly but it's more to understand than just to look at.*

1942 *D43: For me D43 it's a 50-50, because when I talk I refer to the drawing to make it easy to the learners to understand and the drawing and the talk should be more or less be the same because with the drawing will be a talk but in a visual way but the talk will be the drawing but in a verbal way.*

2010 *MRS SMITHS: So you are saying it's so – so*

D43: Yes

MRS SMITHS: Uuum come again I missed the last part.

2017 *D43: Well like I said the drawing will be the talk but in a visual way but with the talk it will be a drawing in a verbal way. So they have to be more or less the same because they have to explain each other in other words*

MRS SMITHS: you are trying to say

2030 *MRS SMITHS: Thank you D43… (Motioning D Neutral to speak)*

2036 *D: (neutral): Mr. N madam (smiling about the new identity) (MRS SMITHS: Uhhm) I would say, like uuum the drawing madam you have to be like, if you've to be explaining what you drawing, you can always refer maybe talking about a certain organ like the oesophagus you can just say that's the oesophagus, pointing in the*

direction where it is and just say what is its purpose the foods passes down there, that's how you can use your drawing madam when with are talking you can always refer to what to what you're saying.

MRS SMITHS: You are trying to say it becomes easier?

D: (Neutral): Yes madam

2111 *MRS SMITHS: D(N) and D43, D08 your contributions they are very, very important, well appreciated and put into correct use to understand this study where we were looking at the importance of drawing and talk. And starting with the drawing first in order to motivate a talk, because we, through observation we have just discovered that in a normal class learners rarely get adequate time to talk, right eh. Worse more or much more talking about something they would have put down in a talk. Just like we have discovered that drawing on its own may be inadequate and needs that synthesis, it needs to be complemented by talk, and then knowing that a class has so many learners it becomes a challenge for a teacher to uh exhaust every learner's ideas, so if you could also make use of these audios then it would be easier for the teacher later to listen to our talk as well as look at our drawings and that way the much, the marking of the drawing and the talk will give the teacher a better picture of how much you know, because the system (the classroom teaching) seems not to give us enough time to understand what you know and in the end we take it as if learners don't know. And in the end we will be wasting the learner's time (inaudible) or we end up confusing the learner because learner might be seeing things differently from how we would be talking, but before I close I see there is uuum D63, right. D63's drawing is coming to compete with the D43 and D08. What can you say about your drawing D63?*

2319 *D63: Uuum madam you have stated that this girl she ate and she drank maam (inaudible) draw the digestive system maam... (incomplete)*

2340 *MRS SMITHS: So that's what you're, that is the purpose of your digestive system? (D63: yes) But when I look at it as a grade 8 I see there is something that it is sitting on… and then an arrow that is coming from behind, what is the meaning of that?*

2355 *D63: This arrow maam? (MRS SMITHS: Yes)…It's just showing that, that's where the food bolus is going in maam*

2405 *MRS SMITHS: Ok and what is that because it is not labelled?*

2408 *D63: This is a liver*

2411 *MRS SMITHS: Right, fine. So how would you use your drawing to explain to this child the path that is taken by your food?*

2419 *D63: (smiling) madam since uuum (2423) some kids maam they understand, they don't understand with verbal, verbal, they understand visual maam. So using this it is easy maam (inaudible),*

2434 *(an intruder disruption)*

2438 *D63: (laughs) so maam it's easy maam (inaudible) it's easy to draw the structure (inaudible)*

2454 *MRS SMITHS: Ahhh, D63 you're not being audible, try to be, speak up please… Fine I see you have drawn these parts here (pointing to the drawing) and there seems not to be any label for them, how do you explain it to the learner?*

2513 *D63: Aaah maam since I forgot to label them, this is a kidney maam for the excretion of u-u- urine…*

MRS SMITHS: And where does this urine come into this system, into this whole scenario?

2529 *D63: so maam as we said that this girl (inaudible) (inaudible), so mama, (laughter), so mamx2, kidney's function is to excrete urine, things like water, (inaudible)…so when he drank, (inaudible), so urea from the liver and from the liver it goes to the kidney (inaudible).*

2604 *MRS SMITHS: Right you are talking about the kidney, where does this, the waste from the kidney go to?*

2611 *D63: Maam?*

2612 *MRS SMITHS: Where do they go to from the kidney according to your drawing?*

2617 *D63: Maam, are you talking about the juice (Laughs) to the bladder maam,*

2625 *D 43: can I help (in a whisper)*

MRS SMITHS: No (to D43) To the bladder but I don't see the bladder there

2631 *D63: Maam because the drawing maam of this person maam is (inaudible)*

2636 *MRS SMITHS: Where is the bladder?*

2640 *D63: The bladder is here, there (pointing to the drawing) maam*

2643 *MRS SMITHS: There… where, I can't see,… but it is there?*

2645 *D63: Yes maam*

2645 *MRS SMITHS: Do you mean to say if they are behind? (Teasing him)*

2650 *D63: Eish maam uhh, what do you call this maam (inaudible) maam. So maam (inaudible)*

2704 *MRS SMITHS: Ok, and fine and how did it go out of the body?*

2708 *D63: Uuum, through your… (Laughs)*

2714 *MRS SMITHS: No, you are free, be free, speak freely (encouraging him to speak)*

2715 *D63: The sexual… the sexual… the sexual organ, maam*

2720 *MRS SMITHS: Ok fine but it's not there here, why didn't you draw it*

2722 *D63: (Laughs) (inaudible) I have drawn a lady (inaudible)*

2730 *MRS SMITHS: Yes, but yes you are not showing it there. The grade 8 would want to know what happened to the fluid, how does it go out of the body*

2738 *D63: Aaah maam eish… that would be too sensitive for a kid maam*

MRS SMITHS: Is it?

D63: Yes

MRS SMITHS: I like your contribution because I didn't know, no one has spoken about some parts being sensitive, and then if they are sensitive then how would you talk to them, how would you mention them to this grade 8

2757 *D63: Uh maam*

MRS SMITHS: The grade 8 wants to know what happens to the juice, does it remain in the body forever

2808 *D63: Then we already know maam (inaudible) already know the structure if the of the girl thing the boy thing*

MRS SMITHS: The girl thing and the boy thing

2817 *D63: Yes maam so I will try to not be Hush (inaudible)*

MRS SMITHS: Thank you so much D63, I see uuum

2834 *P: D17*

MRS SMITHS: Ok D17, you need to dispute or challenge these drawings, please feel free

2840 *D17: Madam how can I challenge something*

MRS SMITHS: No no no, you are free. Which drawing do you think best explains the task that we had? Which was to talk about what the child observed?

2853 *D17: Maam may I please, ok. Even if the handwriting is not clear on D63, I really took it for me, because this other just gives the name of the organs but D63 stated what happened. MRS SMITHS: How would it help?*

2917 *D17: How would this help, because it shows the process of how the juice went through the whole system maam. It doesn't only show the part, the organ… it only shows, it also shows the (inaudible) process of the organ.*

2935 *MRS SMITHS: With this grade 8 you mean to say the child will then have to read this or should listen to the talk by D63?*

2943 *D17: Haaii (vernacular, for Noo) uhh, to the talk of D63…?*

MRS SMITHS: *Uuum*

2946 D17: *No (uuum) he just have to do that.*

MRS SMITHS: *So this grade 8 according to you needs not to listen to D63 explaining the process but should then take them, take the pages and read through the drawing?*

2959 D17: *Uuum maam*

3000 *D63: (barges in) maam, it's the same like, it's the same like, neah (Afrikaans for right?) we have the same thing, so,*

3007 *D17: mam, it's like the grade 8 child has to look at the drawing, then D63 they also have to explain because then are some things (inaudible) just like explaining what happens when the juices are from theee, filtered from the kidney going to the*

muscular circle which is bladder and it goes out to the exterior. He didn't explain such things, so needs to explain such things so I think we need to labra…. eLabor….

MRS SMITHS: *Elaborate*

3037 (laughter from peers)

3039 D17: *Elaborate more uhh, uhh (laughs)*

3045 D63: *Some of the things maam you just have to like write the definition and start explaining (inaudible – too many people talking)*

3108 MRS SMITHS: *Right D63, feels definitions are important. Right, you were D…?*

3017 *D19: (inaudible)*

3022 MRS SMITHS: *Come closer sir, which drawing would best describes or help this Grade 8 understand what you are saying*

3028 D19*: Uuum maam for me I go with D63 because it explains (inaudible) how the processing of the food goes down to the stomach (inaudible).*

MRS SMITHS: *Ok, we talked about (inaudible) which will be filtered from the kidney, how will they go out of the body because I don't see here and the grade 8 would want to know.*

3157 D17: *Yeah I think you have to look at the drawing. D63 has to explain everything because I also don't see the blood circle which the bladder and everything is (inaudible) doesn't elaborate everything (inaudible)*

MRS SMITHS: *What is that everything? You know how will the fluid go out?*

3212 D19: *(In audible) will go out through the, what's this, artery – ureter or something*

MRS SMITHS: *And where, from the ureter what happens?*

3221 D19: *Then it would goes to the blood cycle which put pressure on it and then it goes out*

3227 MRS SMITHS: *And then go out where here I don't see even an organ that must take the fluid out*

3233 [Too many voices of D17, D43 and D Neutral] Urethra…

3235 D17 Yeah…that's what I said

MRS SMITHS: *Urethra then what?*

3238 D17: *Yeah ureter it's from the kidney then goes to the urethra, then to the bladder which is the muscular sac which go out to the exterior*

3247 MRS SMITHS: *How does it go out to the exterior?*

3249 D (Neutral) Madam, the urethra carries the urine (D17: Interrupts, Yes) and the bladder carries…

3254 D17: *The urethra carries the urine madam (inaudible -too many voices). Goes to the bladder then the bladder is the muscular sac which you wanna (inaudible). It contains uh, actually holds the urine for small amount of time then (inaudible)*

3307 MRS SMITHS: *When it releases it to the exterior, from this drawing, which part?*

3313 D17: (laughs) *Yeah that's the thing all this drawing here doesn't explain (silence) 3317 (murmurs)*

3323 MRS SMITHS: *What is that, I hear you are saying eee, ohh?*

3328 D17: *Wwwwhat is that maam?*

3330 MRS SMITHS: *Which structure would take the fluids out?*

3333 D17: *(Laughs) Yaah, D63 doesn't but he did, ehh, (inaudible) he explained, well… (Murmurs)*

3340 MRS SMITHS: What is that (inaudible)?

3341 D17: *(Inaudible) other members' voices interrupts) couldn't give the names of the thing but he explained what happens*

3346 MRS SMITHS: *What structure would come into play to take the fluid out of the body, you just said to the exterior, how does it get to the exterior?*

3356 D17: *Through the urethra (another learner interrupts) urethra from the bladder*

3400 D17: Hayii (vernacular), Noo, *She is saying through the thing there…it has to…your thing there, ohh… 3405should we say the name of it,*

34 07 MRS SMITHS; you are scientists

3408 D17: Ohh yes maam the penis or the vagina maam

3412 MRS SMITHS: *What would be hard to say that*?

3414 D17: *Uuum (laughs) eeh maam uuum nothing is hard, (many voices) it's a grade 8 learner we are explaining to so we can't say such words*

3426 MRS SMITHS: *Thank you very much. What, who, says you can't use such words, who said so?*

3430 D17*: Maam, Uuum grade 8 maam, they have naught minds so we can't*…we can't (many boys' voices)

3440 D17: *(Inaudible) they must be taught not just a drawing to know every process happening in the drawing, we can't know everything that is happening in that drawing (inaudible). The functions of (inaudible – too many voices) you explained, how you told us about penis and which part does what unlike given a drawing then and expected to know36*

3522 MRS SMITHS: *Ok*

Appendix 5.0: Research Instructions, Permission Letters

Appendix 5.1.1: The drawing activity instructions. **No: 1**

Title: A teacher's explorative investigation of using drawings to stimulate learner talk in the Grade 11 Life Sciences classroom.

INSTRUCTIONS:

1. Read and understand the instructions before responding.
2. Section A: Individual work.
3. Section B: Peer discussion.

NB: You are invited to freely use the researcher's tape recorder for recording the discussion/ talk.

SECTION A: Individual Work (Spend 15 Minutes).

Nthando, a grade 8 learner loves the Life Sciences subject. Today she watched as her friend Nancy, was having a ham sandwich and orange juice for lunch. She observed that Nancy took some minutes to chew before she swallowed and then she drank her orange juice right after eating the entire sandwich. Now, Nthando wants to understand what happens to the sandwich and the juice after swallowing. Imagine that Nthando approaches you for help and then you decide to use drawings to illustrate and then talk about the processes involved. Please use the human body outline provided and label all the organs that the food passes through.

FIGURE 1: HUMAN BODY OUTLINE

THANK YOU FOR YOUR DRAWING.

SECTION B: RECORD YOUR PEER DISCUSSIONS ABOUT THE DRAWINGS [Spend 3x5=15 minutes]

Display your drawings to your peers and discuss how each of the drawings could be useful to Nthando. [**Hint: consider the organs labeled, their positions, and anything else important you can see in the drawing**]. You are invited to use the researcher's tape recorder for recording each group member's ideas and help Nthando understand fully how the food is passed along and what happens to it.

You may use the other human body outline given below, Figure 2, to show the changes that you have decided to make as a peer group. Save your recordings using your research identities

FIGURE 2: HUMAN BODY OUTLINE (for the group drawing)

THANK YOU AGAIN FOR YOUR DRAWING.

Appendix 5.1.2: Questionnaire: **on A teacher's explorative investigation of using drawings to stimulate learner talk in the Grade 11 Life Sciences Classrooms**

May you share your views and experiences about using drawings of the alimentary canal as a strategy to stimulate talk? Your ideas will help me to understand how the approach can be applicable to the teaching and learning in Grade 11 Life Sciences classes. Please feel free to use any language that you are comfortable to express your views in.

NB. Use your identity number which you had from the drawings in session A, Appendix 2.1.1.

Gender_____ **No. ___**

SECTION D: Individual Work on this evaluation. Spend 5 Minutes

1.1.1. Have drawings been used in your learning of Life Sciences?
Yes/No_____

1.1.2. If YES, in which topics have you used them most?

_____

_____

1.1.3. How have drawings been used in your learning of Life Sciences? _____

_____

1.2 Do you think drawings are important for learning Life Sciences? Yes/No

_____

Explain your answer briefly.

_____

1.3 In few lines, could you share what you enjoyed most about this study?

_____

_____

1.4 In few lines, may you share information about the activity of making drawings of the alimentary canal using the following questions?

1.4.1. What did not work for you about the making drawings of the alimentary canal?

_____

_____

1.4.2.Why did it not work for you?

_____

1.4.3. What could be done better to make it work for you next time?

1.5 Would you recommend having this approach of teaching and learning in the Grade 11 Life Sciences class?

1. Strongly Agree

2. Agree

3. Never

4. Disagree

5. Strongly Agree

1.6 Explain your suggestion from question 1.5 above briefly.

Thank You, Your Views Are Highly Respected

Appendix 5.1.3: Focus Group interviews

SECTION C: Focus Group Discussion guide questions. (Spend 15 Minutes)

You are invited to respond to any question that you are comfortable to answer. Answering these questions is voluntary. You are basically expected to share what you think about the accuracy of the drawings and or to clarify what is unclear in the drawings for me. Each one of us will try to give his/her own meaning or interpretation of the drawings and the discussion.

We need to speak loud for the recording to be good and let each one of us identify his/her self (by the numbers that were on the drawings used in section A) before or after you have shared the contribution.

In order to benefit from this activity, let's make a list of a few very important ground rules that we can use.

1. Everyone's idea is important and so we need to respect it. [We can suggest three more];

2. Anonymity and confidentiality

3._____
_____

4._____
_____

5._____
_____

Part A: **Drawings can be shown on white board or projected for the focus group members to see**.

i) What could be correct/incorrect about this drawing (pause as the drawing will be screened) …any one?

ii) What more could we say to support/dispute the suggested ideas (pause for participants to think)…yes…

iii) May you explain that point further please someone (pause)…you are right!

Part B: Some concepts from the discussion recordings are replayed for the participants to hear.

Let us listen to the following phrases and statements that were outstanding from the collected data

iv). What could be the meaning/s of the phrase?
_____

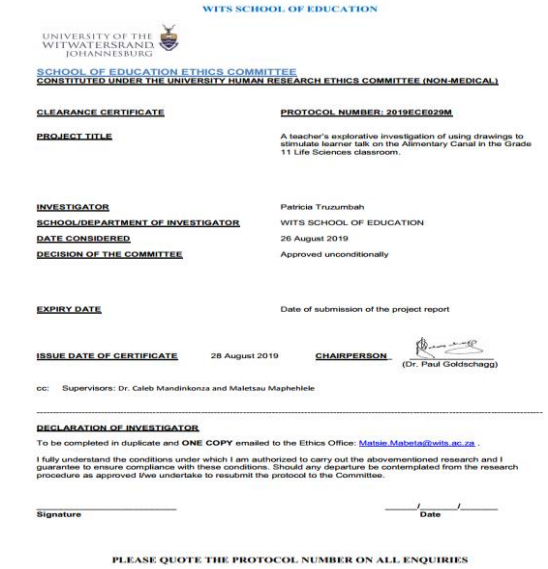
v). If these words are used in a sentence, what meaning/s do they send around_____?

vi). What other ideas go together with these words; (words will come from the data analysis._____
_____

THANK YOU

Appendix 5.2: Research Approvals

Appendix 5.2.1: Wit's Research Committee



WITS SCHOOL OF EDUCATION

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF EDUCATION ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	PROTOCOL NUMBER: 2019ECE029M
PROJECT TITLE	A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences classroom.
INVESTIGATOR	Patricia Truzumbah
SCHOOL/DEPARTMENT OF INVESTIGATOR	WITS SCHOOL OF EDUCATION
DATE CONSIDERED	26 August 2019
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	Date of submission of the project report

ISSUE DATE OF CERTIFICATE 28 August 2019 CHAIRPERSON (Dr. Paul Goldschagg)

cc: Supervisors: Dr. Caleb Mandinkonza and Maletsau Maphehlele

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** emailed to the Ethics Office: Matsie.Mabeta@wits.ac.za .

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Signature _____ Date _____/_____/_____

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix 5.2.2: GDE Approval letter

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	27 August 2019
Validity of Research Approval:	04 February 2019 – 30 September 2019 2019/247
Name of Researcher:	Truzumbah P
Address of Researcher:	27 Millar Street
	Triomf
	Johannesburg, 2092
Telephone Number:	061 342 7620
Email address:	401662@students.wits.ac.za
Research Topic:	A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences classroom.
Type of qualification	Masters' in Science Education
Number and type of schools:	One Secondary School
District/s/HO	Gauteng North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

27/08/2019

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix 5.3: Consent Letters

Appendix 5.3.1: The Principal & SGB

Letter to the Principal, SGB Chair, Etc. 28-08-19

Dear Principal

My name is Ms. P. Truzumbah and I am a Masters student at the University of the Witwatersrand's School of Education. I am doing research on "A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences Classroom".

My research is targeting the Grade 11 Life Sciences learners that will be invited to voluntarily participate in the study and give their written consent. I select five participants from each of the three classes who would have given consent letters that I know to be knowledgeable of the topic of alimentary canal to form the convenient sample. These fifteen participants will start the participation during Life Sciences lesson time. They will complete drawings of the human alimentary canal for ten minutes in response to some instructions. Then they will use their drawings to stimulate audio-recorded talk with peers while seated in groups of five for fifteen minutes. The generated data will be collected and stored in a password protected computer at the University of Witwatersrand's School of Education. In the week that follows, I will ask learners to conduct a focus group discussion privately in my classroom after school for 15 minutes followed by 5 minutes to complete a written questionnaire. The focus group will comprise of five participants who will be selected from the convenient samples for their exceptional drawings and audio recordings. They will be asked to elaborate on their work and audio record the talk while the researcher makes video recordings where the participants' faces are blurred.

I chose your school because it is near to my residential place, which is convenient and accessible to me for my data collection. Your school has a diversified enrolment that has potential to provide a variety of responses for this research. I am therefore inviting your school to participate in this research.

The research participants will not be advantaged or disadvantaged in any way and the questions used for the interactive peer discussions are not part of their syllabus. The participants will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks for the learners in participating in this study. The

participants will not be rewarded for participation or be disadvantaged for non-participation in this study.

The names of the research participants and identity of the school will be kept confidential at all times and anonymity of research participants will be upheld in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed between 3-5 years after completion of the project.

I will be available and happy to provide any further information whenever you need it. I look forward to your positive response. .

Yours sincerely,

Ms. P. Truzumbah

No.27 Millar Street

Triomf, Johannesburg

Cell phone: 061 3427 620

Email. Address: 401662@students.wit's.ac.za

Appendix 5.3.2: Participants/Learners

28-08-19

Dear Learner

My name is Ms. P. Truzumbah and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on "A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences Classroom".

My study involves exploring the use of drawings as possible tools that can reveal the learners' knowledge which they bring to the topic on the Alimentary Canal.

I am inviting all the Grade 11 Life Sciences learners to participate, however, only fifteen from those who show their consent by signing forms are signed will be selected to form the convenient sample. The first session will begin during the Life Sciences lesson time and will take about 30

minutes. You will be asked to complete drawings of the human alimentary canal for ten minutes and then you will discuss the accuracy of the drawings in groups of five peers for fifteen minutes. I will need to make use of audio-and video- recordings in order to support my write-up of the study. In that regard, I am inviting participants that are willing to audio-record their peer-peer discussions using the researcher's audio recorder. I am asking for your permission to make video recordings where the faces will be blurred during the drawing and the peer discussion sessions. The data from the fifteen participants will be collected for storage and later analysis at the University of Witwatersrand's School of Education.

After a week, I will ask for another session with a sample of five participants who will be termed a focus group. These five are further selected from the initial 15. The focus group participants will be asked to elaborate on some of the issues that will emerge from the analysis of the drawings and the peer discussions for 15 minutes. This session with the focus group will be conducted from my classroom, privately, after school and behind closed doors. In addition, each focus group member will be asked to respond to a questionnaire where they will express their views and experiences about the study for five minutes. The research requires me to capture all views and experiences about the study, and in that respect, I am asking for your permission to use audio and video recorders. The video will blur your faces to protect your identity and no real names will be used, to maintain anonymity. The data generated from this session will be stored in my supervisor's password protected computer for about 5 years at the University of Witwatersrand's School of Education. .

Remember, this is not a test, it is not part of the syllabus, nor is it for marks. This process is voluntary, which means that you are not being forced to participate. Also, if you decide to withdraw from the study at any time during the study you are free to do so and your class marks will not be affected.

In the report I will make up a name for you so that no one can identify you. All the information about you will be kept confidential in all my writing about the study. The collected information will be destroyed 5 years after I have completed my study.

Your parents have also been provided with an information sheet and consent form, however it is your decision to join us in the study.

I look forward to working with you.

Please feel free to contact me if you have any questions.

Thank you

Ms P. Truzumbah

No. 27 Millar Street

Triomf

Johannesburg
Cell phone: 061 3427 620
Email. Address: 401662@students.wit's.ac.za

Learner Consent Form

Please fill in the reply slip below if you agree to participate in my study called: "A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences Classroom".

My name is: _____

Information about the study	**Circle one**
The intention of this study has been explained to me	YES/NO
Permission to review/collect documents	**Circle one**
I agree that my drawings of the human alimentary canal can be used for this study only.	YES/NO
Permission to be audiotaped	
I agree to be audiotaped during the discussions of this study.	YES/NO
I know that the audiotapes will be used for this project only	YES/NO
Permission to respond to a questionnaire	
I would like to write responses to the questionnaire for this study.	YES/NO
I know that I can stop the writing at any time and don't have to answer all the questions asked.	YES/NO
Permission to be videotaped	
I agree to be videotaped in during the discussions for this study.	YES/NO
I know that the faces will be blurred and that the videotapes will be used for this project only.	YES/NO

Informed Consent
I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, and videotaped

- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

Appendix 5.3.3: Participants' parents

Dear Parent 28-08-19

My name is Ms. P. Truzumbah and I am a Masters student in the School of Education at the University of the Witwatersrand. I am doing research on "A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences Classroom".

My research involves conducting an investigation on how drawings can be used to stimulate talk on the Alimentary Canal. The introduced strategy is to serve as an interactive method to elicit the knowledge that the learners bring to the Life Sciences classrooms in support of the CAPS document vision (Department of Basic Education, 2011). All the current Grade 11 Life Sciences learners from your child's school are being invited to participate in the study. Those learners whose parents have consented and themselves have consented will be considered and fifteen participants will form the convenient sample anticipated.

The study will commence by asking each of the fifteen participants to make drawings of the human alimentary canal for ten minutes. They will further discuss the accuracy of their drawings within groups of five peers for fifteen minutes. This session will occur during the lesson so as to benefit all the learners, however participants 'lesson will be separated from the non-participant. Only the data from the fifteen participants will be taken for storage and further analysis at the University of Witwatersrand's School of Education. After a week, I will ask for another session with a sample of five participants who will be termed a focus group. The focus group's participants will be asked to elaborate on some of the issues that will emerge from the analysis of the drawings and the peer discussions for 15 minutes. This second session with the focus group will be conducted after school, indoors to maintain private interaction. In addition, each focus group member will be asked to respond to a questionnaire for five minutes where they express

their views and experiences about the study. The research requires that I use audio and video recording tools to capture all proceedings. In that regard, I am asking for your permission to allow your child/ ward to participate in the study. I am further asking that your child/ ward be audio and video recorded. The video will have the faces blurred to protect the participants' identity and numbers will be used instead of the real names for anonymity. Data generated from this session will be stored in my supervisor's password protected computer for at the University of Witwatersrand School of Education to be destroyed five years after completion of the study.

I chose your child's class because it is a Grade 11 Life Sciences class which is the suitable target for the study. The topic under discussion is taught at Grade 11 and I teach the Grade 11 classes. Your child will not be advantaged or disadvantaged in any way and the questions used in the interactive activity are not part of their syllabus. It will be emphasized that s/he can withdraw his/her permission at any time during this project if s/he feels like doing so without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writings about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

I will be available and happy to provide any further information whenever you need it. I look forward to your positive response. Thank you very much for your help.

Yours sincerely,

Signature (Insert signature)

Ms P. Truzumbah

No. 27 Millar Street

Triomf, Johannesburg

Cell phone: 061 3427 620

Email. Address: 401662@students.wit's.ac.za

Parent's Consent Form

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called: "A teacher's explorative investigation of using drawings to stimulate learner talk on the Alimentary Canal in the Grade 11 Life Sciences Classroom".

I, _____ the parent of _____

Permission to review/collect documents	**Circle one**
I agree that my child's drawings of the human alimentary canal can be used for this study only.	YES/NO

Permission to be audiotaped	
I agree that my child may be audiotaped during discussions for this study.	YES/NO
I know that the audiotapes will be used for this project only	

Permission to respond to a questionnaire	
I agree that my child may respond to a written questionnaire for this study.	YES/NO
I know that he/she can stop the responses at any time and doesn't have to answer all the questions asked.	YES/NO

Permission to be videotaped	
I agree that my child may be videotaped in class during this study.	YES/NO
I know that the faces will be blurred and the videotapes will be used for this project only.	YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- he/she does not have to answer every question and can withdraw from the study at any time.
- he/she can ask not to be audiotaped and or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____