Investigating the take-up of Open Educational Resources for Maths Teacher Education:

a case study in six Higher Education sites in South Africa.

Full submission for Master of Education by dissertation

VOLUME 1

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Abstract

This study has investigated the take-up, at a range of South African tertiary institutions, of Open Educational Resources (OER) designed for mathematics teacher education. Although numerous studies (e.g. Darling-Hammond, 2006; Jonassen & Rohrer-Murphy, 1999; Loughran, 2006) have identified criteria for the development of quality materials for teacher education, and have investigated ways in which these have been and should be used, little attention has been paid to the implications of these findings for the use of OER in teacher education. In 2006 the South African Institute of Distance Education (SAIDE) initiated the ACEMaths project to pilot a collaborative materials design and adaptation process in response to a Department of Education call for large scale teacher upgrading programmes leading to an Advanced Certificate in Education (ACE) in priority areas. Nine South African tertiary institutions formed the collaborative group for the development of Mathematics teacher education materials. Six of these institutions committed to using the pilot materials in their teacher education programmes in 2007. Methodologically, the research is a case study of cases (Adler & Reed, 2002), in which the varying uses of the materials in these six institutional sites constituted the individual cases. At each site data were gathered from session observations, questionnaires and interviews. Artefacts, such as examples of customised materials, were also collected. Cross case analysis revealed that institutions used the ACEMaths materials in both similar and different ways and in a range of programmes. Findings from this analysis and their implications for both initial inter-institutional designing and subsequent intra-institutional re-designing and re-use of OER are discussed.

Keywords

Open Educational Resources (OER); Models of OER usage; Materials design; Communities of practice; Mathematics teacher education.

Declaration

I declare that this research project is my own work, written under the supervision of Yvonne Reed. It is submitted for the degree of Master of Education in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.

_____

Ingrid Sapire

_____ day of _____, 2010

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Appendix N: SAIDE ACEMaths Pilot Version Unit Two

Appendix O: SAIDE ACEMaths Pilot Version Unit Three

Appendix P: SAIDE ACEMaths Pilot Version Unit Four

Appendix Q: SAIDE ACEMaths Pilot Version Unit Five (and reading for Unit Five)

Appendix R: SAIDE ACEMaths Pilot Version Unit Six (and readings for Unit Six)

Chapter 1 Introduction

At present a world-wide movement is developing which promotes unencumbered open access to digital resources such as content and software-based tools to be used as a means of promoting education and lifelong learning.
(Geser, 2007, p. 16)

1.1 Background

In South Africa today there are still too few teachers (qualified and in the process of qualifying) to meet the demand for classroom teachers in the schools (DoE, 2007). In addition, the need for in-service professional development of teachers has been recognized for many years. While programmes have been offered to some teachers to provide for this, there are still many classroom teachers who are either under-qualified, or teaching subjects which they are not qualified to teach. The need for teachers to engage with a new outcomes-based curriculum has placed additional strain on them in their classrooms. Even teachers who are confident in the subject matter may have their confidence undermined by their lack of understanding of the implications of implementing Outcomes-based Education (Brodie, Lelliot & Davis, 2002; Chisholm et al., 2000; Jansen & Christie, 1999; Taylor & Vinjevold, 1999). Many teachers also have to cope with large and diverse classes. All of these factors contribute to a feeling of unease and dissatisfaction in the ranks of teachers.

Teachers' concerns have been recognised by the national Department of Education. For example, the *National Policy Framework for Teacher Education and Development in South Africa* (DoE, 2007) proposes a strategy for teacher education and development. The departmental initiative to provide funding for a large scale roll-out of teacher upgrading bursaries (DoE, 2007) indicates its acknowledgement of the need to provide teachers with opportunities to improve their qualifications and better equip themselves for success in their classrooms. This roll-out of bursaries means that teachers will be in a position to upgrade their qualifications, but it also means that the institutions which are expected to provide the relevant courses need to be ready to do so. An analysis of course prospectuses in 2006 on the institutional websites indicated that tertiary institutions did not have the capacity to meet the demands that would be

placed on them in 2008/9 for the provision of in-service teacher upgrading programmes.

Universities and non-governmental organisations (NGOs) have offered in-service courses which have evolved over time to meet the needs of the teachers. Curriculum requirements for such programmes were specified in the government policy document *Norms and Standards for Educators* (2000). These specifications have been incorporated into programmes such as the Bachelor of Education (B Ed) or Advanced Certificate in Education (ACE) at tertiary institutions. The general curriculum requirements and particular interpretations of these requirements have had an impact on the way in which programmes have been developed (Makoni, 2000; Sayed, 2004). Findings from research on professional development programmes suggest that many participants in good quality upgrading programmes become more confident, more skilled and capable of making a difference in schools (Adler, Slonimsky & Reed, 2002; Botha, Deveruex, Adendorff, & Sotuku, 2006).

The South African Institute for Distance Education (SAIDE)'s Open Educational Resources (OER[1]) initiative was set in motion in 2006 in response to the call for national large scale provision of teacher upgrading in South Africa. "The specific goal of the initiative is a set of collaboratively designed modules supported by a common set of materials for use in Advanced Certificate in Education programmes for serving teachers in South African schools." (SAIDE, 2006, p. 1) The pilot module chosen for development[2] entitled *Teaching and Learning Mathematics in Diverse Classrooms* was developed, trialled and evaluated in 2007-2008. It was designed to serve a dual purpose: as the mathematics module in a Learners with Special Educational Needs (LSEN) ACE course, and as a theory of learning and teaching mathematics module in a Mathematics ACE course. The module may have applications in other courses that wish to address the teaching of mathematics in South African classrooms, and even further afield once the materials are released as OER on the web.

[1] Throughout this dissertation the abbreviation OER will be used interchangeably for both the singular Open Educational Resource and the plural Open Educational Resources in line with this convention in current OER literature.
[2] The choice of the mathematics module is discussed in 1.5.

1.2 The aim of the research project

The broad aim of this research project is to investigate the take-up[3] in multiple sites of the OER module *Teaching and Learning Mathematics in Diverse Classrooms.*

1.3 Research Questions

The following questions informed the investigation:

a) How did teacher educators in the six sites intend to use the pilot OER material with teachers?
b) Which parts of the pilot OER material did the teacher educators in the six sites actually select, and what factors influenced this selection?
c) How did the teacher educators use the pilot OER in the teacher education programmes and how did the students respond to these materials?
d) What are the strengths of the materials development process and of the OER materials produced?
e) Are there obstacles to the use of the OER and if so, what are these and how can they be overcome?

1.4 Rationale

In *Powerful Teacher Education: Lessons from exemplary programmes* Linda Darling-Hammond uses findings from research to argue that quality teacher education materials are central to the improvement of teaching (Darling-Hammond, 2006). The introduction to this proposal described the present context of teacher education in South Africa (one of great need) in relation to the existing shortage of teacher in-service up-grading programmes. Responding to this need motivated the development of the SAIDE ACEMaths[4] materials. It was assumed that high quality materials (such as it was intended the SAIDE OER would be) could assist institutions in the provision of the courses needed for teacher up-grading. Materials development needs to be monitored and reviewed to promote optimum quality. Fullan (2001) also argues that

[3] Take-up (implementation and adaptation) by lecturers is the limited focus of this study. Take-up by students is not considered although some feedback from student users did inform the research.
[4] SAIDE ACEMaths is the name that was given to the project established to develop materials for use in ACE (and other) teacher education programmes by a collaborative team brought together and managed by SAIDE.

quality curriculum materials are needed to bring about innovation in teaching. The development of curriculum should not be insular, which could reinforce non-functional curricula. It should rather be collaborative, to allow for interaction and sharing of ideas. Materials developed for teacher education programmes need to acknowledge the role of the teachers, draw on their experience and take them forward (Fullan, 2001; Loughran, 2006). The collaborative manner in which the pilot module, *Teaching and Learning Mathematics in Diverse Classrooms,* was developed contributed in part to a built-in review process while the materials were in the development stage. However a thorough understanding of the take-up of the materials was deemed necessary for informing the next step in the development process which would involve the production and dissemination of further OER materials.

The aim of the developers of the SAIDE ACEMaths materials is to assist institutions in the provision of ACE (or other) programmes for quality teacher education. But the quality of the material needs to be assured if outsiders are to be encouraged to use it. The findings of this research on the take-up of the pilot SAIDE ACEMaths materials should enable further revision of the material to take place based on users' experience of the material "in action". Identification of differences between the intended and actual uses of the materials could assist designers in further development and revision of the existing materials. Understanding of the take-up in each site should give insight into existing and potential applicability of the materials to a wide variety of teacher education programmes. Obstacles to the use of the materials may also emerge from the sites, where different individual lecturers may have experienced different challenges. This investigation, guided by the research questions, aims to shed light on the contribution of OER materials to change and improvement in teaching.

The Inclusive Education Policy for South African schools places other demands on teachers in addition to the demands of Outcomes Based Education (OBE) (DoE, 2005). The *Guidelines for Inclusive Learning Programmes* have been drawn up to "provide guidance to teachers […] on how to deal with diversity in the classrooms and schools of our country" (DoE, 2005, p. 7). The SAIDE ACEMaths materials aimed to address the needs of teachers in diverse classrooms in South Africa, with reference to the *Guidelines for Inclusive Learning Programmes* as well as other sources.

These OER materials could be used in multiple sites, and as such could be part of an initiative that facilitates the scaling up of programmes. "Scaling up of programmes" is a field in which "there have been few(er) studies" (Adler, Ball, Krainer, Lin, & Novotna, 2005, p. 376). This study of the take-up of the pilot SAIDE ACEMaths materials aims to give insight into whether, and if so how, the provision of OER facilitates the scaling up of programmes. Any obstacles to the use of the materials which emerge from the study could also give insight into factors which prevent scaling up of programmes.

The research on the take-up of the materials in the pilot phase of the initiative is the first step. Findings from this case study of cases (Adler & Reed, 2002) could be used to suggest directions for the SAIDE ACEMaths OER project and other OER initiatives. The next step would be to investigate their release on the web and subsequent take-up.

1.5 The researcher's role in the SAIDE ACEMaths OER project

I was involved closely with the project from its inception which necessitates an explanation[5] of my role as both researcher and content expert on the team. In 2006 I was employed as the coordinator of the Mathematics ACEs at an institution that offered mathematics ACE courses (at an FET and GET[6] level) in South Africa. During that year, the institution was invited by SAIDE to join a team of collaborators in the development of materials for ACE modules. I participated in the initial teleconference where potential modules and institutions to be invited to participate were identified. The module common to most of these institutions was Mathematics for the Foundation and Intermediate Phases and so it was decided that this would be the module to be developed further by the collaborative team. After this teleconference it was agreed that I would participate in the project.

The launching workshop on 11 – 12 September 2006 brought together 25 representatives from twelve education institutions who responded to the invitation to

[5] One of the readers of my research proposal suggested that I should do this.
[6] Grades 10-12 constitute the FET band (Further Education and Training) and Grades R-9 constitute the GET band (General Education and Training) of schooling in South Africa.

be involved in the project. On the first day of this workshop with all 25 participants present, general ideas about the development of OER, licencing and collaboration were debated. The second day of the workshop was attended by 14 participants who formed the initial team for developing the mathematics module. This team consisted of mathematics and inclusive education specialists from eight higher education institutions[7]. I was a participant on the first day and co-leader of the curriculum development workshop on the second day. This was the first meeting of the collaborative team. At this workshop aspects of the curriculum were discussed and it was decided that the module would be named *Teaching and Learning Mathematics in Diverse Classrooms*, a name which also reflected the diversity of the development team.

While I was leader of the mathematics curriculum discussion held at this workshop and I was aware that I could contribute to the development of the materials, I was still unaware of the possibility that the institution in which I worked would make use of the module. This was because in the preliminary discussions the emphasis on Foundation and Intermediate Phases did not seem specifically appropriate to its needs, since the courses it offered were aimed more at the Intermediate and Senior Phases (in the GET band) and at the FET level. At the following workshop I became aware of the possibilities for adaptation and use of the materials. This was of course highly motivating for me and I was pleased to be elected as the "content leader" of the team. The decision to enrol for a masters degree (by dissertation) and to research the take-up of the materials was taken early in 2007. By this stage I had been formally engaged by SAIDE as content leader of the team.

In this role I was responsible for preparation and for co-leading of the collaborative workshops, recording decisions about the materials development taken by the team at all workshops, implementing and circulating drafts of materials to the team, collating comments from the team and writing the parts of the materials that needed to be written. I remained closely involved in the project until the launch of the materials, when they were disseminated on the web on the OER Africa platform in 2008. I thus was record keeper and researcher for the team, prior to my decision to register for an

[7] The ninth institution represented in the team joined at a later date, joining in the collaborative process from the second workshop.

M Ed degree and prior to obtaining ethics clearance for the research[8]. The team was advised when I made my decision to register for the M Ed degree. They knew about it before the observations were carried out at the different sites. They supported me and participated willingly in both the pilot project take-up and review process, part of which was a data collection process for the research.

The data used for this research were all obtained with the consent of the team members, since even before I decided to embark on the research towards a degree, all team members (including myself) were aware of the pilot nature of the project and that it would be closely monitored. One of my contractual obligations, as content leader on the team, was to compile the project report on the quality review of the materials to inform the revision of the materials prior to dissemination on the web. I was also contractually obligated to report on the take-up of the materials, since this was of interest to SAIDE in relation to their planning of other similar projects. While discussing these tasks with the project leader I decided to register for the degree and use the data from the project research for the parallel purpose of research for an M Ed dissertation. The report on the process, quality, review and take-up of the materials would be written for the purposes of reporting to the funder of the project. The dissertation, an in-depth analysis of one of the aspects of the report (take-up) would serve a dual purpose – it would allow further insight into the project for SAIDE and other interested parties as well as personal professional development for myself.

The two excerpts below are from the SAIDE ACEMaths project report (2008a). The first one explains the requirement for all participants to be involved fully in the pilot process. The requirement for involvement in the pilot was to ensure maximum possible spread of the pilot implementation and to allow for meaningful research into this take-up.

> An understanding was established from the outset that if an institution sent representatives to the workshops and received the adapted materials, there would be a requirement to engage with, adapt, and use the materials in some way in courses during 2007. (Welch & Sapire, 2008a, p. 6)

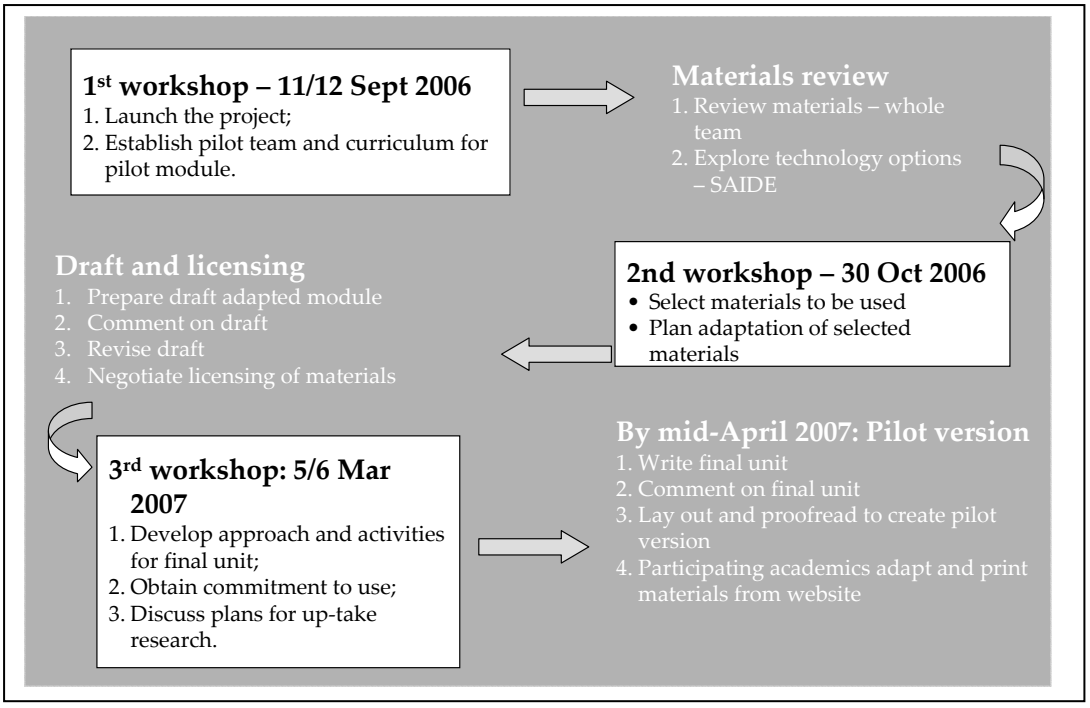
[8] Ethics clearance was granted in due course and all ethical requirements were adhered to. Consent according to the requirements of the ethics clearance was obtained from all of the participants. For copies of the letters of consent see Appendices H, I and J.

The second excerpt explains the way in which the team, which I will argue in this dissertation developed into a community of practice, operated and maintained contact. Communication was through simple electronic and software alternatives (email and Microsoft Word) since this was accessible to all team members. Technological challenges related to the use of more advanced software were avoided. This choice was made by consensus at the first workshop.

> The mechanism for sustaining the community of practice was workshops and email contact as well as access to the drafts of the modules on a webpage associated with the SAIDE website. (Welch & Sapire, 2008a, p. 6)

Figure 1.1 below maps out the activities in the first six months of the project. As is evident in the diagram, there was a flurry of initial activity, and the materials were assembled for use in pilot form within the first six months.

Figure 1.1: Activities in first six months of SAIDE OER project[9]



(Welch & Sapire, 2008b, p. 10)

The task for the team members after the first workshop was to source materials from their institutions which they thought could be used in the collaboratively developed

[9] This flow diagram of activities is taken from the final SAIDE ACEMaths project report: *Piloting an OER materials adaptation process* (2008b). In this dissertation I refer to "take-up" rather than "up-take" as referred to in the table.

module. These materials were to be emailed or posted (where the materials were not available in electronic format) to SAIDE. It was my task to collate the materials. SAIDE then sent out packs of hard copies of all of the materials put forward for inclusion in the module. All team members were asked to comment on the materials and to send their selection preferences (with explanations) to SAIDE. My next task was to compile their suggestions in preparation for the second workshop, so that we could start the second workshop with a clear idea of similarities and differences in our choices and take the discussion forward from there.

Another of my tasks between the first and second workshops was to review existing modules on "learning and teaching mathematics" in a South African context, in order to make a recommendation on the choice of a core text. I reviewed all available texts (not only texts from participating institutions), noting in particular their coverage, style and applicability to the South African teacher education context. I presented this information to SAIDE and the team who could then make an informed choice of core text.

At the second workshop, on 30 October 2006, a core text (which did come from one of the institutions present) was chosen. This was to be supplemented with additional material[10] which was selected on merit, but care was taken to include something from each of the institutions. The team worked together to select materials from the pool for inclusion in the collaborative module. Selection was guided by a module design which was first agreed upon by the team. My next task was to compile the adaptation, combining the core text with the additional material. The first draft of the module was circulated electronically to all of the team members. They then sent comments to me which I used to revise the draft before the third workshop.

The third (and final) materials development workshop was held on 5 – 6 March 2007. Here the team worked on the second draft of the module. The first set of workshop activities was directed towards finalising the group decision on the approach to be taken by the learning guide. The thread to be drawn through each of the units in the

[10] The additional material was predominantly mathematical content to supplement and replace existing mathematical content in the core text. Its inclusion served the dual purpose of acknowledging contributions from all team members and enhancing the mathematical content of the module.

guide was that of diversity, as suggested by its title, *Teaching and Learning Mathematics in Diverse Classrooms.* The second set of workshop activities consisted of sessions where tasks for inclusion in the module were workshopped. It was then my task, after the third workshop, to draft the pilot version of the materials to be used in the implementation phase.

Once the pilot materials were ready for use, my focus was on the take-up research, for the purposes of both the project report and the dissertation. The ACEMaths community (of which I was a member) was involved in piloting the materials at institutions spread around South Africa. Five of the participating institutions[11] were visited between March and September 2007, with a final visit to the sixth participating institution in May 2008.

The project came to an end in 2008. The final collaborative workshop was held in February 2008, to report on the interim results of the take-up research, and address comments emerging both from the expert review of the materials by a mathematics education expert and comments on the materials from practitioners and students. Between February 2008 and August 2008 the materials were revised and prepared for publication on the web. I was responsible for the materials revision. Work on the project and the research continued to run parallel. At the same time SAIDE worked with OER Africa to develop the website where the materials would be placed.

In September 2008 the materials were launched at the second Teacher Education Programme (TEP) conference[12]. The report to the funders was presented at an interactive session introducing the ACEMaths page on the OER Africa site. This was the official launch of the materials on the web. The ACEMaths community page was established on the OER Africa platform, where all of the materials (as well as other references and explanations of the theoretical underpinning of the project) are now freely available to users. Forums and blogs were set up to allow for ongoing

[11] I was able to observe two lecturers at the institution where I worked since there were three of us at this site using the materials in two ACE programmes during the pilot implementation phase.
[12] This was an open conference, entitled *Teacher Education Conference: Concluding conference of the Teacher Education Programme, a collaborative research and development programme funded by the Embassy of the Kingdom of the Netherlands*.

communication among community members[13]. In August 2008 the final project report was published.

My ongoing involvement in the project from the initial workshop until the writing of the final project report meant that I was able to obtain data over a longer period than usual for a masters dissertation. Thus although this dissertation primarily presents and focuses on data from the implementation phase in 2007, some additional data from 2008 and 2009 have also been included. These data give insight into the continued functioning of the website and the community and into the scale-up of use of the materials. In my analysis I have remained as objective as possible and tried not to allow personal involvement in the project to bias my findings. I have taken comments from a wide range of colleagues to ensure that the findings are objective.

1.6 Chapter overview

This dissertation consists of six chapters. The second chapter presents the literature review for the research. In the third chapter the research methodology is described and discussed. The fourth chapter presents the data from the six sites, as individual cases. A cross case analysis of the findings of the case study of cases is put forward in Chapter Five. Conclusions are drawn in the sixth chapter.

[13] There has not been active communication of members through the web page. In February 2009 the ACEMaths roadshow enabled the presentation of the materials at three tertiary institutions. This resulted in some activity and growth in the community. The community of practice established through the collaborative development process has recently been investigated by a private research company with a view to reinvigorating and developing it. In June 2009 solutions guides to two chapters and one of the appendices were posted on the ACEMaths web page. Members of the community are still in intermittent email contact, thanks to their meeting and forming bonds through the active community of practice which formed during the development phase.

Chapter 2: Literature review

2.1 Introduction

The readings that I have used to develop the literature review for this research are located in three key areas of scholarly work and investigation: Open Educational Resources (OER); materials for effective teacher education and communities of practice. Since the materials which are the focus of this study are OER, awareness of their potential as well as of the potential challenges facing their development and dissemination is essential. The aim of the project was to produce materials to enhance capacity in teacher education programmes (specifically ACE programmes, although even in the pilot phase the materials were used in a wider range of programmes at tertiary institutions than was originally envisaged). The materials and curriculum requirements for effective teacher education, planning and implementing a curriculum, as well as changes brought about through implementing a new curriculum all come under scrutiny in this study. In the project that is the object of analysis, the process of developing the OER was collaborative. During this time, and in the period of take-up observed during the pilot phase, embryonic communities of practice were established. Analysis of the data on aspects of the team's collaboration is informed by literature on communities of practice.

2.2 Open Educational Resources

The materials developed by the SAIDE ACEMaths project are to become OER for higher education once the pilot phase has been concluded. As the OER movement[14] is relatively new, there are many unanswered questions about the development and use of these resources. The literature discussed enables me to review the SAIDE pilot OER in relation to three key areas. Firstly, the OER spectrum, secondly the potential

[14] In the literature the emerging practice of developing and sharing materials on a more open basis is spoken about as the "OER movement". For example in the foreword to the Organisation for Economic Co-operation and Development Centre for Educational Research and Innovation (OECD/CERI) study *Giving Knowledge for Free: the Emergence of Open Educational Resources*, it is stated that "until recently, … learning materials were locked up behind passwords within proprietary systems, unreachable to outsiders. The open educational resources (OER) movement aims to break down such barriers and to encourage and enable freely sharing content" (2007, p. 3).

of OER and thirdly technological challenges that face managers, developers and users of OER.

2.2.1 Defining Open Educational Resources

The World Wide Web was launched in 1992, bringing about changes in communication pathways and opening access to information on a scale never before imaginable. Research into the accessibility and development of high quality educational content started to gather momentum some time later. The term Open Educational Resources (OER) was adopted after the UNESCO 2002 Forum on the impact of Open Courseware for higher education in developing countries (e.g. Atkins, Seely Brown, & Hammond, 2007; Geser, 2007; OECD/CERI, 2007).

Open Educational Resources (OER) are resources which are freely available on the web for use by anyone. The resources can be end products (that is freely available content) but they can also be the means to an end (that is the software that facilitates materials development and/or the actual process of collaborative development of material though interaction in an environment that has been set up to allow for such development). The "free" availability does not necessarily mean "free of cost" though it can mean this. The freedom may be in the ease of access, made possible by the Internet. There is no single definition of OER (Geser, 2007), though many writers use the one adopted by UNESCO in 2002 when the term first came into use: "the open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes" (Albright, 2005, p. 1).

The Organisation for Economic Co-operation and Development Centre for Educational Research and Innovation (OECD/CERI) gives the following definition on its website:

> By 'open educational resources' we understand:
>
> - Open courseware and content;
> - Open software tools;
> - Open material for e-learning capacity building of faculty staff;
> - Repositories of learning objects;

- Free educational courses (OECD/CERI, accessed 18/05/2007).

Another definition claimed by Jan Hylén (of OECD/CERI) to be "the most commonly used definition of OER" is:

> Open Educational Resources are digitised materials offered freely and openly for educators, students and self-learners to use and re-use for teaching, learning and research. To further clarify this, OER is said to include:
>
> - Learning Content: Full courses, courseware, content modules, learning objects, collections and journals.
> - Tools: Software to support the development, use, re-use and delivery of learning content including searching and organization of content, content and learning management systems, content development tools, and on-line learning communities.
> - Implementation Resources: Intellectual property licences to promote open publishing of materials, design principles of best practice, and localization of content. (Hylén, 2006, p. 2)

These alternative definitions give some insight into the range of products and processes that can fall under the umbrella term "Open Educational Resources".

A document on open educational resources and practices prepared by a European grouping, the Open e-Learning Content Observatory Services (OLCOS), called the OLCOS Roadmap 2012, includes a fairly lengthy account of the ongoing discussions in regard to a comprehensive definition of OER. It states that "an authoritatively accredited definition of Open Educational Resources does not exist at present" (Geser, 2007, p. 20). The compilers of the Roadmap assert that the ongoing discussion around defining the term is productive and ensures that the focus of OER remains broadly on content and tools. They also state their commitment to encouraging what they call "open educational *practice*". While the content and tools are merely the means, the end is to foster, "open educational practices within and across educational institutions, as the actual practices are decisive in whether, which and how digital educational content, tools and services will be employed" (Geser, 2007, p. 38).

2.2.2 Examples of OER projects

There are a number of examples of OER projects that have responded in different ways to the challenge of making educational resources widely available. Common to all of these is the sharing of information and collaboration in processes via the

Internet. The examples of OER given below show the broad range of products and processes that can be grouped together under the common term of 'OER', demonstrating all aspects of the definition of OER set out above.

2.2.2.1 Content

Certain large institutions provide course content[15] as OER, some provide non-course-based OER, and some provide software. The following are providers of open content for higher education in America, the United Kingdom and Africa[16]. They illustrate the various possibilities for OER providers.

- Carnegie Mellon Open Learning Initiative (OLI), http://oli.web.cmu.edu/openlearning/ : focuses on the provision of interactive learning content. "The materials it provides are good examples of what appeals to students today and are based on sound educational development practices" (Albright, 2005, p. 4).
- Commonwealth of Learning (COL), http://www.col.org/ : hosts the Learning Object Repository[17], which is a website with open educational materials and tools.
- JISC, http://www.jisc.ac.uk : is an OER Programme that supports UK colleges and universities in the use of digital technologies by providing several services including a world-class network, access to electronic resources and new environments for learning, teaching and research (JISC, accessed 30/12/2009).
- JORUM, http://jorum.ac.uk/ : is a free online repository service which provides access to teaching and learning resources to Further and Higher Education Institutions in the UK. Jorum is a JISC -funded Service in Development in UK Further and Higher Education, to collect and share learning and teaching materials, allowing their reuse and repurposing. (JORUM, accessed 30/12/2009)
- MIT OCW (Massachusetts Institution of Technology Open Courseware), http://ocw.mit.edu : the primary goal of this project is to make MIT's teaching material available online. The aim is to have all of the course material online. This

[15] Content provided includes mathematics as well as other content.
[16] The OER movement caught on first and fastest in America but currently OER are becoming more widely used in the United Kingdom than they are in the United States. There are OER resources and projects in many other countries in the world, but they still predominate in America and the UK. This comment is based on an observation that UK OER sites are currently proliferating while many of the USA sites which were started a few years earlier have not continued expanding at the same rate.
[17] The template for the final version of the ACEMaths materials is a COL OER tool.

has been called a "course publication model" or a "static institutional publishing initiative" (Albright, 2005, p. 4). The way it functions is a bit like a library out of which resources can be taken, though electronically.

- OER Africa, http://oerafrica.org/ : is an initiative of SAIDE "which aims to play a leading role in driving the development and use of OER in the African continent" (SAIDE, 2009, p. 5). The OER Africa website hosts four communities, one of which is the ACEMaths community.
- OpenLearn, http://openlearn.open.ac.uk : OpenLearn was a two year initiative which has now been adopted by the Open University UK. It "set out as an experiment to explore how offering free content could be achieved" (McAndrew et al., 2009, p. 1). It provided the foundation for collaborative development and research into these collaborations and reuse of OER. Their goal now is to bring open education approaches into the main processes of the Open University UK.
- Rice University Connexions, http://cnx.org : project brings together content, communities and software. The aim of Connexions is that "anybody, anywhere in the world, is free to contribute course materials, and the modular content structure is designed to promote re-mixing and re-use in different contexts" (Albright, 2005, p. 4).
- TESSA (Teacher Education in Sub Saharan Africa), http://www.tessafrica.net : is an OER research and development initiative providing multimedia materials for teachers and teacher education to nine countries in Sub-Saharan Africa including South Africa, in four languages.

Not all OER are aimed primarily at the higher education sector. There are many other types of open content. Yochai Benkler (2005) cites Wikipedia as an example of an OER providing non-course content through peer production in an electronic environment. Wikipedia takes its name from the collaborative technology used to organize information on web-sites, called Wiki. Benkler, a key thinker in the area of OER, describes how the functioning of Wikipedia demonstrates the power of peer production and peer review, since it is controlled in a decentralised way through the creation of social norms amongst a large and geographically dispersed author group[18].

[18] See http://en.wikipedia.org/wiki/Wikipedia:About for further information on the history and functioning of Wikipedia.

He is of the view that it rivals the Encyclopaedia Britannica not only in comprehensiveness but also in accuracy.

2.2.2.2 Software tools

What is interesting about OER is that they are not simply open content. There is an entire system facilitated by the World Wide Web that uses, stores and supports the creation and use of OER. The widespread use of Free and Open Source Software (FOSS) has meant that there is a range of software tools available for all aspects of OER development, management and dissemination. Lists of software are available. For example the UNESCO IIEP *Report of the discussion on Free and Open Software (FOSS) for Open Educational Resources* (2006), has an appendix consisting of five parts, listing and describing FOSS tools for OER development, management and dissemination. The appendix pages are modified and updated on an ongoing basis. Another list, published by the Centre for Learning and Performance Technologies entitled the "Top 100 Tools for Learning 2009" was compiled from data contributed by over 200 people in 2009 (Top Tools for Learning, accessed 30/12/2009).

Even certain kinds of games are OER. For example, multiplayer online games are immersive environments which allow the individual 'playing' the game to feel as if he/she is part of the environment they are manipulating on the screen. These could be used as education platforms. They provide a "rich potential platform for educational interactions" (Benkler, 2005, p. 23). The Immersive Education Initiative offers free technology and at-cost support to members, including those in further and higher education (Immersive Education Initiative, accessed 30/12/2009).

2.2.2.3 Licencing

Licencing structures and tools are another vital part of the OER system. Conventional licencing systems, which require lengthy permission seeking and often also payment for use of copyrighted material, do not facilitate openness. A lack of understanding of the newer, more open licencing systems versus the older, more restrictive licencing systems can lead to extreme views:

> Too often the debate over creative control tends to the extremes. At one pole is a vision of total control – a world in which every last use of a work is regulated and in which "all rights reserved" (and then some) is the norm.

> At the other end is a vision of anarchy – a world in which creators enjoy a wide range of freedom but are left vulnerable to exploitation. (Creative Commons (1), accessed 12/02/2007)

A new generation of licences was introduced with the GNU General Public Licence (GPL) for open source software as early as 1989 (GNU, accessed 07/02/2010). These licences, instead of restricting use, were designed to grant a number of freedoms in the use of software - freedom to use, freedom to modify, freedom to share. With regard to content, new generation licences were likewise designed to facilitate reuse and creative adaptation, while at the same time protecting certain rights of the creator of the content. There are many different ways of licencing open content such as music, art, photographs, science design. For written material, however, there are two main ways of licencing: the GNU Free Documentation Licence[19] and a range of Creative Commons licences[20].

The Creative Commons (CC) licences were introduced in December 2002 (Creative Commons (1), accessed 08/02/2010). Many authors, instead of using these more open licencing structures, specified their own conditions of reuse. What emerged in the literature is that the proliferation of licencing structures, while intending to facilitate openness, may in many instances have created obstacles to reuse. As James Boyle pointed out:

> The GNU Free Documentation Licence has some interoperability problems with Creative Commons licences. It's not clear if you can take material from Wikipedia and material from a Creative Commons site and put them together to make something new out of it. (J. Boyle, as cited in Appel, 2007, p. 1)

As a result of this proliferation of licences there has been a move to simplify the situation and have one standard licencing system for all OER (Appel, 2007). Although there is still not one standard licencing system the CC licences predominate, with the most commonly used licence now being the CC 3.0 licence. There are choices of restrictions to attach to a CC licence. These are BY (Attribution – indicate the source), SA (Share-Alike – licence in the same way so that others can use the adaptation), NC (Non-Commercial – not to be sold for financial gain) and ND (No Derivatives – the

[19] Used by Wikipedia when it started in 2001 although most Wikipedia text is now dual-licenced.
[20] Used by several projects, such as MIT OCW and OER Africa.

work may not be adapted in any way, it must be used as is). The CC 3.0 licences can be used on a ported (jurisdiction specific) or unported[21] (for a wider international audience) basis (Creative Commons (2), accessed 08/02/2010). Once a CC licence is attached to an OER it is irrevocable, so the correct choice of licence which meets requirements of *inter alia* the project, the creators and the funders is important (D. Kernohan, personal communication, 14 October 2009).

2.2.3 The potential of OER

Albright claims that "the OER movement is breaking down barriers that have blocked access to academic content" (2005, p. 3). The movement towards open educational content and electronic dissemination of materials is of international interest at present, with acceptance of this movement on the increase. Although it will be some time before there is general acceptance of and involvement in the provision of open resources, their development and use is expanding (Bateman, 2008; Geser, 2007; Joyce, 2006; McAndrew, 2006; Moon 2004; Vest, 2004). There are many reasons that could compel involvement in the OER movement on the part of both institutions and individuals. Five of these are outlined below.

2.2.3.1 Ethical and philosophical reasons for OER involvement

Leaders involved in OER have justified the movement by pointing to the way it generates knowledge-making which is more accessible; which may be (though it is not always) free of financial cost; and which can be disseminated by new technologies across the world (Atkins et al., 2007; Benkler, 2005; McAndrew et al., 2009). For instance, Charles Vest, the president of the Massachusetts Institute for Technology (MIT) has argued that through the provision of OER the staff of MIT together with all those who share their materials "will build a web of knowledge that will enhance human learning worldwide" (Vest, 2004, p. 1). This statement needs to be understood at an individual and institutional level. Although sharing knowledge has always been part of teaching, collaboration in the development of OER has allowed for new ways of sharing enabled by technology. As Attwell comments:

[21] The Wikipedia dual-licencing system uses the GNU Free Documentation Licence (GFDL) and the Creative Commons Attribution-Sharealike 3.0 Unported License (CC-BY-SA-3.0).

> It may be that rather than seeing Open Content as a new phenomenon we should rather look at changing forms of cultural exchange and regulation, based on changes in production processes, new forms and organisation of innovation, new understandings of knowledge production and, of course, rapid changes in technologies. (2006, p. 2)

The OER movement aligns with the fields of democracy and civic education which are at odds with the predominant consumer culture of society (Boyte, 2006; Boyte & Skelton, 2009). Active civic culture is a productive culture which has resulted in networks such as the Learning Cities. This is an international movement where cities are reclaiming and developing their community and learning environments by decentralising centres of power and promoting active participation on all levels of governance of the city (Larsen, 2009). In its call for sharing and collaboration the OER movement provides an opportunity for citizen participation in education.

OER foster lifelong learning through easy access to resources (Geser, 2007) and can be used in support of the United Nations Human Rights Declaration which states that

> Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. (Article 26, as cited in Hylén, 2006, p. 5)

2.2.3.2 Collaboration and its potential to spur innovation

Vest has also claimed that co-creative "collaborations will spur innovations in all kinds of interdisciplinary education and research" (2004, p. 3). Collaboration and sharing were included in the list of observed and reported benefits resulting from involvement on behalf of lecturers in the Open Learn project (2009). The value of individuals using OER and participating in their production is part of the vision of the OER movement. The UNESCO Final Report on the discussion on Free and Open Software (FOSS) for Open Educational Resources (2006) identifies two major approaches to the development of OER:

> A 'cathedral' model for OER development involves a highly organised, top-down structure that may require paid teams of experts to lead the development[22].
>
> In contrast, in a 'bazaar' model, a basic FOSS architecture and tools are made available to potential OER developers with the expectation that the

[22] For example MIT OCW, see 2.2.2.1.

> development will be driven by need and facilitated by support from the emergent community[23]. (UNESCO IIEP, 2006, p. 2)

Collaboration is a defining feature of OER: in both production and use (Geser, 2007; McAndrew et al., 2009). The UNESCO IIEP final forum report states that "the forum endorsed the concept shifting the philosophical underpinning of OER from 'knowledge for all' to 'construction of knowledge by all' " (Albright, 2005, p. 15). This is a subtle shift away from the top-down approaches (such as the MIT OCW) which were initiated with the good of humankind at heart, but that do not (in their current model) represent a move away from the teacher-centred handing down of knowledge or academy-centred production of knowledge. Albright (2005) mentions moving away from a top-down approach as one of the challenges the OER movement needs to address.

Through the use of OER individuals are likely to become better equipped to function as part of the knowledge society, and collaborate with others in tasks that confront them in their everyday lives. As the OLCOS Roadmap says, OER can

> … promote digital competence for the knowledge society beyond basic ICT skills through making available tools and content that allow learners to develop their critical thinking and creativity. (Geser, 2007, p. 21)

2.2.3.3 Value for the individual, value for the institution

OER materials and software in contexts in which individuals have easy access to computers can allow students to keep up to date on a self study basis. Some students may wish to showcase their work and such showcasing would be facilitated by OER. There is undeniable value for the individual in gaining access to good quality, flexible materials and enabling interactions with colleagues (Bateman, 2008; Hylén, 2007; Joyce, 2006). OER could bring about the transformation of educational practices, bringing them closer to "what individuals will need to participate successfully in a dynamic knowledge-based society" (Geser, 2007, p. 37).

Issues around the acceptance of OER by institutions are discussed by several writers (Hylén, 2007; Joyce, 2006; McAndrew, 2006; Moon 2004; Vest, 2004; Wiley, 2007). These include (amongst others) standardisation of OER material, licences, access,

[23] For example Rice University Connexions, see 2.2.2.1.

quality and sustainability. In spite of this there is a growing consensus that institutions do stand to benefit through the use of OER. They can use OER to attract future students, for the continuous education of past students and to enhance their public relations. Institutions also stand to gain from free OER services offered by organisations such as JORUM and JISC[24] which offer services enabling them to develop, disseminate and sustain their OER initiatives.

The example of the UK OpenLearn project demonstrates the multiple benefits of OER to the institution (Gourley & Lane, 2009). The list of benefits which are expanded in the project research report are:

> Developing and extending the reputation of the university;
>
> Deepening and broadening the community;
>
> Contributing to the University's information, advice, guidance, outreach and widening participation activities;
>
> Lessons and benefits gained from exposing and describing the OU's content through OpenLearn;
>
> The benefits of testing and experimenting with new technologies;
>
> Creating and nurturing strategic partnerships;
>
> Exploring, examining and improving organisational structures and processes; and
>
> Enhancing and building upon research strengths (McAndrew et al., 2009, pp. 8 – 14).

2.2.3.4 Commercially based incentives

Materials development is a slow and costly process. Bateman suggests that "one of the major monetary costs to African educational systems is that of acquiring pedagogically sound educational materials" (2008, p. 43). OER can help to alleviate this problem since they facilitate cost containment and potential for optimal use, through re-versioning in education programmes. OER leverage public funding more effectively because they allow materials to be reused. Whether OER are developed through external funding or institutional budget allocations, there is a higher return on money spent in this way than on money spent on single application materials development (Geser, 2007; Hylén, 2007; Joyce, 2006).

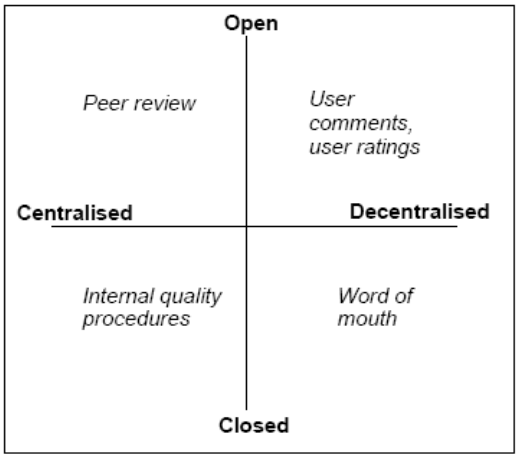
[24] See 2.2.2.

2.2.3.5 Quality assurance

The usefulness and quality of OER is the subject of many discussions (Albright, 2006; Joyce, 2006; McAndrew, 2006). Collaboration in the development of OER can bring about innovation and lead to the improvement of teaching materials (Attwell, 2006; Benkler, 2005). Improved quality is also facilitated by the collaboration mentioned above, since sharing expertise and beginning with ready made materials is likely to lead to revision and improvement of existing materials. Quality assurance of materials is a natural by-product of an open community of practitioners sharing materials as has been demonstrated in the case of peer-review of Wikipedia entries (Benkler, 2005; Geser, 2007). There are cautions expressed about relying on the peer-review model for quality assurance, and Middlehurst has suggested that "alternative methods that focus on agreements, contracts and outcomes may be more appropriate" (R. Middlehurst, as cited in Bateman, 2008, p. 40).

Quality assurance is an issue of concern particularly in the area of community based ('grass-roots') OER development, but also in more formal centralised processes. Quality assurance must be present for OER to have value. Different processes for the management of quality assurance have been suggested by Hylén. As Hylen comments, "teachers, students and self-learners looking for resources should not have difficulties finding resources, but still might have problems of judging their quality" (2006, p. 6). Systems of filtering and accreditation are needed as the volume of content and number and range of users increase (Albright, 2005). Hylén (2006) has suggested there are different ways of managing quality assurance in OER projects The suggested processes can be placed in a two dimensional plane along two axes (see Figure 2.1 below), one indicating the level of centralisation (or decentralisation) and the other the degree of openness (or 'closedness') of the process.

Figure 2.1: Quality assurance options for OER (Hylen, 2006: 8)



2.2.4 Technological challenges in OER projects

The development, review, use and re-use of OER take place in an environment of radical and rapid technological change (to a greater or lesser extent). This leads to technological challenges which need to be addressed for the vision of the OER movement to become a reality. There are technological aspects that need to be clarified and optimised, for best possible development and distribution of the materials. Included here would be the choices made in relation to the model (which includes the decisions about licencing[25]) for the OER. This affects placement, accessibility and re-usability of the materials. Obstacles experienced by different OER projects have been written about and ways in which to overcome them have been suggested (Albright 2005; Geser, 2007; Hylén, 2007; Joyce, 2006; McAndrew, 2006). The obstacles to development and use of OER as they emerge from this pilot project are part of the investigation. Four technical challenges encountered in OER projects are discussed below.

2.2.4.1 Format – designing for reuse

The format chosen for the presentation of the materials will determine the extent to which they can be reused. Wiley quotes the Learning Technology Standards Committee's working definition of the term: "learning objects are defined here as any entity, digital or non-digital which can be used, reused or referenced during

[25] Licencing tools for copyright appropriate in an OER context were discussed in 2.2.2 above since they themselves are an open educational resource.

technology supported learning" (Wiley, 2000, p. 4). He criticises this definition for being extremely broad and narrows it in his own definition to "any digital resource that can be reused to support learning" (Wiley, 2000, p. 7), limiting learning objects to "include anything that can be delivered across the network on demand, be it large or small" (Wiley, 2000, p. 7). He discusses the granularity and combination of learning objects. Granularity relates to the actual breakdown of the learning object into units of presentation and can go from presentation of the whole course to presentation of small units of information in separate useable bits. Combination refers to the ways in which units can be put together. Wiley has developed a taxonomy that can be used to determine the reusability of learning objects through determining the learning object's type and characteristics. He argues that instructional design must support an "instructionally grounded approach to learning object sequencing" (Wiley, 2000, p. 11). The tension to be managed in this respect is between a chunk that is so large and with specific learning pathways built in so firmly that it is difficult to adapt and reuse and a chunk so small that it is impossible to see the teaching and learning aims or locate it sensibly within a course design.

The issue of OER development for reusability was extensively explored in an early Open University OER project: The Course Reuse and Versioning (CURVE) project which aimed to enable easy reuse of course material by course teams both for routine updating and specialised versioning. The project worked with course teams at the Open University to create reusable learning materials that can be transferred into other course contexts or for use by other students with minimal or no adaptation. The CURVE findings suggested that designing for reuse has three dimensions: structure, coherence and transferability (Kubiak, 2003). Transferability is facilitated if, for example, the number of context specific terms is reduced, particularly the jargon related to one institution or the use of examples that make sense only in one context. Reusability is facilitated by modular course structure, or resource-based approaches in which a number of independent resources are integrated by means of a study guide.

2.2.4.2 Production – software alternatives

Software such as Wikis and Blogs, and management systems such as Moodle[26], are being used more and more in the development of OER. This is because they are easy to use and changes can be made to them online and saved immediately. A record of changes that have been made is kept so that quality control is possible as the writing process unfolds. Blogs keep the entries in journal style which is suitable for certain OER. Another software alternative is a Wiki. Peer production through the use of Wikis has proven very successful, as in the example of Wikipedia (Benkler, 2005). Several hundred thousand individuals have worked together to produce millions of Wikipedia entries, through internet communication, because Wikis keep a record of changes and enable easy addition and reversal of edits. Moodle is a learning management system (LMS) that can be used to set up internet-based courses and web sites which can host discussion forums and blogs, and to which documents can be uploaded (Moodle, accessed 30/12/2009). Wiki for creation of documents and Moodle for project site creation are now easy to use because they can be accessed via Google and are free. Other more commonly used software, such as Microsoft Word[27], and communication mechanisms such as email are less technologically advanced but can still be successfully used for collaborative development by groups who are spread out over a large geographic area.

The choice of software, operating system and data centre information technology (IT) services by developers and users of OER is often related to (and limited by) their own computer facilities. Cloud computing (a system of centralised IT services) offers wider options to users to make use of centralised, powerful, secure and reliable data centres. "Cloud computing takes the complexity off the desktop – the software, operating system, and processing power – and moves it into the cloud, which is a central location" (Erenben, 2009, p. 2). Using cloud computing, individuals or institutions can outsource the functions that they require to a hosting company (for example Amazon, Google or Adobe) and save money on both software licences and hardware.

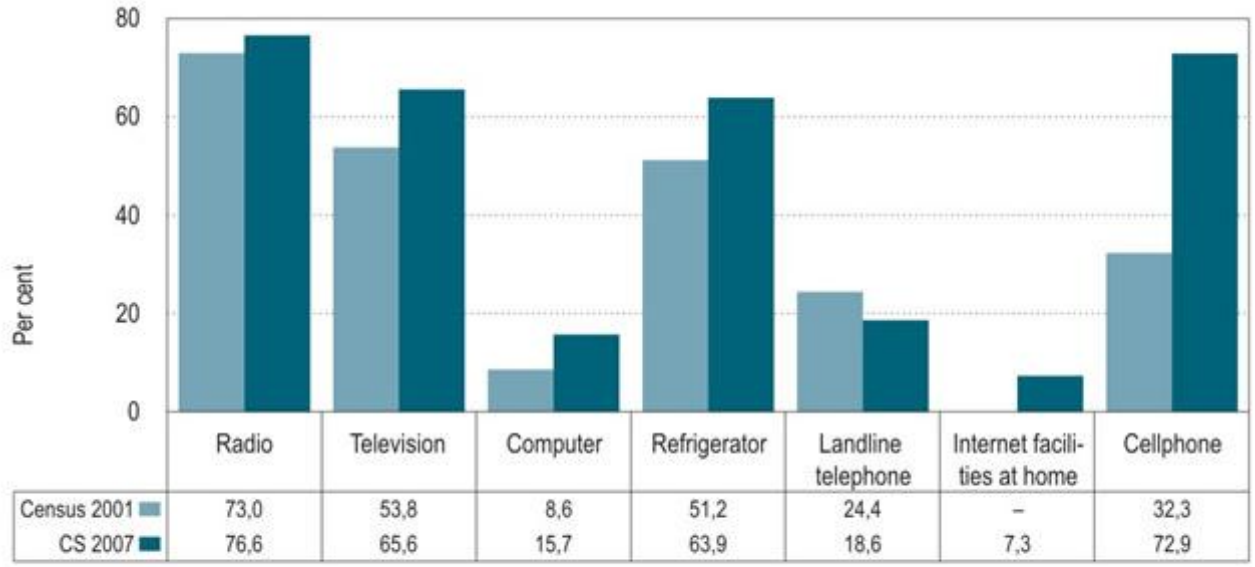
[26] On the *Top 100 Tools for Learning 2009*, Wordpress (a blogging tool) was 7th on the list, Moodle was 16th , and Wikispaces (a Wiki tool) was 31st .
[27] On the *Top 100 Tools for Learning 2009*, Microsoft PowerPoint was 14th on the list, Gmail (Web-based email) was 18th and Word (word processing software) was 42nd.

2.2.4.3 Engagement and editing – technological opportunities

Traditional educational institutions are structured around the teacher as a dispenser of knowledge. Even the use of OER can remain within this paradigm (Albright, 2005). However OER have the potential to allow learners to become creative and collaborative themselves, and participate actively in their learning experience. More recently OBE promoted the view of the teacher as a facilitator of learning, a view which is in line with the vision put forward in the OLCOS Roadmap (Geser, 2007). OLCOS argues that Wiley's notion of "learning objects" goes against the grain of meaningful learning, because it suggests a transfer model of education. The Roadmap suggests, as an alternative, collaborative models (using software such as Wikis and Blogs) that develop "value chains". Participation in OER projects can stimulate learning through involvement with technology. One of the planned outcomes of the OpenLearn project was "enhanced knowledge and understanding of OER delivery, how it can be effective, and the contribution it can make to further development of e-learning" (Gourley & Lane, 2009, p. 59).

In South Africa there are still obstacles in the way of achieving the OER goal of enabling more open teacher education practices, since the dominant model of teaching in tertiary institutions remains teacher centred and does not model interactive open practices (Bateman, 2008; Morrow, 2007). In schools particularly, we see continuing teacher dominance in classrooms in spite of curriculum changes introduced by OBE (Christie, 2008; Taylor & Vinjevold, 1999). Low per capita computer ownership/access and extremely low internet access limit the use of computers and IT as a mode of teaching and learning. As can be seen in Figure 2.2 below, although ownership of computers nearly doubled from 8,6% to 15,7% between the 2001 and 2007 census taking and home internet access increased from 0% to 7,3% over this period, these figures still represent ownership and access in percentages that are far too low for the general public to enjoy of the benefits of the knowledge society.

Figure 2.2: Percentage of households with household goods in working order



	Radio	Television	Computer	Refrigerator	Landline telephone	Internet facilities at home	Cellphone
Census 2001	73,0	53,8	8,6	51,2	24,4	–	32,3
CS 2007	76,6	65,6	15,7	63,9	18,6	7,3	72,9

(StatsSA, accessed 24/01/2010)

Most lecturers at tertiary institutions in South Africa have access to computers with internet facilities and hence should be able to participate in OER projects and the technological opportunities they allow. The skill levels of these lecturers vary and need to be developed where necessary. Gourley and Lane suggest that the "need for information and communication literacy is fundamental and may often be lacking in many so-called digital natives[28]" (2009, p. 60). There is radical democratization of technological production alternatives available to individuals (and institutions) and OER involvement can enable their growing awareness of what is available and how to put it to use.

2.2.4.4 Production/Placement – management and dissemination

Once the OER are ready to be disseminated (if they have been independently produced and not interactively produced online, such as, for example, Wikipedia entries) they need to be placed in an appropriate storage facility on the web. If the OER have been produced online, this would have been done within a Virtual Learning

[28] "Digital natives" is the expression used for the generation that has grown up with computers.

Environment (VLE) or equivalent learning management system (such as Moodle), and the materials would already exist in an accessible web space.

Storage and dissemination facilities for open content on the web are provided in the form of repositories or portals. A repository is "either a local, institutional or central (e.g. subject- or discipline based) digital archive for depositing and providing access to digital contents" (UNESCO IIEP, 2006b, p. 8). Examples of repositories are the COL Learning Object Repository and JORUM. A portal is a "web site that offers a broad array of resources and services, such as emails, forums and search engines" (Webopedia, accessed 07/02/2010). OER Africa and Thutong[29] are examples of portals. Repositories and portals can only be considered as part of the OER system if they are accessible and if the licencing arrangements on their content facilitate reuse and adaptation.

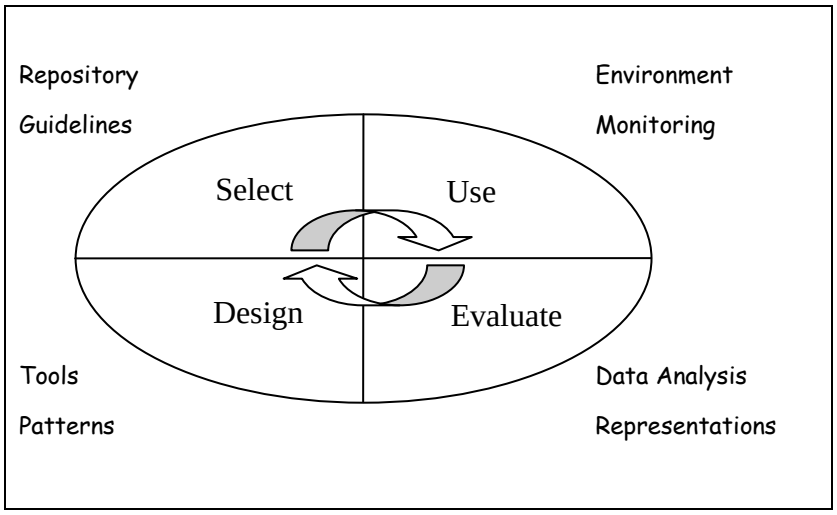
For OER to be successful, they need to be used, reused, revised and developed. Users are thus a vital part in the OER chain. User support systems are beneficial, although not all OER publishing initiatives (such as MIT OCW) encourage communication with users. Other initiatives (such as Carnegie Mellon's OLI) have user support systems built into the resources themselves. Such systems stimulate feedback which could give insight into learning methods and identify areas where additional support might be needed (Albright, 2005). The choice of repository will influence the potential for online interactivity, depending on the software which is in place.

The OER cycle illustrated in Figure 2.3 below demonstrates how different elements in the cycle can generate outputs which can be used by others. This is described in the excerpt from the OpenLearn report:

> Each stage can also generate specific outputs such as a design representation or a new evaluation instrument, which can be put back in for others to use. For example a user might query an existing OER repository, such as OpenLearn, as a means of selecting OER for use. Another user might develop a survey instrument for evaluating the use of, say, science-focused OER which they then make available to the community, and yet another user may then apply that instrument to evaluate their use of Science OER. (McAndrew et al., 2009, p. 22)

[29] The educational portal of the South African Department of Education.

Figure 2.3: The OER effectiveness cycle



(Adapted from McAndrew et al., 2009, p. 22)

It is to the field of teacher education, in a state of flux, with changes brought about through development of on-line education potential (amongst other changes and challenges to mainstream academia), that the ACEMaths materials are offered. Literature on materials for effective teacher education can be used to inform the analysis of what could facilitate and what may hinder take-up of OER in an educational context. Selections from this literature are discussed in section 2.3.

2.3 Materials for effective teacher education

A review of the literature on the provision of quality materials for teacher education offers insight into what users may look for in OER such as the ACEMaths materials and is used to inform an analysis of OER for potential users of these resources, particularly in the field of mathematics teacher education. In this section of the chapter there is a focus on provision for distance education, though not exclusively so, since OER could be taken-up by users in distance or face-to-face education programmes. Literature on the role of materials in curriculum change in the field of teacher education is also used to analyse the take-up of the materials.

2.3.1 Effective teacher education

There is a growing body of literature on effective teacher education (e.g. Adler, 2004; Darling-Hammond, 2006; Korthagen, 2001; Loughran, 2006). In *Powerful Teacher Education: Lessons from exemplary programmes*, Darling-Hammond suggests that in

order to "prepare teachers so they are ready to enter teaching armed with knowledge and skills enabling them to serve diverse students well and learn continuously from their practice" (2006, p. 276), teacher education programmes should demonstrate the following elements:

- Coherence based on a vision of good teaching that permeates the programme,
- A strong core curriculum,
- Extensive practical teaching experience,
- An inquiry approach, and
- Assessment based on professional standards. (Darling-Hammond, 2006, pp. 276-277)

These broad categories cover a wider range of aspects than will be addressed in this study, but it is significant for this study that "a strong core curriculum" (which should be embedded in the materials of the course) is a key element. This part of the literature review expands on how materials can contribute to the core curriculum for effective teacher education programmes.

2.3.2 Curriculum requirements for effective teacher education

The ACEMaths materials have been developed to be used in maths teacher education programmes in South Africa (although they are open to use by others). In developing countries (such as South Africa) teacher education is particularly important as education is seen as one of the main levers for development identified by UNESCO (Iredale, 1996). According to Iredale, one of the short-comings of teacher education in developing countries such as South Africa is that teacher development programmes tend to focus on subject content upgrading. In contrast to this view, some writers feel that content upgrading is the most crucial aspect of teacher development (Taylor & Vinjevold, 1999). Adler, in her research for the QUANTUM project, is concerned about a balance between content and pedagogy. In looking for this balance she is "concerned with the mathematics … school teachers need to know and know how to do in order to teach mathematics successfully in South Africa's diverse classroom contexts" (Adler, 2004, p. 1). The QUANTUM project research has shown that in South Africa mathematics courses for teachers are often either too pedagogical or too mathematical.

There is a growing recognition that the content of a teacher education programme needs to give attention to both content and pedagogy (Adler, 2004; Darling-Hammond, 2006; Loughran, 2006). Darling-Hammond describes the "professional knowledge base" needed by teachers in addition to basic content knowledge in their field. For materials to be effective in providing input for this knowledge base, they need to offer information in three general areas:

> 1. Knowledge of learners and how they learn and develop within social contexts
> 2. Conceptions of curriculum content and goals – understanding of the subject matter and skills to be taught in light of the social purposes of education
> 3. Understanding of teaching in light of the content and learners to be taught, as informed by assessment and supported by productive classroom environments. (2006, p. 83)

These areas roughly correspond to Shulman's notions of pedagogic knowledge, content knowledge and pedagogic content knowledge (1986), interpreted for the field of mathematics teacher education, although Shulman does not emphasise the social context or purpose of learning. He argues that teachers need to know about learners and learning (point 1 above) and they should know their mathematical content (point 2 above). In addition to this, in order to be able to teach mathematics more effectively, they need to know about how that content is learned and the implications of this (point 3 above) for teaching the content. This means that in the South African context teacher education programmes and the materials used in these programmes need to be developed to provide the input needed (both content and pedagogical) so that teachers are able to develop their conceptual knowledge in practice (Adler et al., 2002).

But the curriculum of a programme is about more than just the content. The design of the overall programme and of its supporting materials contributes towards the delivery and overall impact of the courses. Jonathan Jansen has discussed the powerful effect of knowledge transmitted through teaching styles which can have an even greater impact than the content of what is being taught (Jansen, 2009). The OER nature of the materials and the collaborative style of development are more democratic and could enable lecturers to take ownership of the materials since they have been involved in their adaptation. If this process of democratisation could then be embodied in the delivery of the materials, students enrolled for the programme

could experience similar benefits of a more participative, democratic learning experience.

2.3.3 Understanding the role of materials in teacher education courses

OER are materials and thus an understanding of the role of materials in teacher education courses lies at the heart of the project. Materials play a role in almost every aspect of an educational course, but four key roles will be discussed here. The NADEOSA Quality Criteria Task Team worked between 1996 and 1998 to develop a framework for quality distance education[30]. The team developed thirteen standards/criteria representing the main institutional elements of distance education provision. OER materials have the potential to play a role in at least four[31] of the criteria on the list:

- Programme development;
- Course design;
- Assessment;
- Materials. (Welch & Reed, 2005, p. 9)

In the outline for the Council on Higher Education (CHE) *National Review of the ACE qualification* (2006), criteria 1, 2 and 7 on their list[32] relate to programme development, course design and assessment. This indicates the significance of these aspects to teacher education in the view of the CHE. Criterion 1 "The National, Institutional and Unit Context" specified elements of programme development with reference to the *Norms and Standards for Educators* (DoE, 2000), amongst others. Criterion 2 "Programme design" was about course design. Criterion 7 related to student assessment.

[30] The NADEOSA quality criteria used in this section are intended to apply to both distance and other modes of teacher education. The 1998 *Quality Criteria* list was initially not published as a policy document, because generally it was thought that the criteria should inform standards required for all (and not just distance) educational provision. It was subsequently published in 2005.
[31] The other nine NADEOSA criteria are Policy and planning; Learners; Learner support; Human resource strategy; Management and administration; Collaboration; Quality assurance; Marketing; Results. (Welch & Reed, 2005, p. 9)
[32] The other seven CHE (2006) criteria are Student Recruitment, Admission and Selection; Staffing; Teaching and Learning; Programme coordination; Infrastructure and Library Resources; Student retention, Throughput rates and Programme Impact and programme Reviews.

In the SAIDE Materials Design Wheel (2008), programme design, course design and materials design are seen as three separate (though interlinked) levels of design. Assessment is presented as one of strands which needs to be taken into account on each of these levels. Overall programme and course design have to support and facilitate the methodologies and approaches that are designed into the materials. The SAIDE Materials Design Wheel and Concept Document is used extensively in the discussion on providing for quality in materials for teacher education courses that follows. Curriculum expert Bob Moon has endorsed the standards and material of SAIDE. For example in his review of a SAIDE publication *Learners and Learning* he concludes that SAIDE is "to be congratulated on establishing a benchmark that all of us building new courses should seek to emulate" (2002, p. 27).

2.3.3.1 Programme development

At programme level, planning needs to make provision for "structural links between courses, timing, administration etc., taking into account the national and local contexts" (SAIDE, 2008, p. 3). Decisions relating to content are also made at the programme level, to make sure that there is sufficient content across the programme to provide a scaffold towards the concepts that make up the body of the programme (SAIDE, 2008). A superficial curriculum is one of the problems identified in poor teacher education programmes (CHE, 2004; Darling-Hammond, 2006). Programmes need to be driven by quality and effectiveness, and materials used should be actively revised to improve and contribute towards teacher education programmes (Darling-Hammond, 2006; Ridge & Waghid, 2000). The NADEOSA criterion for programme development reads:

> Programmes are flexible and designed with national needs as well as the needs of prospective learners and employers in mind; their form and structure encourage access and are responsive to changing environments; learning and assessment methods are appropriate to the purpose and outcomes of the programmes. (Welch & Reed, 2005, p. 23)

Under programme curriculum the following elements of the criterion are listed:

> 3.11 The outcomes, content, teaching and learning strategies and assessment methods in the programmes are aligned and appropriate for the level and purpose of the programme.
>
> 3.13 The various courses of the programme are integrated.

> 3.14 To facilitate conceptual pathways through the programme, due attention is paid to the appropriate sequencing of modules/courses in a programme, and to the management options. (Welch & Reed, 2005, p. 24)

Materials developers do not always make the decisions about programmes, but they should be aware of the structure and purpose of the programmes for which they are developing materials, so that they carry out their task appropriately. SAIDE quotes Randell (2005) in suggesting three important questions to guide good decision making with respect to materials: "who the audience is, what the purpose of the programme is and how the learning resources will be used" (SAIDE, 2008, p. 5). OER with the potential for integration into teacher education programmes need to be evaluated by programme providers with these questions in mind before they are taken-up.

2.3.3.2 Course design

As SAIDE has emphasized in numerous publications, the course is more than the materials it is the structure of learning that is designed into those materials (SAIDE, 1994). The NADEOSA criterion for course design reads:

> The course curriculum is well-researched, with aims and learning outcomes appropriate to the level of study; content, teaching and learning and assessment methods to facilitate the achievement of the aims and learning outcomes; there is an identified process of development and evaluation of courses. (Welch & Reed, 2005, p. 26)

Elements of the criterion are expanded in the publication to flesh out aspects of course planning, course curriculum and quality assurance. In a Mathematics Education module there should be a balance between the mathematics content and the pedagogical content designed into the course outline (Adler, 2004) and materials selected for use in a course should reflect this balance. To adapt an existing module one needs to review the curriculum and structure of learning designed into the source module, and adapt where necessary.

Course design decisions need to be made regarding the learning pathway(s), pacing, language and resources, since "diverse audiences can have an effect on the purpose of materials, or the way in which they are used" (SAIDE, 2008, p. 4). The "course design has to support and facilitate the methodologies and approaches designed into

the learning spiral[33] at the materials level" (SAIDE, 2008, p. 4). Courses should model "a learning environment where there is access to integrated and relevant study/academic skills" (SAIDE, 2008, p. 5). Materials selected for use in a course should hence provide opportunities for active engagement in learning activities. They should be relevant and provide learner support towards integration of knowledge and skills developed through the course and the full course programme.

2.3.3.3 Assessment

In a constructivist learning environment assessment is for learning. "Social constructivist perspectives require much more than a reorientation of the interrelationship between teaching, learning and assessment; at their heart they see the latter as embedded within the teaching and learning process" (Adams, 2006, p. 252). This is in accordance with the view of assessment put forward in the NSE (2000) and in the current South African curriculum documents. Assessment needs to be considered at the programme design and course design levels, and it needs to be designed into the materials. "Assessment requires its own comprehensive strategy, but is fundamentally linked to the learning process" (SAIDE, 2008, p. 4). At the programme and course levels, a broad assessment strategy needs to be devised to "ensure linkages across and between modules" (SAIDE, 2008, p. 4). At the materials level, the assessment is contained in activities, designed into the text, "integrated and sequenced on the learning pathway" (SAIDE, 2008, p. 6). These activities should correspond with the broader assessment strategy for the programme and course.

Designing assessment into a course and course materials is especially important in distance learning. This is because learners will "engage with the materials primarily in relation to tasks set for assessment" (SAIDE, 2008, p. 6) and they need to have a means of establishing their progress. Assessment, in particular formative assessment which is assigned marks, can motivate a learner to work through a course (by working through the materials) since this can provide them with an "opportunity to receive

[33] SAIDE works within a constructivist framework of learning and has developed the idea of a "learning spiral" to describe the learning process. The spiral involves learners engaging in learning activities which they reflect on (guided by a mediator which could be a teacher or mediation designed into materials). This active reflection builds on learners existing knowledge and draws them towards understanding (learning) of new knowledge, in an ever circling spiral of learning as they progress thought a series of activities in a similar manner (Moll & Drew, 2008).

individualised feedback on their work" (SAIDE, 2008, p. 6). In distance learning most learners are fitting their studies into already full lives and "if an activity is not compulsory, there is the tendency to overlook it" (SAIDE, 2008, p. 6). Planning (by learners) in distance learning, and assessment can help them to plan their study time and make the most of the limited time available to them to complete the course.

2.3.3.4 Course materials

Materials designed for distance education should be subject to the most stringent quality standards (Lockwood, 1994; Rowntree, 1994; Welch & Reed, 2005). "At the level of materials design the quality process is itself a cycle of writing, editing, critical reading, trialing, developmental testing, feedback and redesigning and re-writing" (SAIDE, 2008, p. 7). The NADEOSA criterion for course materials reads:

> The content, assessment, and teaching and learning approaches in the course materials support the aims and learning outcomes; the materials are accessibly presented; they teach in a coherent way that engages learners; there is an identified process of development and evaluation of course materials. (Welch & Reed, 2005, p. 28)

Elements of the criterion are expanded in the publication to flesh out aspects of materials development such as planning, quality course materials and quality assurance. Planning is key to materials design and all other design elements should support the planning decisions (SAIDE, 2008, p. 5). The learning process designed into the materials should be developmental and place demands on the learners (and in turn learning support tutors). The learning spiral[34] through the materials should be designed to give learners "access to knowledge and new ideas, and guidance to think about what they did, whatever thoughts they had, or answers they gave, and why and how they came to have new ideas and new knowledge" (SAIDE, 2008, p. 5).

Content in learning materials should be presented as a sequential, structured dialogue, to enable learners using the materials to follow the learning pathway that has been designed (SAIDE, 2008, p. 5). Content needs to be supported by active learning models (Lockwood, 1994). Content is also influenced by context (SAIDE, 2008, p. 5). Robinson and Zinn (2007) emphasise the importance of preparation of teachers for

[34] See the discussion of the SAIDE Learning Spiral in 2.3.3.3.

diverse classes in the South African context. Definitions of diversity vary. Some, which emphasise commonalities in difference are seen as educationally useful, while others that stress differences and advocate separation according to differences are not (Inglis, 2004; DoE, 2005; Morrow, 2007). Materials should put forward a systemic view of diversity, which acknowledges the complexity of differences and similarities in a system where individuals need to work together towards achieving excellence rather than be set apart and isolated from one another in order to fulfil their potential (Inglis, 2004; DoE, 2005).

The context "helps to determine the learning pathway that you want to establish in the learning process, and which is reflected in the materials design" (SAIDE, 2008, p. 7). Materials should be structured to support the learning pathways that were identified in the planning stage at programme and course design levels (SAIDE, 2008, p. 7). Resources can be integrated into the materials or referred to as "external" resources to be used in conjunction with the designed materials. Learner support needs to be written into the materials in some way, but also "there will be times when learners require face-to-face support from another person or people, such as other students, tutors or lecturers" (SAIDE, 2008, p. 7). This leads into the next section, on mediation of materials.

2.3.4 The role of mediation

Observation of mediation of OER at take-up sites can give insight into individual use and adaptation of materials. Materials can support teacher educators and teachers but materials are not equivalent to education. The way in which different educators mediate the same materials adds different value to the materials. This is just one of the aspects of take-up to be considered in this study and a brief discussion on some points raised in the literature follows.

There is a role for "others" in individual construction of learning because through mediation, "others" help to provide the context in which construction of knowledge can take place (Vygotsky, 1978). Some mediation can be written into the materials themselves – this is the goal of distance education materials – but sometimes this is not sufficient, or at least it can be enhanced by lecturer mediation. According to Ridge

and Waghid, “even when students are provided with high quality materials, it seems that in-person support remains important” (2000, p. 97). For mediation to be effective sufficient time needs to be allocated to it (Bezemer & Kress, 2008). Students interacting with a distance education text independently need to give themselves enough time to make effective use of the activities designed into the materials to mediate their independent learning process. Lecturers need to design programmes with consideration to the time they will allocate to mediation of learning.

Korthagen asserts that mediation of materials is essential, and the way in which materials are mediated will impact on their effectiveness (2001). Korthagen emphasises the importance of linking practice and theory (2001). In his view learning takes place when there is an interplay between practice and theory. Loughran (2006) argues strongly for developing a pedagogy of teacher education in which teacher educators do not just model practice but engage students actively in reflective practice. The ideas of Korthagen and Loughran here suggest that mediation enables learners to reflect on theory while engaging in practice, under the guidance of the lecturer.

A community of teacher educators has the potential to develop educators to provide the interplay between practice and theory, hence furthering the ends of effective teacher education. Cochran-Smith (2004) discusses the development of a community of “teacher education practice”. Communities of practice will be discussed in the next section of this chapter but they are of relevance here in relation to their potential for providing a forum for ongoing discussion between teacher educators about mediation of materials. In such a forum materials can be evaluated on an on-going basis by all members. Participation in a conversation amongst teacher educators about how to most effectively mediate materials is likely to benefit both the teacher educators and their students.

According to Korthagen (2001), teacher education needs to move (and move teachers) away from a traditional approach to mediation. With reference to school mathematics, the “traditional approach” sets the maths teacher in front of the class, teaching concepts to learners. They often simply write exemplars of procedures and explain algorithms rather than mathematical concepts. In a “traditional classroom” passive

learners sit and write down everything the teacher says and then do their maths by copying and revising the algorithms that have been shown to them. It can be argued that materials used in teacher education should present a challenge to the traditional approach and that presentation of teacher education materials should be done using an approach that involves active participation and reflection. Korthagen suggests that at all levels of teaching, active involvement (and reflection) needs to be stimulated, and teacher educators in particular need to reconsider what is involved in the process of learning to teach. A move away from the traditional approach involves change. Institutional investment in existing programmes, particularly in the university context, might not promote such change (Darling-Hammond, 2006). Materials that embody a "new" approach could support lecturers in adopting the new approach and move against institutional inertia.

2.3.5 Teacher education and change

Teacher development implies teacher change (Clarke & Hollingsworth, 2002). Fullan (1993) has shown that many professional development programmes fail to consider the process of teacher change. OER which can be freely adopted and adapted could be useful to individuals within institutions who wish to change aspects of their courses. Materials need to be written in such a way that they promote change without undermining the self-confidence of teacher educators or their students. They need to inspire change by demonstrating the potential of the effective methods which they present. Darling-Hammond (1996) in her discussion on effective teaching argues that the materials used in teacher education programmes can promote growth and change if they are of the appropriate quality and have appropriate content[35]. Change and innovation are essential to the continued improvement and development of any teacher education programme (Darling-Hammond, 2006; Fullan, 1993).

Transformation of programmes cannot be driven solely by individuals and needs the support of the institution in order to be successful (Fullan, 1993). Lecturers could however use OER as a catalyst for change (Bateman, 2008) in individual courses. If they are to provide a catalyst for change, OER materials should have the potential to support a strong core curriculum, be of high quality and be effectively presented.

[35] See 2.3.3.4.

Change can be fostered by the formation of communities of learning[36] which are established around the transformation of teaching and learning practices (Geser, 2007).

Adler describes a move away from thinking simply about teacher change which could lead to a discussion of the failure of teachers to "meet the ideals of reform" (Adler, 2002, p. 9). She refers to "a new discourse in teacher education literature … talking about *teacher learning* rather than teacher change" (Adler, 2002, p. 9). Learning results in growth, and growth generally leads to change. An investigation of lecturer learning can inform the analysis of change enabled through materials, such as the ACEMaths materials, in a take-up study.

The ACEMaths materials were developed collaboratively by a team of mathematics teacher educators for use in their institutions and ultimately by a wider audience. Literature on communities of practice is now discussed as it too is used in the analysis of the take-up data.

2.4 Communities of practice

The concept of communities of practice (Lave & Wenger, 1991; Wenger, 1998; Wenger, McDermott & Snyder, 2002) offers a theoretical framing for an analysis of the development and take-up of the SAIDE ACEMaths materials. "Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al., 2002, p. 4). Different communities of practice have different features. They can be different sizes, they may be long-lived or short-lived, they may be distributed or collocated, they may be homogeneous or heterogeneous, they may be within or across boundaries, spontaneous or intentional, unrecognised or institutionalised (Wenger et al., 2002, p. 24-27). Within a community of practice, learning can and does take place through participation and in this part of the literature review I discuss aspects of Lave and Wenger's theory which have relevance for this research.

[36] Communities of practice are discussed in the next section of this literature review.

2.4.1 Materials design in a communities of practice context

Materials and programmes can be designed in accordance with the principles of communities of practice articulated by Lave, Wenger and others. The fundamental principle is that learning takes place through participation (at various levels) in the community. According to Wenger "learning cannot be designed … and yet there are few more urgent tasks than to design social infrastructures that foster learning" (Wenger, 1998, p. 225). This implies the importance of facilitating the learning process through community design. Wenger et al. (2002) argue that one should not "launch communities for their own sake, but … build the organization's overall capacity to learn and innovate" (pp. 190-191). They suggest that:

> The best way to develop a knowledge organization is through a guided evolutionary process that tests multiple approaches and builds on experience over time. … The important thing is to start something, see what energy it elicits and build from there. (pp. 191-192).

Materials design in a community of practice can follow this evolutionary path. The design process sets in motion the participation of the community members and evolves with their input. This is in the community of the designers of materials. The materials themselves will then be used in educational settings, eliciting further participation of members of a different community. Participation in educational contexts is usually based on materials. Thus the impetus for energy in a learning community is generally created, at least partially, by the materials, pointing to the importance of well designed learning materials.

2.4.1.1 Design for learning through active participation

Key to design in communities of practice is a social theory of learning (Wenger, 1998). From a social perspective, "learning changes who we are by changing our ability to participate, to belong, to negotiate meaning" (Wenger, 1998, p. 226). Participating in the design and re-design of materials[37] could foster learning. Involvement in the process of materials design would give lectures the opportunity to develop their design skills. Active participation on the part of lecturers would result in them learning more. From a communities of practice perspective one should "design a little – implement a lot" (Wenger et al., 2002, p. 191) in order to elicit passion and

[37] See 2.3.

participation of community members. This appears to contradict the design principles in the SAIDE criteria which are highly specified and could lead one believe that the elements of design are all predetermined and there no room for "evolution". But Wenger is referring to an ideal context where an active community of practice exists. In such a community, the activity of designing takes place through participation, and "implementation" is actually active participation in materials design.

The spiral of learning (within a constructivist framework) devised by SAIDE was put forward as the approach to learning that should be embedded in materials design. This is not the same as participatory learning, but it is not entirely at odds with the participation metaphor[38] since it requires active participation in and reflection on activities for learning to take place. The difference is that for learning to take place according to the constructivist framework, the activity could be mediated by a tutor or a text, whereas learning according to the participation metaphor can only take place within a community of practice.

2.4.1.2 Interactive self-mediating materials

Mediation by a lecturer who facilitates of active participation in a learning community, would be preferable to learning in isolation, but this is not always feasible in the South African context. Mediation in materials is central to distance education. Where distance learning is necessary, design of interactive materials that enable learners to follow a well designed learning pathway can enable learning that would otherwise not be possible. Such materials should be able to mediate the content through activities which are designed into the text (SAIDE, 2008). This mediation through the text provides the individual user with a means to "participate" in the learning process, even if not in a community of practice.

2.4.1.3 Activity systems for instructional design

Thus as has been shown, although learning cannot be designed, materials can be used to support the infrastructure that supports learning, and these materials need to be based on sound instructional design. Activity theory can provide a framework for the

[38] See 2.4.4.

design of constructivist learning environments (Jonassen & Rohrer-Murphy, 1999). One of the fundamental assumptions of activity theory is that activity is a precursor to learning. The role of the instructional designer (and every teacher educator using the SAIDE pilot OER materials becomes an instructional designer) is to "interpret the rules and roles of the community" (Jonassen & Rohrer-Murphy, 1999, p. 66) and to embed these in the series of activities that are designed. The usefulness of the designed materials can be understood in the context of the activity, "by looking at the way people use it, the needs it serves, and the history of its development" (Jonassen & Rohrer-Murphy, 1999, p. 67). In terms of the SAIDE pilot OER initiative, there are three activity systems involved. The first is the original development team. The second is the individual users in each of their sites, who have to adapt the materials to suit both their and their students' needs. The students using the materials are a third.

2.4.1.4 Designing in distributed communities of practice

Within the boundaries of a community "based on Open Source Software and Open Content … innovation will occur" (Attwell, 2006, p. 5). Attwell calls this an "activity system" through which participants interact with others and technology to create OER. The ACEMaths community is an example of a distributed community of practice, which Wenger et al define as "any community of practice that cannot rely on face-to-face meetings and interactions as its primary vehicle for connecting members" (Wenger et al., 2002, p. 115).

Distributed communities of practice face challenges which can make building and sustaining these communities difficult. These challenges may be experienced in relation to four factors: "distance, size, organizational affiliation and cultural differences" (Wenger et al., 2002, p. 116). Distance can present challenges to a community if members are located far apart and technology does not present sufficient possibilities for them to interact. In addition to this, technologies "are not real substitutes for face-to-face interaction" (Wenger et al., 2002, p. 116). If a community is too large or too small this can present challenges, since there may be too many members to coordinate or too few to maintain a lively community. Organisational affiliation can present challenges in relation to the community members' willingness to share knowledge. "Such issues can be particularly big

stumbling blocks for communities that span several different organizations, where intellectual property is a source of competitive advantage" (Wenger et al., 2002, p. 117). National, organizational and professional cultures can present problems in diversified communities. Cultural differences impact predominantly on communication – both face-to-face and through technologies (Wenger et al., 2002, p. 118). The implications of these challenges for participants in a collaborative development community may explain either their resistance or willingness to participate in such a community.

2.4.2 Cultivating communities of practice

Wenger has argued for reconceptualising education, because "we need to think about education not merely in terms of an initial period of socialisation into a culture, but more fundamentally in terms of rhythms by which communities and individuals continually renew themselves" (Wenger, 1998, p. 263). Wenger et al, in *Cultivating Communities of Practice*, discuss seven principles for cultivating communities of practice. They explain that they make these principles explicit, because this "makes it possible to be more flexible and improvisational" (2002, p. 51). The design principles are:

1. Design for evolution.
2. Open a dialogue between inside and outside perspectives.
3. Invite different levels of participation.
4. Develop both public and private community space.
5. Focus on value.
6. Combine familiarity and excitement.
7. Create a rhythm for the community. (Wenger et al., 2002, p. 51)

The first principle, "Design for evolution" is followed if there is a catalyst for community development. If the catalyst is there, the community will evolve naturally since "evolution is common to all communities, and the primary role of design is to catalyze that evolution" (Wenger et al., 2002, p. 54). The second principle "Open a dialogue between inside and outside perspectives" stresses the need for insider perspective in the initial development of the community with reference to outsider perspectives which may enable insiders to see new possibilities and "effectively act as

agents of change" (Wenger et al., 2002, p, 55). The third principle, "Invite different levels of participation" refers to the diverse nature of a community and different levels of participation naturally evident in a community: a co-ordinator who will be part of the core group but in addition to this, as part of the group there are also active members and peripheral members. Wenger *et al* suggest that peripheral membership is meaningful, arguing that, "peripheral activities are an essential dimension of communities of practice" (Wenger et al., 2002, p. 56). The expectation that all members will have the same level of participation is unrealistic "because people have different levels of interest in the community" (Wenger et al., 2002, p. 55). For continued growth of a community, members should move through the different levels of the community by being given different opportunities to expand their participation in the community.

The fourth principle, "Develop both public and private community space", emphasises the relationships between community members and the need for these relationships to be given opportunities to deepen in one-on-one "private spaces". The private and public dimensions of a community are related and "when individual relationships among community members are strong, the events are much richer" (Wenger et al., 2002, p. 59). The fifth principle, "Focus on value", highlights the importance of awareness that the community can offer value to its members. Community membership is most often voluntary and members need to be made aware of and to accept the value offered to them by the community. Community discussions assessing the value of the community help the "members as well as potential members and other stakeholders understand the real impact of the community" (Wenger et al., 2002, p. 61). The sixth principle, "Combine familiarity and excitement" emphasises the need for the community space to offer members a safe familiar space but also a space for conferences and workshops where the latest ideas are discussed. "Create a rhythm for the community", the seventh, and final principle highlights the idea that "the rhythm of a community is the strongest indicator of its aliveness" (Wenger et al., 2002, p. 63). The rhythm of the community needs to be regular and at a pace that gives the community

> … a sense of movement and liveliness. If the beat is too fast, the community feels breathless; people stop participating because they are overwhelmed. When the beat is too slow, the community feels sluggish. (Wenger et al., 2002, p. 63)

Communities of practice can develop naturally, but "an appropriate amount of design can be a powerful tool for their evolution … [and] growth" (Wenger et al., 2002, p. 63). Evidence of design according to these principles in the SAIDE ACEMaths community will show the extent to which it was designed, functioned and can continue to function as a community of practice.

2.4.3 Enabling peripheral participation in communities of practice

Lave and Wenger (1991) argue that learning takes place through "legitimate peripheral participation". This requires that "newcomers" to a community become involved in the activities of the community and ultimately change their status from "newcomers" to "old-timers" through participation in the community.

> The key to legitimate peripheral participation is access by newcomers to the community of practice and all that membership entails. But though this is essential to the reproduction of the community, it is also problematic at the same time. (Lave & Wenger, 1991, p. 100)

The problem to which Lave and Wenger refer is the potential for access to the community to be manipulated in a way that prevents legitimate peripheral participation. They say that "access can be denied by not giving productive access to activity in communities of practice" (Lave & Wenger, 1991, p. 103). One finding from Mary Lea's investigation of university students' first engagement with academic literacies, was that peripheral participation in higher education can be limited by a "gatekeeping role of university writing" (Lea, 2005, p. 193).

Lea critiques the Wenger 1998 and Wenger et al 2002 publications arguing that in these publications Wenger "is moving closer to the idea of an educational model and further from the heuristic qualities present in the original publication" (Lea, 2005, p. 185). She asserts that "in Wenger (1998), he does develop the concept of communities of practice further and makes some direct reference to learning communities in educational settings, suggesting that educational design should be concerned with supporting the formation of learning communities" (Lea, 2005, p. 185). But she argues that this subtle shift has moved the theory away from providing "an understanding of the way in which organic communities of practice function, towards one of design and support for learning communities" (Lea, 2005, p. 185).

Designing a learning community according to a communities of practice model shifts the focus from critique to design and implementation. This could forgo the use of the concept of communities of practice as a heuristic, which would enable "exploration of the ways in which learning does or does not take place and [foreground] not just success but also constraints on learning and on full participation in the community's practices" (Lea, 2005, p. 188). Consideration needs to be given to how the negotiation of peripheral participation in the ACEMaths community could facilitate and sustain (or inhibit) community membership and growth.

2.4.4 The participation metaphor and the acquisition metaphor

Sfard (1997) writes of two metaphors for learning: the participation metaphor and the acquisition metaphor. She argues that there are dangers in choosing just one to explain the learning process. The participation metaphor refers to learning that is on-going and takes place in a context, while the acquisition metaphor refers to learning that involves gaining ownership over some kind of self-sustained entity. Both metaphors are useful for this study. Both types of learning can take place within a community of practice for those who are prepared to "try to live with both" (Sfard, 1997, p. 10) since each metaphor can be seen as "offering differing perspectives rather than competing opinions" (Sfard, 1997, p. 11). Communities of practice can provide a space where ongoing learning and development (according to the participation metaphor) as well as constructivist learning (according to the acquisition metaphor) can take place. But for this to be achieved and continued, the communities need to be active.

2.5 Conclusion

In this literature review I first introduced OER, their potential and some challenges faced by developers of OER in the provision of materials for the broad field of education. There is an indication that the utopian vision of OER involving "sharing back" is fading, although OER are still very much about sharing. To be successful, sharing assumes access. Access is a perennial issue for designers and users of materials, with the added dimension of technological access in the domain of OER.

The second part of the review focused on materials for effective teacher education. Mediation of materials is key to their success. In distance education the goal is to design mediation into the materials, but the literature reviewed suggests that students will always benefit from additional mediation, even when they are provided with high quality materials.

Finally, aspects of communities of practice relating to materials design were discussed. Collaboration in the development of materials can result in the formation of communities of practice among teacher educators and students at their institutions. Participation is key to the involvement in a community. Technological infrastructure is important for any community of practice, but technology alone is not sufficient to establish and maintain participation in a community.

The literature on OER, materials design and communities of practice discussed above is used in the presentation and analysis of data in Chapters Four and Five.

Chapter 3 Research Methodology

3.1 Introduction

This research project is a practice-based case study of cases (Adler & Reed, 2002) in which varying uses of the SAIDE ACEMaths OER in a range of institutional sites, constitute the individual cases. The research is essentially qualitative in that data has been gathered from a small group of mathematics teacher educators[39]. Case studies, and in this research a case study of cases, are recognised as one form of qualitative research (Bassey, 1999; Gillham, 2000). Qualitative research has been found to be particularly relevant in educational settings, where case study data enables detailed description of the setting and findings which can then be analysed (McMillan & Schumacher, 2006). Bassey identifies three different kinds of educational case studies: theory-seeking and theory-testing case studies (which are particular studies of general issues), story-telling and picture-drawing case studies (which are analytical accounts aimed at illuminating theory) and evaluative case studies (1999). Bassey describes evaluative case studies as "enquiries into educational programmes, systems, projects or events to determine their worthwhileness, as judged by analysis by researchers, and to convey this to interested audiences" (1999, p. 58). This research is an evaluative case study of the SAIDE ACEMaths project to determine what can be learned from the take-up of the materials so that interested parties can apply these lessons to similar projects.

Since the starting point of a case study is the collection of data, case studies are empirical enquiries which are "conducted within a localised boundary of space and time; into interesting aspects of an educational activity … mainly in its natural context and within an ethic of respect for persons" (Bassey, 1999, p. 58). This research was carried out in six different educational sites where the ACEMaths materials were being piloted. As stated in Chapter One, the aim of this research is to investigate the take-up of materials and ways in which this take-up can inform further development of both these materials and other similar OER development projects. Take-up of

[39] A small part of the data from the student questionnaires relating to ownership of or access to computers was quantitatively analysed.

materials involves aspects of use such as selection, orientation, preparation and evaluation of the materials and all of these were taken into account in this research. As an evaluative case study, the study sets out to illuminate these aspects of the take-up of the material and so it can most specifically be referred to as an illuminative evaluative case study (Bassey, 1999). While this study is too small to lead to generalisations, Bassey (1999) writes about the potential of case studies to lead to "fuzzy generalisations". He argues that, "the concept of 'fuzzy generalisation', coupled with coherent case study reports, is a valuable way of bringing educational research findings into professional discourse" (Bassey, 1999, p. 57).

3.2 Research sites and research participants

The research sites (6) are all teacher education entities within universities in South Africa. In two instances these entities are NGOs affiliated to universities. The research participants (10) are mathematics teacher educators (lecturers), mathematics teacher-learners (students) involved in the development, piloting and revision of the ACEMaths materials. Lecturers became involved in the SAIDE ACEMaths project voluntarily. Once they were involved in the materials development they were asked to participate in the pilot implementation of the materials so that the quality and usefulness of the ACEMaths materials could be researched and evaluated. Not all lecturers involved in the materials development participated in the pilot implementation due to various constraints which are discussed below. Students (266) were involved through their lecturers' participation in the pilot implementation.

3.2.1 Lecturers

The lecturer participants and their sites are listed in Table 3.1 below. The ten participating sites are named using upper case letters from A to J. Lecturers from the first six sites took part in the pilot implementation study. Lecturers from the other four sites participated in different ways, as shown in the table and discussed below. Seventeen lecturers at ten sites[40] were involved in the materials development process.

[40] Two of the sites were situated at one participating institution and hence nine tertiary institutions were represented in the process.

Not all lecturers participated in the same way, but each has been numbered and will be identified by this number throughout this dissertation.

Table 3.1: Lecturer participation by site (2007)

Site	Lecturers	Involvement
A	Lecturer 1 Lecturer 2	Development Pilot Revision
B	Lecturer 3 Lecturer 4	Development Pilot Revision
C	Lecturer 5	Development Pilot Revision
D	Lecturer 6	Development Pilot Revision
E	Lecturer 7 Lecturer 8 Lecturer 9	Development Pilot Revision
F	Lecturer 10	Development Pilot Revision
G	Lecturer 11 Lecturer 12	Development Withdrew from pilot Revision
H	Lecturer 13 Lecturer 14	Development Revision
I	Lecturer 15	Development
J	Lecturer 16 Lecturer 17	First workshop only

Participation was voluntary and as can be seen from the table it varied for different participants, though the majority of participants were involved for the full development, revision and implementation process. Ten of the lecturers were involved in the pilot implementation, 15 were involved in the materials development process and 14 were involved in the materials revision process. Site G lecturers participated in the materials development and revision process, but withdrew from the pilot implementation. Lecturers from Site H were involved in the development and revision of the ACEMaths materials but did not volunteer for the implementation phase since the lecturers were unable to identify a course in which they would be able to use the materials in 2007[41]. The lecturer from Site I was involved in the development of the ACEMaths materials but did not volunteer for the implementation phase and was not involved in the revision process. Site J lecturers attended the initial workshop and

[41] The lecturers at this site identified two courses in which the ACEMaths materials could be used in 2009 subsequent to the pilot implementation.

then withdrew from the process. The ten lecturers (Lecturers 1 – 10) who were involved in the pilot implementation were the main participants in this study.

3.2.2 Students

The students at the institutions at which the ACEMaths materials were piloted formed another group of participants. The number of students enrolled at each institution varied according to the different courses. Most of the students registered for the programmes in which the ACEMaths materials were used were teachers enrolled in in-service programmes to up-grade their qualifications. Following the work of Mays (2001), Deveruex and Amos (2005), and others, they are referred to as teacher-learners. Some of the students were involved in initial pre-service teacher training and these are referred to as learner-teachers. Because of the complexity of referring to different student-groups more specifically as "teacher-learners" or "learner-teachers" all students are simply referred to as students in this dissertation. A summary of the student participants is provided in Table 3.2 below.

Table 3.2: Student participation by site (2007)

Site	Course	Number of students	Pre-service/In-service
A	Course 1 Course 2	15 15	In-service In-service
B	Course 1	45	In-service
C	Course 1 Course 2	20 6	Pre-service Pre-service
D	Course 1	35	In-service
E	Course 1 Course 2	30 60	In-service In-service
F	Course 1	40	In-service and pre-service

3.3 Research Instruments

According to Bassey (1999) case study research needs to be conducted in such a way that sufficient data are collected by the researcher for the purposes of the research. Bassey gives several reasons why sufficient data need to be collected, including that the researcher should be able to, "explore significant features of the case, create plausible explanations of what is found, test for the trustworthiness of these interpretations and construct a worthwhile argument or story" (Bassey, 1999, p. 65) In qualitative research, where findings are based on analysis of the data, it is important to include data from several sources, particularly if these sources can be used together to increase the validity of the findings. Several research instruments were used to allow

for triangulation of the data in this study (McMillan & Schumacher, 2006; Silverman, 1993). These include questionnaires (lecturer and student), lecturer interviews and session observations, artefacts in the form of adaptations of the ACEMaths materials as well as assessment tasks based on the OER. The research instruments are discussed below and the administration of the instruments is explained in section 3.4 of this chapter.

3.3.1 Lecturer questionnaires

Four questionnaires were ultimately completed by the lecturers who piloted the ACEMaths materials. The first (Appendix A) was developed in consultation with the pilot materials project leader. It was used to obtain programme background and information on intended use of the ACEMaths materials from the participants. The second (Appendix B) was drawn up to obtain information on actual use of the ACEMaths materials by the participants. At the end of the implementation phase, two additional lecturer questionnaires were drawn up after the data analysis had begun and some additional questions had emerged. The third questionnaire (Appendix C) focused on actual and intended use of the ACEMaths materials to probe the participants' views on differences/similarities between these uses. The fourth questionnaire (Appendix D) probed the lecturers' views on presentation and mediation of the ACEMaths materials and obstacles to the use of the materials.

3.3.2 Lecturer interviews

Data were also collected through the use of interviews. In the interviews I tried to probe the lecturers' own perception of their implementation of the SAIDE OER, the usefulness of the materials and the ways in which their students had worked with the materials. The questions focused on the use, adaptation and assessment of the SAIDE OER. There were also questions relating to the observed session and the quality of the ACEMaths materials. The interviews ranged from 45 to 90 minutes in length. All nine of the lecturers using the ACEMaths materials (except myself) were interviewed. The interviews were carried out at the same time as the site visits for the observations[42].

[42] Except at Site C where the interview was carried out in July, but the session observation was done in September, of 2007.

Interviews provide the opportunity for the collection of more detailed data than questionnaires since the discussion in an interview can flow more easily and spoken answers are generally more detailed than written ones. The structure of the interviews was also developed in consultation with the pilot materials project leader and piloted at one of the institutions where two lecturers were present. Piloting the interview schedule (Appendix F) enabled me to check the usefulness and relevance of the schedule and to practice my interviewing skills, as successful interviewing is not always easy to achieve (Denzin & Lincoln, 2000). The pilot was also used to determine how easily the lecturers would move into the discussion of the usefulness and quality of the SAIDE OER. Since all of the lecturers being interviewed were part of the collaborative team and were contributing to the development of the materials they were relaxed and participated actively in the interview without needing excessive prompting.

A semi-structured interview (Denzin & Lincoln, 2000) was chosen so that some structure could assist the flow of the discussion while allowing the opportunity for follow-up on responses to questions. In an interview one can probe for the expansion of the responses that are given to questions (Cohen & Manion, 1980; Fraenkel & Wallen, 1990). The intention was to move from more closed to more open questions. The interviews did not deviate much from the schedule, but various key questions were followed up in different ways at different institutions according to the information that came up during the interview. Interviews can be directed and influenced by the presence and interpretations of the researcher (Hitchcock & Hughes, 1989; Silverman, 1993). For this reason I tape recorded all of the interviews and then transcribed them, because transcripts "provide an excellent record of naturally occurring interaction … and offer a highly reliable record to which researchers can return as they develop new hypotheses" (Silverman, 1993, pp. 10-11).

3.3.3 Session observations

Further data were gathered through the observation of sessions where the ACEMaths materials were in use. All lecturers who piloted the ACEMaths material (except myself) were observed. The observed sessions ranged from 45 to 120 minutes in

length. In depth observation is the strength of an ethnographic case study. The observation in this study was limited because of the number of sites at which observations had to be carried out and the time constraints. However, observation at each site was still seen as a worthwhile exercise, since it allowed the researcher the opportunity to observe the use of the materials *in situ*.

Qualitative research is often criticised for potential bias because it is based on the interpretation of the researcher (Gillham, 2000; McMillan & Schumacher, 2006). This interpretation could influence the analysis of the data from any source, but more particularly the data recorded from observations, since these field notes are written from the observer's perspective. I tried to minimise the effect of bias in my observations by recording, as explicitly as possible, what I saw happening in relation to particular observation pointers (Appendix G), though I am aware that such a list of observation categories may orient the observation in particular ways.

One session in which each lecturer used the ACEMaths materials was observed. I chose to be a non-participant observer because this reduces the potential influence of the observer on the session being observed (Frankel & Wallen, 1990; Swann, 1994). In addition to using the observation pointers to reduce bias, I used them to increase the chances that observations across the different sites were consistent. The observation pointers helped draw my attention to particular aspects of the SAIDE OER materials being used in the lecture, and to the extent to which the materials were being used. Field notes were written during the observation sessions as "snapshots" of implementation, for comparisons of the implementations at the different sites. I made notes of the students' responses to the material being presented. The type of material being dealt with in the class was noted. For example, was it predominantly mathematics, or was it the theory of teaching and learning mathematics, or a combination of the two? I took note of the specific references to the issues related to diverse classrooms and how these were raised and dealt with by the lecturers in the session observed.

In Chapter Four when the data are presented, I will describe the outline of the lecture at each site by giving brief descriptions of the introduction, body and conclusion of the lecture, so that comparisons can be made across these "snapshot" observations.

3.3.4 Lecturer follow-up conversations

The collection of data from the lecturers involved in the ACEMaths project was completed through follow-up conversations with all lecturers who used the materials in the pilot implementation phase and also with lecturers who were not involved in the pilot implementation but who were involved in the materials development and revision. These conversations took place through email correspondence[43], since the lecturers are located throughout South Africa.

3.3.5 Artefacts

Artefacts in the form of assignments set by each of the lecturers on the pilot ACEMaths material were collected for analysis and comparison across sites. Customised versions of the ACEMaths materials were also collected from each of the sites where these had been produced. The artefacts provided data on the lecturers' individual use of the ACEMaths materials.

3.3.6 Student questionnaire

A questionnaire was completed by the students using the ACEMaths materials (Appendix E). This was developed in consultation with the pilot materials project leader and was piloted at one of the institutions where about 30 students were present. After the pilot, the order of the questions was altered slightly, to enable a more logical grouping. The pilot questionnaires did not form part of the data for the research. The final student questionnaire consisted of three sets of open-ended short questions where students were expected to answer giving an indication of knowledge gained through the use of the materials, opinions on the value of the materials and information on ownership of or access to computers.

The first set of questions related to the students' learning and was included to ascertain information on the transfer of knowledge through the OER. The guiding

[43] There were spurts of communication with all of the participants at various times over the period from the final revision workshop right up to January 2010, whenever I needed to clarify or obtain new information from them.

question here was: “1) Please answer the questions below, and where possible explain how the SAIDE OER course materials have helped you in achieving the knowledge required to answer each question (Appendix E: 1).” One of the sub-questions in this part was “c) How can we teach mathematics effectively, particularly in diverse classrooms (Appendix E: 1)?” The first set of questions has not been reported on in this research report, since it did not directly relate to the research questions. Analysis of the responses, in the light of appropriate literature from the field of mathematics education, could form the basis of another study.

The second set of questions called for the opinions of the students on the value of the materials. One such question was “2) What idea(s) from the SAIDE OER course material, if any, will you find most useful in your teaching at school (Appendix E: 2)?” The second set of questions has been used in this study in relation to the student response to the ACEMaths materials to which they were exposed as a result of their lecturer’s take-up of the materials.

A third set of questions, at the end of the questionnaire, was included to find out about student ownership of or access to computers (Appendix E: 2). These responses were tallied and quantitatively analysed since they give insight into the context in which the OER are used.

3.4 Administering the instruments

The scope of this project, located in five tertiary institutions in South Africa across six different programmes, presented a challenge in terms of data collection. Table 3.3 below summarises the data collection process.

Table 3.3: Administering the instruments (2007/8)

Instrument	Sites	Date(s) administered	Comments/Exceptions
Lecturer Questionnaire 1	Sites A - F	Feb 2007	Completed by all lecturers at the final development workshop at SAIDE.
Lecturer Questionnaire 2	Sites A-E Site F	Jul/Sept 2007 May 2008	Completed by all lecturers when they were visited for the site observation.
Lecturer Questionnaire 3 and 4	Sites A – F	Mar 2008	Completed by all lecturers at the final materials revision

			workshop at SAIDE.
Session Observations and Lecturer Interviews	Sites A-E Site F	Jul/Sept 2007 May 2008	Site F was not ready for the observation in 2007 but consented to an observation session and interview in 2008
Student Questionnaire	Sites A-E Site F	Jul/Sept 2007 May 2008	Completed by students after the site observation.
Artefacts – customisations and assessments	Sites A – F	Jul 2007 – Mar 2008	Some artefacts were collected during the site visits, but those outstanding were brought by lecturers to the final revision workshop at SAIDE
Lecturer follow-up conversations	Sites A – F	Feb 2008 – Jan 2010	Ongoing emails as queries arose to clarify data and obtain final student numbers for use of materials after the pilot phase.

As can be seen in the table, some lecturer questionnaires were administered on site, while others were administered at the SAIDE offices during the workshops. Student questionnaires were all administered on site. The participants indicated preferred dates and times for the site visits, and four of them had to be visited in the month of July. I was personally able to do the site visits at five of the six sites, but due to time constraints in the July 2007 schedule, another researcher did the observation visit at one of the sites. She wrote the records of the session observations and interviews and collected the lecturer and student questionnaires, course materials and assessment activities. We met on our return from our visits and discussed her visit in detail, to ensure that I understood what had been recorded and collected and what it represented. Artefacts that were not available for collection during the site visits were brought by the participants to SAIDE when they attended the final revision workshop at the end of the pilot implementation phase. I remained in email contact with all of the participating lecturers to obtain additional clarification and information from them until the final version of this dissertation was completed.

3.5 Data Analysis

The data from the lecturer questionnaires and interviews, the second set of questions from the student questionnaires and classroom observations were coded in order to facilitate a qualitative thematic content analysis. McMillan and Schumacher explain that "qualitative analysis is the relatively systematic process of coding, categorizing, and interpreting data to provide explanations of a single phenomenon of interest" (2006, p. 364). The full list of all data items collected is given in Appendix K. The

names on this list are used to reference quotations from the data items. After transcribing the data from the lecturer interviews, these data together with data from the student questionnaire, the four lecturer questionnaires and from the observation notes were coded using open coding. Categories were created as I read through the data and common themes emerged. These categories were used to organise the data and carry out the thematic content analysis.

Responses from the third set of questions from the student questionnaires to the questions about computer access and ownership were tallied. The quantitative analysis of these responses is used in Chapter Five where these responses are viewed from a take-up perspective.

Assignment tasks were compared across the sites and analysed in relation to the extent to which they drew on the OER materials. Customised versions from the different sites were studied in detail, described (see Chapter Four) and compared (see Chapter Five).

There are criteria that provide a framework to support the validity of a qualitative study (Guba & Lincoln, 1983). The criteria include credibility, dependability and confirmability. Credibility deals with the extent to which the data sources (in this case the lecturers and the students) agree with the analysis and interpretation of the researchers. I authenticated the findings whenever necessary as the research progressed through email correspondence with my data sources. The dependability of the findings is enhanced by the rigour of analysis. To promote rigour I worked with the project leader to discuss the categories formed from the transcribed data. I discussed the analysis with the project leader and collaborative team members as it progressed. Confirmability is the process whereby the data and its interpretations can be confirmed. Confirmability can be achieved by triangulation or "cross-validation" of the data (Hitchcock & Hughes, 1989; McMillan & Schumacher, 2006). Triangulation of data is realised in this study through the use of data from different sources: five questionnaires (lecturer and student), observation notes from sessions, interviews with the lecturers and artefacts (assessment tasks based on the ACEMaths materials and "customised" materials). In Chapter Four these data are presented.

3.6 Consents and ethical clearance

I took great care to comply with the requirements of the submission to the ethics committee. I drafted letters addressed to all of the participants in the research to set out the participation that was required and to ensure that they agreed with the observation, interviews and completion of the questionnaires. The information letters and consent forms outline the study briefly and contain an offer to report back on the study to those involved in the research process. The letters also assure them of confidentiality and the means by which I will assure this confidentiality. The questionnaires (Appendices A, B, C, D, and E), interview schedule (Appendix F), observation categories (Appendix G), information letters and consent forms (Appendices H and I) are all included. The letter to institutions requesting permission to do the research is also included (Appendix J). My application for ethics clearance was granted (Protocol 2007ECE25) as confirmed in a letter dated 18 June 2007.

You can't create educational materials that function effectively in every single context any more than you can write software that runs on every single platform. We should focus on solving specific instruction problems, and make sure our solution at least works for someone.
(Albright, 2005, p. 5)

4.1 Introduction

As indicated in Chapter Three, ten lecturers were ultimately involved in the pilot implementation of the SAIDE pilot ACEMaths materials. They were from five tertiary institutions since at one of the institutions two completely different programmes made use of the material, with each referred to as a different site. There are thus six sites making up the six cases in this study. The research was carried out at all of the implementation sites, to give as broad a picture as possible of the take-up of the materials and the way in which the materials were used to meet a specific need.

Table 4.1: Participants by site and programme (2007)

Site	Programme	Lecturers
A	ACE (mixed mode)	Lecturer 1 and Lecturer 2
B	ACE (mixed mode)	Lecturer 3 and Lecturer 4
C	B Ed (full time)	Lecturer 5
D	ACE (mixed mode)	Lecturer 6
E	ACE (mixed mode)	Lecturer 7, Lecturer 8 and Lecturer 9
F	ACE (part time)	Lecturer 10
G	PGCE[44] (full time)	Lecturer 11 and Lecturer 12

The sites are named in Table 4.1 above using upper case letters from A to G as in Table 3.1. Twelve lecturers at seven sites initially volunteered for the pilot implementation[45]. The table indicates the wide variety of programmes[46] in which the

[44] A PGCE is a Post Graduate Certificate in Education.
[45] Site G lecturers participated in the materials development and revision process, but withdrew from the pilot implementation.
[46] In South African Education Department terminology a programme leads to a qualification. For example, a B Ed programme leads to a B Ed degree.

materials were used. There were three different programmes (ACE, PGCE and B Ed) proposed for pilot implementation and three different modes of delivery across these programmes (full-time, part-time and mixed mode[47]).

The data-gathering process generated a large body of data. In this chapter I present data from each site as a separate case, attempting to offer "thick descriptions" (Bassey, 1999). A brief outline of the six modules making up the ACEMaths materials is given before the cases are presented. A table of quantitative data with respect to student computer ownership or access is given at the end of the chapter. Since there are six different cases, this chapter is considerably longer than the others.

4.2 The OER Module

The OER module being investigated is intended as a learning guide to be used in teacher education courses in South African schools of education. It is informed by the inclusive education policy (DoE, 2001) and supports teachers in dealing with the diversity of learners in South African classrooms. The module is divided into six units, described briefly in the table below.

Table 4.2: Summary of units in *Teaching and Learning Mathematics in Diverse Classrooms*

Unit One: Exploring what it means to 'do' mathematics This unit gives a historical background to mathematics education in South Africa, to outcomes-based education and to the national curriculum statement for mathematics. The traditional approach to teaching mathematics is then contrasted with an approach to teaching mathematics that focuses on 'doing' mathematics, and mathematics as a science of pattern and order, in which learners actively explore mathematical ideas in a conducive classroom environment.
Unit Two: Developing understanding in mathematics In this unit, the theoretical basis for teaching mathematics – constructivism – is explored. A variety of teaching strategies based on constructivist understandings of how learning best takes place are described.
Unit Three: Teaching through problem solving In this unit, the shift from the rule-based, teaching by telling approach to a problem-solving approach to mathematics teaching is explained and illustrated with numerous mathematics examples.

[47] Mixed mode programmes offer a mixture of some face-to-face contact time (which varies from programme to programme) combined with periods of independent study during which teachers are expected to work independently through their study materials and on their assignments.

Unit Four: Planning in the problem-based classroom In addition to outlining a step-by-step approach for a problem-based lesson, this unit looks at the role of group work and co-operative learning in the mathematics class, as well as the role of practice in problem-based mathematics classes.
Unit Five: Building assessment into teaching and learning This unit explores outcomes-based assessment of mathematics in terms of five main questions – Why assess? (the purposes of assessment); What to assess? (achievement of outcomes, but also understanding, reasoning and problem-solving ability); How to assess? (methods, tools and techniques); How to interpret the results of assessment? (the importance of criteria and rubrics for outcomes-based assessment) ; and How to report on assessment? (developing meaningful report cards).
Unit Six: Teaching all children mathematics This unit explores the implications of the fundamental assumption in this module – that ALL children can learn mathematics, whatever their background or language or sex, and regardless of learning disabilities they may have. It gives practical guidance on how teachers can adapt their lessons according to the specific needs of their learners.

4.3 Six sites: a case study of cases

In each case, data from the site are presented in the following order:

- Background information;
- Use and adaptation of the ACEMaths materials[48];
- Teaching session observation;
- Assessment;
- Student questionnaires;
- Lecturer interviews and questionnaires.

4.3.1 Case 1: Site A

4.3.1.1 Background

At the university in which this site is situated two major educational institutions merged as a result of a rationalisation process that took place between 1996 and 2004 to cut back the number of tertiary institutions in the South Africa (Kruss, 2009). One institution had been historically disadvantaged. The institution resulting from the merger has a teacher body that is more representative of the population of South Africa than had been the case at the two separate institutions. English is the language of instruction at Site A where the home languages of the students are predominantly

[48] See Appendix L for the full prospectus of the courses offered at each site. This gives an indication of where the ACEMaths materials fitted into the full course programme at each one.

English or isiZulu. The Faculty of Education is located at two sites which are situated some distance from each other. The Faculty offers a wide range of undergraduate degrees and diplomas as well as postgraduate certificates, Honours, Masters and Doctoral studies programmes.

Implementation at Site A took place in the context of a mixed mode ACE programme for FET (Mathematical Literacy). This programme is a re-skilling[49] ACE through which teachers are able to qualify to teach Mathematical Literacy. Lecturers have interactive sessions with the students when they attend lectures at the university for set periods of contact time during the school holidays (ranging between one and two weeks). Students also attend lectures at weekends and are able to consult with their lecturers by email, telephone or in person. The ACEMaths materials were used with the 15 second year students in this programme. This was a small group because it was the second year of a pilot programme where students were self-funded. At the same time (2007), the institution was contracted by the Department of Education to offer the ACE on a large scale. About 700 first year students were registered in 2007, and a further 500 in 2008 for the ACE programme in FET (Mathematical Literacy), all fully funded by the Department of Education. The students come from all parts of the province and they teach in urban and rural areas.

The campus on which the ACEMaths materials were used is well resourced, has comfortable lecturing facilities and well qualified lecturers. Lecturers used PowerPoint presentations, a data projector, a whiteboard and overhead projector in the presentation of the materials. At this site two lecturers[50] took part in the pilot implementation project. Lecturer 1 has six years of experience as a mathematics school teacher and 12 years of experience as a mathematics teacher educator. She has a doctorate in education from a South African university. Lecturer 2 has six years of

[49] ACE programmes are offered for different purposes. Re-skilling ACEs are intended to qualify a teacher to teach a new subject which he/she has not been previously qualified to teach. Up-grading ACEs are intended to give the teacher the opportunity to become better qualified to teach a subject for which he/she has previously qualified but the qualification may not be at the required NQF level (to meet the changing departmental requirements) OR the teacher may wish to improve his/her own knowledge and skills through completing an up-grading ACE even if his/her existing qualifications are at the required level.

[50] The interview with Lecturers 1 and 2 was a joint interview. When I transcribed the interview I identified the different voices of the two lecturers and am hence able to quote the individually, but these quotes are referenced to the single transcription, Lecturer 1 and 2 Interview Site A.

experience as a mathematics school teacher, 23 years of experience as a mathematics teacher educator and has a masters degree in education from a South African university.

4.3.1.2 Materials

At this site a selection of the ACEMaths materials was used in two of the modules in the ACE (Mathematical Literacy). Lecturer 1 decided that Unit Four (Appendix P) fitted in well with the institution's module *Teaching and Learning Mathematics in the FET (w.r.t Mathematical Literacy)*. She said that:

> I took the part about the problem based classroom because that fits with the idea of maths literacy. So I took Unit Four but then I had to pick bits out of Unit Three because they spoke about the three part lesson and I needed that. (Lecturer 1 and 2 Interview Site A, p. 2)

Ultimately she used the whole of Unit Four, extracts about products and processes and verbs for doing maths from Unit One (Appendix M), extracts relating to constructivism from Unit Two (Appendix N) and extracts about the value of a problem-based approach and the three-part lesson plan from Unit Three (Appendix O). She combined this information with other theory and activities of her own to create her module resource guide.

Lecturer 2 chose to use Unit Six (Appendix R). She explained:

> I chose the Unit Six in its entirety, you know, the one about the inclusive education policy, … I thought, you know, that they would have lots of diverse learners in their classes. The diversity focus fits with maths literacy. … That particular module is professional practice, it has to do with them planning for their practice and reflecting on it. This Unit Six has given them an extra dimension to add on to [their reflection]. (Lecturer 1 and 2 Interview Site A, p. 3)

Her module is entitled *Professional Practice in Mathematics Education*. The module resource guide was made up of four parts. Lecturer 2 used the entire Unit Six as part four of her module resource guide. It formed the bulk of the reading for that module, and a reference material for the primary module assessment activity which was an action research project. A more detailed description of the customisations[51] of the materials at this site is provided in the next section.

[51] The term "customisation" is used in OER literature to refer to particular adaptations of given materials.

Customisation One: Lecturer 1

Lecturer 1 adapted the ACEMaths materials quite substantially, combining them with material of her own to produce a module resource guide. This guide was printed and bound and handed out to the students when they attended their first set of lectures for the module. The guide presented background information on mathematical literacy and contained activities and examples that were chosen specifically for a mathematical literacy programme.

Section One of her guide gives an introduction to the theory of teaching and learning mathematics. For three of its 22 pages the content is taken directly from the ACEMaths materials. The opening paragraphs invite readers to think about their own ideas about mathematics and what mathematics is all about and the section concludes with an overview of some of the "big ideas" in mathematics education. Lecturer 1 used short extracts from the ACEMaths materials in combination with other material, to create introductory notes to the module course guide. The extracts were taken from the ACEMaths Units One, Two and Three.

The first extract taken from Unit Two was in the context of a brief discussion on constructivism in mathematics teaching:

Figure 4.1: Extract from Unit Two, Appendix N, p. 3

> The constructivist view requires a shift from the traditional approach of direct teaching to facilitation of learning by the teacher. Teaching by negotiation has to replace teaching by imposition; learners have to be actively involved in 'doing mathematics'. Constructivism rejects the notion that children are 'blank slates' with no ideas, concepts and mental structures. They do not absorb ideas as teachers present them, but rather, children are creators of their own knowledge. The question you should be now asking is: How are ideas constructed by the learners?

This extract was used together with other parts of the content relating to constructivism in the ACEMaths materials. The lecturer's choice of extracts avoided the polarisation between "traditional" teaching and constructivism, which was evident

in the OER text. She improved the content in this way[52] by using only a few extracts from the ACEMaths units and adding text of her own.

Next she used an extract taken from Unit One indicating some of the differences between the processes and the products of mathematic. This was used in the part of her guide which deals with problem solving and investigations. The extract contains a list of products and processes of mathematical activity as a lead-in to the content that follows. The italicised part of the sentence was added by Lecturer 1 to clarify the content of the table:

Figure 4.2: Extract from Unit One, Appendix M, p. 14

Mathematics is about processes (expressed in 'doing verbs'), but it is also about products (expressed by nouns). In the table below a few examples are given – *the nouns in the "products" column and the "ing" form of verbs in the "processes" column:*

PROCESSES OF MATHEMATICS What mathematicians do	**PRODUCTS OF MATHEMATICS What mathematicians know**
Generalising	Formula
Computing	Theorem
Assuming	Definition
Solving	Axiom
Proving	Corollary
Testing	Concepts (number etc.)

This extract was followed by Lecturer 1's own material on the products and processes of mathematical activity. The next extract was also taken from Unit One. It contains certain "verbs of doing mathematics" which emphasise the point that the materials are making about the importance of active involvement in what is called "doing mathematics":

Figure 4.3: Extract from Unit One, Appendix M, p. 14

What verbs would you use to describe an activity in a classroom where learners are doing mathematics? Van de Walle (2005:13) gives a collection of verbs that can be associated with doing mathematics:

[52] The revised version of the ACEMaths materials took into account comments made by many users (including Lecturer 1) of the pilot materials in connection with the stereotypical presentation of "traditional" teaching and a constructivist style of teaching.

explore	represent	explain
investigate	discover	justify
conjecture	develop	formulate
predict	solve	construct
justify	verify	use

Study these verbs carefully – they describe what action or behaviour is expected from the learners when doing the classroom activity. As Van de Walle notes (2005:13):

They are science verbs, that is, verbs indicating the process of making sense and figuring things out. It is important to note that when learners are engaged in the kinds of activities suggested by the list, it is practically impossible for them to be passive observers and listeners. They will be actively thinking about the mathematical ideas that are involved.

Lecturer 1 then chose to use a summary of the value of using a problem-based approach to conclude the theoretical part of Section One of her guide. The summary is taken from Unit Three:

Figure 4.4: Extract from Unit Three, Appendix P, pp. 27-28

The value of teaching using a problem based approach

- Teaching using a problem-based approach requires the development of tasks that take into account the current understanding of learners, as well as the needs of the curriculum. The value of this approach includes:
- When solving problems learners focus their attention on ideas and sense making. This leads to the development of new ideas and enhances understanding. In contrast a more traditional approach emphasises 'getting it right' and following the directions supplied by the teacher.
- When solving problems, learners are encouraged to think that they can do mathematics and that mathematics makes sense. As learners develop their understanding, their confidence in mathematics is also developed.
- As learners discuss ideas, draw pictures, defend their own solutions and evaluate other solutions and write explanations they provide the teacher with an insight into their thought process and their mathematical progress.
- In solving problems, learners develop reasoning and communication, and make connections with existing knowledge. These are the processes of 'doing' mathematics that go beyond the understanding of mathematical content.
- A problem-based approach is more rewarding and more stimulating than a teach-by-telling approach. Learners are actively engaged in

making sense of, and solving the problem. The development of their understanding is exciting for the learners and the teacher.

These examples illustrate how Lecturer 1 chose extracts from three different units of the ACEMaths materials in order to create the introductory notes for her module resource guide. She was able "pick bits" and cut and paste exactly as she wanted. She selected the parts that fitted best with the maths literacy focus of the ACE programme and presented them according to the sequence of concepts she wanted to present.

This section of her material is followed by some activities from another source which Lecturer 1 added. These activities contrast a simple closed task with a more open-ended task (see Figure 4.5 below). The open-ended task is given to exemplify the kind of activities suggested by the "science verbs" of "doing mathematics" in the ACEMaths extract. Working through these activities should enable the students to consolidate the ideas while engaging in the doing of mathematics:

Figure 4.5: Activities added in context by Lecturer 1, Site A

Example 1:

Find the perimeter of a rectangle with sides 12 cm and 9 cm. (Site A Customisation One, 2007: 18)

Example 2:

Draw some shapes that have the same perimeter as a rectangle with sides 12 cm and 9 cm. (Site A Customisation One, 2007: 19)

These examples are discussed and explained in the text written by Lecturer 1. The first task is purely procedural, calling for the calculation of the perimeter of a shape which can be done by using a standard formula. There is one correct answer to this task. The second task is more open ended. It calls for shapes to be drawn that will satisfy certain conditions. To find these shapes, learners have to apply their knowledge of the perimeter of a rectangle. This requires them to think of shapes, test that they satisfy the given condition, and then draw the shapes. There are several shapes which will satisfy these conditions and so there are several answers to this question. The first task does not require this level of thinking. They are both simple tasks, but are effective in demonstrating the difference between the activity of "doing mathematics" and performing mathematical procedures.

None of the material taken from the SAIDE OER is referenced to it. The extracts simply merge with the text so that there is no disruption to the flow in this section. On the introductory page it states that "some of the material used in these notes is extracted from the materials prepared for the SAIDE Open Educational Resources Project" and full copyright details of the ACEMaths materials are given. In this way, the "attribution" requirement of the creative commons licence under which the ACEMaths materials were released was satisfied.

Section Two of Lecturer 1's guide gives information about Mathematical Literacy as a new subject in the FET curriculum. This section is nine pages in length, and contains no content taken directly from the ACEMaths materials. Mathematical literacy in South Africa is presented within a local and international framework thus equipping the students to be critical of the school Mathematical Literacy curriculum put forward in the National Curriculum Statement (NCS).

Section Three of Lecturer 1's guide begins with a discussion of the kinds of learners that may be found in a Mathematical Literacy class. This is followed by text consisting of an adaptation of virtually the whole of Unit Four. This is where Lecturer 1 included the three-part lesson plan from Unit Three (Appendix O, pp. 19-24). The section has 32 pages, 27 of which consist of content taken directly from the ACEMaths materials. At the point where the text of Unit Four begins in the customised version, the full front page, acknowledgements and ACEMaths copyright information are inserted. The page numbering of the guide continues, so that pages 38 to 40 are the front page, acknowledgements and copyright information of the ACEMaths materials, and then the text continues again on page 41. This disrupted the flow of the materials to an extent, and could have been done in a less obtrusive manner. Lecturer 1 said that in practice it had not distracted from the usability of the materials and that she felt it gave full credit where it was due[53].

In Section Three of Lecturer 1's customised version, she did not use all the activities from Unit Four. The first activity which calls for general reflection on the steps involved in planning for a problem based lesson (Appendix P, p. 5) was replaced by a

[53] In Lecturer 1's subsequent version she fulfilled the attribution requirement of the creative commons licence once only at the beginning of the guide having realised that this was sufficient.

reflection activity relating to set problem tasks included in the guide. The mathematical examples that Lecturer 1 chose to include were appropriate for teachers of mathematical literacy. The second activity (Appendix P, p. 6) was used unchanged. The third activity (Appendix P, p. 9) was omitted, and not replaced. The fourth activity (Appendix P, p. 12) was omitted, and not replaced. The first part of the fifth activity (Appendix P, pp. 14-15) was used, with an adaptation of the points for reflection taken from the second part. The sixth activity (Appendix P, p. 20) was omitted, and not replaced. The seventh activity (Appendix P, p. 22) was used with question one (of four) omitted. The eighth activity (Appendix P, p. 24) was used unchanged. This use/replacement of activities demonstrates Lecturer 1's customisation of the ACEMaths materials.

Customisation two: Lecturer 2

Lecturer 2 also combined ACEMaths materials with other materials of her own to produce her course work guide, but did not alter the OER materials in any way. She used the whole of Unit Six with both appendices (Appendix R), as the fourth part of her module resource guide. She reproduced this material exactly as it was produced for the pilot and printed the front page, acknowledgements and copyright information, hence fulfilling the attribution requirement of the creative commons licence.

4.3.1.3 Session observation

I was not able to observe a session at Site A because the contact session was cancelled while I was on site as the teachers were called back to school to make up for time lost as a result of teacher strikes. I discussed the nature and content of the lectures with the lecturers when I interviewed them. Lecturer 1 gave me full electronic records of the planning for and presentation of one of her maths literacy lectures. These session observation notes are thus based on the interview and electronic records rather than actual observation.

The ACEMaths materials featured very strongly in the PowerPoint presentation. The introductory slides used the content extracts on the three part lesson plan from Unit Three. The steps for planning a problem-based lesson from Unit Four contributed to the body of the lesson.

Session introduction:

Using her PowerPoint presentation the lecturer gave general input on the three recommended parts that should make up a lesson plan, key activities needed during these parts and tips for teachers to think about while planning a lesson.

Body:

She then discussed in detail all of the steps involved in planning a problem based lesson, using a maths literacy problem. The problem which she used in the session was selected from the module guide. It is one of the four maths literacy problems which Lecturer 1 included in her module guide[54].

Figure 4.6: Session activity PowerPoint, Site A

The municipality wishes to create 100 flower beds and surround them with hexagonal paving slabs according to the pattern shown above. (The flower beds are the black part, and the white is the paving slabs). In this pattern, 18 slabs surround 4 flower beds.
How many slabs will the municipality need?
Find a formula that the municipality can use to decide the number of slabs needed for any number of flower beds.
A suggestion:
This problem is best approached by drawing diagrams but the hexagons are a bit tricky to draw. So in order to prevent the lesson being wasted in drawing carefully, suggest that rough diagrams with circles to represent the paving slabs will suffice.

These are the steps suggested in the ACEMaths materials and included in the module guide:

Figure 4.7: Steps for planning a problem based lesson, Appendix P, pp. 2-4

STEP 1: How is the activity done?
STEP 2: What are the desired outcomes of the activity?
STEP 3: Will the activity allow learners to achieve the outcomes?
STEP 4: What assessment will you include with the activity?
STEP 5: Articulate learner responsibilities
STEP 6: Plan the 'before' portion of the lesson.

[54] See 4.3.1.2.

STEP 7: Think about the 'during' portion of the lesson.
STEP 8: Think about the 'after' portion of the lesson.
STEP 9: Write your lesson plan.

The lecturer spoke about the way in which the first four steps call on the teacher to define the heart of a lesson. The next four steps call on the teacher to expand on how he/she will carry out the plan in a classroom. The last step is simply the recording of the plan. After this, the other three problems were given to the students so that they could apply what they had learnt in the discussion about the planning of a problem-based lesson.

Conclusion of session:

The lecturer then introduced another maths literacy problem-solving task for the students to use in the planning of a problem-based lesson, following the method discussed in the session. She put up a slide with the following information (see Figure 4.8 below), to help the students to relate all of the given information to their task.

Figure 4.8: Session conclusion PowerPoint, Site A

A lesson plan for an investigation

The outline here is a possible format of the critical decisions:

1. The mathematics or goals	2. The task and expectations
3. The 'before' activities	4. The 'during' hints and extensions for early finishers
5. The 'after'-lesson discussion format	6. Assessment notes (whom you want to assess and how).

In the interview, Lecturer 1 explained that she felt that the lesson had gone well, saying, "they said in their evaluation, and I could see by doing it, that they really like classroom ideas, you know… here is a nice thing to do in the classroom, they really perk up and they like that" (Lecturer 1 and 2 Interview Site A, p. 8). When working on their task, the students had the support of the session content and the lecturer's summarising slide, but also their module guide. The lecturer was disappointed that, as

teachers, the students had been called back to teach, thus interrupting their contact session. She called it a “lost opportunity because we were just getting into the materials” (Lecturer 1 and 2 Interview Site A, p. 23).

4.3.1.4 Assessment

For each module, students write two assignments during the course of the year and have an examination at the end of the year.

For Lecturer 1’s module students sat a written examination, which counted 50% of their overall mark. As indicated in the example below from the November Examination (Question 3), the paper was challenging, and called for students to apply the theory they had been exposed to in the course. The OER materials were well represented.

Question 3 called on students to plan for a problem-based lesson using a given problem. The material on the three part lesson plan was covered extensively in the contact session, at which time the students had to plan another problem-based lesson using a different problem, so the ideas should have been familiar and meaningful to them, and it should have been possible for them to draw up such a plan under examination conditions.

Figure 4.9: Extract from assessment artefact, Site A

Question 3

Plan a lesson based on the locker problem reproduced below. The lesson must be suitable for a Grade 10 Mathematical Literacy class consisting of 35 learners. The group is mixed in term of gender and race, and while some learners have sound basic mathematical skills others battle with even simple arithmetic.

The lesson plan must include consideration of the diversity of learners, and clear "before", "during", and "after" plans.

THE LOCKER PROBLEM

Teachers at a school decided to try an experiment. When break is over, each teacher will walk into the school one at a time.

The first teacher will open all of the first hundred locker doors. The second teacher will close all of the locker doors

with even numbers. The third teacher will change all the locker doors with numbers that are multiples of three. (Change means closing locker doors that are open and opening locker doors that are closed.) The fourth teacher will change the position of all locker doors numbered with multiples of four; the fifth teacher will change the position of the lockers that are multiples of five, and so on.

After 100 teachers have entered the school, which locker doors will be open?

The memorandum outlined the following criteria calling for planning according to the three-part lesson plan from the SAIDE materials:

Figure 4.10: Extract from assessment artefact, Site A

Before
Consider the teachers and predict what will happen based on prior knowledge required
Plan warm up activity to get into the task (5 marks)

During
Structure of lesson
Hints to help those who can't get going (showing insight into problem)
Extension for those who are done
Plans for wrap up and possible group presentations (5 marks)

After
Plans for wrap up and possible group presentations
Assessment plans (5 marks)

Diversity
Could be mentioned throughout but should include issues of gender, race (with possible language problems) and differing maths background. (5 marks)

Evidence of insight into the actual problem task and correct solution to Locker problem (5 marks)

25 marks

This memorandum shows that the marker was looking for ideas prompted by the SAIDE OER extract on the three part lesson plan. The addition of the element relating to diversity shows that the lecturer was expecting the students to make a link to the content of Unit Six. The problem chosen for the task is a challenging, multi-step

problem, requiring the application of mathematical conceptual knowledge and also giving students an opportunity to apply the theory learned in the module.

The examination for Lecturer 2's module took the form of an action research project. She was able to administer this rather difficult and time-consuming task because the 2007 student group was so small. To complete the projects students had to draw on the theory presented in the module since they had to show how they had accommodated diversity in their classes. She said in the interview that she had told them, "you can't anymore now just have the activity and ignore the fact that there are these diverse needs" (Lecturer 1 and 2 Interview Site A, p. 8). Lecturer 1 noted that several of the students had diversity as a focus when they undertook their action research projects. Lecturer 2 gave the students a lot of support including consultation and written feedback on an ongoing basis for partial submissions as the year progressed. She said that she thought that her module, through the examination equivalent assignment, pulled together the two Site A modules based on the ACEMaths materials.

4.3.1.5 Student Questionnaire

Positive comments on the ACEMaths materials from the students (teacher-learners at this site) included:

- The honesty of the teacher[55] motivated me. If others can do it, so can I.
- All teachers should use these materials.
- The materials are easy to read.
- The way of teaching in the SAIDE materials develops thinking.
- They are so useful and relevant for schools.

There were no outright negative comments from any of the students at Site A.

4.3.1.6 Lecturer interview and questionnaires

Lecturers at this site thought that the students were particularly interested in the diversity issues from Unit Six. Lecturer 2 said that they were "very thought

[55] This refers to the "teacher" in the case study which forms part of one of the appendices to Unit Six of the ACEMaths materials.

provoking" (Lecturer 1 and 2 Interview Site A, p. 9) and that "there definitely [were] students who … [found] it extremely interesting" (Lecturer 1 and 2 Interview Site A, p. 13). Some of these ideas, such as the Inclusive Education Policy, and the related diversity issues, were completely new to them. Lecturer 2 said that "Not one of these students had heard about it in their schools" (Lecturer 1 and 2 Interview Site A, p. 12). The material was a bit overwhelming for the students in coverage and reference to policy documents. Lecturer 1 also brought diversity into her teaching, "because we said that it would be a thread that [would run] through" (Lecturer 1 and 2 Interview Site A, p. 7). Lecturer 2 indicated that the materials had contributed to her personal growth as well as that of her colleague, saying that "in the undergraduate B Ed modules that [we] teach, we too have become more aware of the diverse needs of our students" (Lecturer 2 Questionnaire 2 Site A, p. 2).

The sense that the students found Unit Six stimulating and yet overwhelming came across in many comments made by Lecturer 2. She commented that "they found it a lot to read, and I don't think we had a chance to work through it enough for a lot of them" (Lecturer 1 and 2 Interview Site A, p. 8), and that "one student was saying to me, you know, this is such a lot and it is so exciting" (Lecturer 1 and 2 Interview Site A, p. 9), and finally that "they [were] just overwhelmed with it" (Lecturer 1 and 2 Interview Site A, p. 13).

Both lecturers said that they would be using much the same materials when they taught the modules for a second time, except that they would have to structure the planning of the lectures very carefully as in 2008 they were expecting a very large student group of about 700 students. This group would be taught by tutors, who are all maths students themselves, but not necessarily familiar with the issues of diversity underpinning the material. The lecturers expressed concern about the ability of the tutors to cope with the presentation of these unfamiliar ideas. They said that they would provide the tutors with highly structured plans and give them the readings well in advance so that they would be able to prepare themselves for the task. They were planning to revise their assessment of Lecturer 2's module, since they thought that an action research project may not be feasible with a large student group. They thought of giving out previous students' reports as exemplars, and suggesting students try similar research in their contexts. Their aim would be to try and identify incidences of

‘good mathematics practice’ and the research projects undertaken by such a large group of mathematical literacy students might provide them with very interesting insights. Both lecturers expressed their gratitude to SAIDE for initiating and maintaining the OER project which they felt had enriched their courses.

4.3.2 Case 2: Site B

As indicated in Chapter Three, Site B was the site at which I was unable to carry out the site visit personally because the time of the visit coincided with the time of another site visit.

4.3.2.1 Background

Site B is an independently funded NGO linked to the university in the grounds of which it is located. It aims to improve the quality of mathematics teaching and learning through in-service education, mainly in deeply rural areas. Although the unit is an integral part of the Faculty of Education at the university, it is not formally part of it. Courses offered at this site are accredited by the university. English is the language of instruction at Site B where the home languages of the students are predominantly isiXhosa or English.

The programme at Site B in which the ACEMaths materials were implemented is a mixed mode GET Maths ACE programme. The researcher who carried out the site visit met two of the lecturers involved in the programme at Site B. Lecturer 3 used Unit Three (Appendix O) as a whole, with a first year group. Lecturer 4 worked with Lecturer 3 in planning some of the sessions, read the ACEMaths materials and discussed these materials with the researcher but did not use the materials. At this site the students accumulated readings as lectures progressed, rather than receiving a single course guide. The class size was about 46 students, and lessons were planned as interactive sessions. In this mixed mode programme, lectures were given at the university for one week during each of the school holidays.

Site B is well resourced and has comfortable lecturing facilities and well qualified lecturers. In addition, the site offers its students a resource room with a wide variety of mathematical manipulatives which are used during lecture sessions. Students are encouraged to use the manipulatives in their own teaching of mathematics. The lecturer at this site who took part in the pilot implementation project (Lecturer 3), has 16 years of experience as a mathematics school teacher (5 of those as HOD of Mathematics), 13 years of experience as a mathematics teacher educator and has a masters degree in mathematics education from a South African university. Lecturer 4 has 9 years of experience as a mathematics school teacher, 22 years of experience as a mathematics teacher educator and a doctorate in mathematics education from an Australian university.

4.3.2.2 Materials

Lecturer 3 at Site B initially identified Units One, Two, Three, Five and Six as the most relevant for their ACE. In the end he used Unit Three on problem-solving in mathematics which he identified as most readily useful for his course and he also used parts of Unit Two. He did not have time available in his course programme to incorporate any more of the material. He used "the case studies of the two teachers [which] set the tone for the activities that followed" (Lecturer 3 Questionnaire 3 Site B, p. 1). The researcher observed that there was "complete coherence between [the lecturer's] own approach to problem-solving and that in the SAIDE materials, particularly with regard to the opening two case studies" (Lecturer 3 Observation notes Site B, p. 4). Aspects of Unit Three that he emphasised were the three part lesson plan, illustrations of various problem solving strategies, multiple entry points to problems, and information on shifting from a traditional approach to problem based tasks in the mathematics classroom. The lecturer said that the students "were positive about the material" (Lecturer 3 Questionnaire 2 Site B, p. 2)

He thought that it would be best to keep Unit Three intact, and refer to it in class. He used it as "an additional source material [and] a reference when choosing problems" (Lecturer 3 Questionnaire 2 Site B, p. 1). He handed it to the class as a reading and asked the students to read through it at home, and integrate it into their teaching.

4.3.2.3 Session observation

The session observed was on problem solving and its role in the teaching of mathematics with a focus on the concept of area. In the course of the session there was a general group discussion about the two case studies from the beginning of Unit Three which were used as exemplars for reflecting on teaching practice. In the lesson, Unit Three was used not for its activities, but for theoretical comment on the activities that the lecturers had previously developed for this course.

Session introduction:

Lecturer 3 started with a "recap" of the previous lesson on the teaching of perimeter. Then he asked the class how they would approach the teaching of fractions. After hearing their responses, he asked them to have a look at the different approaches of the teachers in the two case studies at the beginning of Unit Three[56], asking "which is the best and why?" (Lecturer 3 Observation notes Site B, p. 2). The observer then noted that the "students answer[ed] briefly and then the lecturer ma[de] a teaching point out of the comparison" (Lecturer 3 Observation notes Site B, p. 2). After this, he set small groups working on maths problem solving activities.

Body:

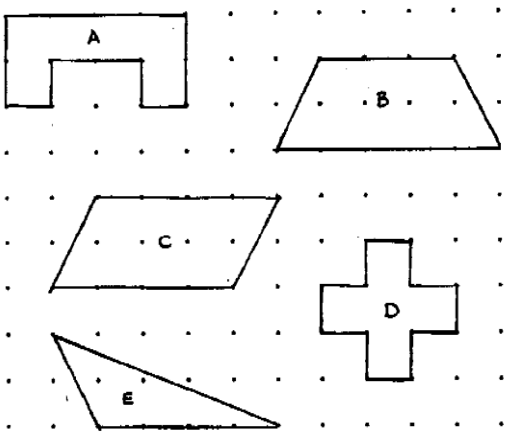
Students first engaged with a pre-prepared worksheet which had several different shapes drawn on dotted paper. They had to count the squares in each shape in order to get the area, and count the dots to get the perimeter. They then had to compare answers. After this came the part of the lesson in which they talked about the three stages of learning about area: region, size, and surface. This activity enabled the students to start to think about problem-solving strategies while engaging in a problem-solving activity themselves.

The next worksheet, shown in Figure 4.11 below, used dotted paper again. This was the real problem-solving section of the lesson. Students were asked to draw a rectangle on the dotted paper with a perimeter of 20 cm, and then describe their strategies they had used. They then had to do the following task using the various strategies they had discussed previously, such as counting unit squares, using a

[56] The two case studies show two teachers teaching fractions in different ways.

formula, dividing the shape into easier parts for finding the area and using Pick's Theorem.

Figure 4.11: Worksheet used in session, Site B



a) Calculate the perimeter of shape A

b) Calculate the area of shape A using any strategy

c) Calculate the area of shape B using two strategies

d) Calculate the area of shape C using Pick's theorem

e) Calculate the perimeter of shape D

f) Calculate the area of shape E using two different strategies.

When the task was set, students were referred to the three important rules for problem-solving tasks presented in Unit Three. Students were expected to use these as a guide to assist them to reflect on their problem-solving strategies. Page references in Unit Three were given, for easy access.

The final task was a contextualised word problem concentrating on the calculation of area and perimeter but without dotted or squared paper.

Conclusion of session:

The session was concluded with an opportunity for report back by the small groups. The lecturer "used the SAIDE material [as] a trigger for structured reflection" (Lecturer 3 Observation notes Site B, p. 3). Due to time constraints, there was only time for one report back.

4.3.2.4 Assessment

The assignment for the course referred directly to Unit Three. It called on the students to reflect on learner problem-solving strategies case studies and guidelines given in Unit Three.

Figure 4.12: Extract from assessment artefact, Site B

Assignment on Teaching through Problem-solving

1) Read the two case studies in the beginning of Unit Three and give your own response to the first activity in the Unit.
2) Select three problems from your Maths Challenge booklets and ask your learners to solve the problems. Record the different strategies they use. When you submit your assignment include the problems as well as the strategies used.
3) Read the four basic steps to consider in designing a problem-solving lesson – page 26 in Unit Three.
4) Design a mathematics activity using these four basic steps. The activity must be problem-based and suitable for the grade that you teach.

You will be assessed according to the following criteria:

- Able to critically explain which approach is the most preferred approach and why
- Able to explain critically which approach allows for meaningful construction of ideas
- Able to provide evidence of three examples chosen and the problem-solving strategy used.
- The chosen activity in Q3 is problem-based and suitable for the particular grade.
- The activity chosen promotes thinking, understanding and lends itself to some discussion.

The assignment content related to the contact session. Lecturer 3 said that it "was done very well by the majority of the student[s]" (Lecturer 3 Questionnaire 3 Site B, p. 1).

4.3.2.5 Student Questionnaire

The positive response of the students (teacher-learners at this site) is confirmed by their responses in the student questionnaire. Students said things such as:

- The materials should be sent to all schools for the use by maths teachers.

- The Department of Education should recommend the use of the materials.
- SAIDE OER material really showed me a whole new way of teaching.
- It offers material that is relevant to our teaching and learning of learners.
- They are so useful in the sense that I can be pleased if SAIDE can invent more material as it helps our children.
- I recommend and thank them for their support and following up adults in improving their education standard.

Students did also have criticisms and other negative comments, the most commonly expressed of these views at this site related to the amount of time needed to read the materials:

- The materials are too big for a short period of time.

Even though the students' exposure to the ACEMaths materials at Site B was so brief, they had a chance to see and read them, and form their own opinions of them. This shows the potential of the ACEMaths materials to reach and inform the teachers who use them. It is interesting that so many very positive comments were made by students at this site, where the materials were very peripherally put to use.

4.3.2.6 Lecturer interview and questionnaires

Lecturer 3 used the whole of Unit Three, and parts of Unit Two. He said that although the students were positive about the material, "many don't like reading and so I am not sure how much they actually read and comprehended" (Lecturer 3 Questionnaire 2 Site B, p. 2). The observer noted at the site visit that the "students were supposed to have read [Unit Three] but many hadn't actually done so" (Lecturer 3 Observation notes Site B, p. 2). The lecturer interview was brief and reflected the peripheral use of the materials at this site. Lecturer 3 had a lot to say about his future intentions for using the ACEMaths materials. He used parts of Unit Two in 2007, and stated that "Unit Two will be scaffolded and used again, with other materials" (Lecturer 3 Questionnaire 4 Site B, p. 1). For 2008, he planned to give the teachers Unit Three as pre-reading hoping that he would be able to monitor a little more carefully how much the students actually read. He also hoped to be able to use more of the materials should it fit in with the course plans. For 2008 he planned to use Unit One as the basis

for all the work on patterns which he did with his students in the ACE (MST) and ACE (Science) courses, concentrating on NCS Learning Outcome 2: Patterns, Functions and Algebra. This is because Unit One has a large amount of material on working with patterns.

Lecturer 3 had intended using Unit Six with his students in 2007, but he "did not manage to get to it" (Lecturer 3 Questionnaire 3 Site B, p. 1). He ascribed this in part to poor planning, saying:

> I think planning is very important. Aspects we intended doing, we did not do – Unit Six. … I felt it was necessary for all ACE students. I intend this year [2008] to try Unit Six with the B Ed (in-Service). (Lecturer 3 Questionnaire 3 Site B, p. 1)

He said that he would "like to try and implement Unit Six with [his] B Ed (In-Service) group using [Lecturer 1 and Lecturer 2]'s ideas" (Lecturer 3 Questionnaire 4 Site B, p. 1) integrating them somehow. His final comment on Unit Six was that "maybe [I should] adapt Unit Six, change it slightly by summarising certain parts so as not to make it such a big document" (Lecturer 3 Questionnaire 4 Site B, p. 2).

Lecturer 4 used her own materials for the teaching of constructivism in mathematics teaching. She said that Unit Two on constructivism had "too much complicated mathematics which obscured the major points relating to constructivism" (Lecturer 4 Interview Site B, p. 4). She shared the readings that she used when teaching the topic of constructivism with the collaborative team, and some of these were used as references in the revised version of the ACEMaths materials.

4.3.3 Case 3: Site C

4.3.3.1 Background

The university at which Site C is situated was formed from the merger of two technikons in 2003. The merger process was complex and had started several years earlier. The campuses where teacher education takes place (two former colleges of education) were incorporated into one of the technikons in 2001, to form the Faculty of Education and Social Sciences. Mathematics education lecturers are involved in

teacher education on both campuses. English is the language of instruction at Site C where the home languages of the students are predominantly English, Afrikaans or isiXhosa.

Implementation at Site C was in the context of a B Ed Intermediate/Senior phase in the GET band. The B Ed is a full time pre-service programme. Students can select to specialise in mathematics in their third and fourth year of study. The lecturer used the ACEMaths materials with students in the B Ed3 Intermediate/Senior phase registered for the *Mathematics Specialisation* module. She also used it with the B Ed4 Intermediate/Senior phase *Mathematics Elective* module. These students qualify to teach maths from Grade 4 to Grade 9. Both courses have one 45 minute period a week for 24 weeks.

The number of students in each year varies a great deal. The fourth year group with which the lecturer used the materials had 6 students in the class, while there were 20 students in the third year group. In general there are between 25 and 30 students in each class depending on registration for the year. Lecturer 5, involved in the implementation at this site, has 7 years of mathematics school teaching experience and 14 years of mathematics teacher education experience. She has a masters degree from a South African university and is registered for a doctoral degree at a South African university.

4.3.3.2 Materials

Initially the lecturer thought that she would use Units One, Three and Four with the third years and Unit Six with the fourth years. Ultimately she used three of the units with the two student groups. The third year didactics course for maths specialization students is about the teaching and learning of mathematics. Lecturer 5 decided to use Units One and Two as readings for that course. She said that "I liked the overall structure of the units, it appeared to address all aspects of mathematics education and gave you the chance to focus in depth on one or all of the topics" (Lecturer 5 Questionnaire 2 Site C, p. 1). The fourth year students have a compulsory period once a week on remedial mathematics, in which they learn about coping with different kinds of learners. The lecturer used Unit Six with this group. She said:

> I had a look at the whole course, obviously I worked through the materials, and I saw the last one, the unit six, … it works beautifully … with my remedial group … So this… the reading from unit 6 is a really nice background. (Lecturer 5 Interview Site C, p. 3)

She used the materials as readings in courses for which other readings were also recommended. Having read through the units that she had selected from the ACEMaths materials more closely, she thought that they were quite dense in places, and so she decided to structure the students' reading of the material on a week by week basis. Lecturer 5 mediated the reading by assigning a particular section for reading between each of the weekly lectures. "I broke it up into sections" she explained (Lecturer 5 Interview Site C, p. 7). She also set a particular activity or set of questions for the students to think about which would focus them on the content of the reading for that week. After that, in each session they discussed the content further, to clarify student questions. They also reflected in greater depth on the particular content and its relation to teaching mathematics in the Intermediate and Senior phases. "We unpacked the main points for reflection" (Lecturer 5 Questionnaire 2 Site C, p. 1). The discussions were carefully structured to ensure that the students had covered the material and were able to understand its content.

4.3.3.3 Session observation

The final discussion that the lecturer had with the fourth years counted as an oral mark towards their assessment for the course. She had told the students that they were not going to be allowed to attend the discussion (which they called an interview) unless they had read the whole of Unit Six and were ready to answer questions that she would ask them. In the interview session, two of the students indicated that they had not completed the reading. The lecturer negotiated with them and they remained in the class, since they felt able to answer questions based on what they had been able to read and on their experience.

Session introduction:

The lecturer and students greeted one another and sat together around a table, to create an informal atmosphere for the interview. She opened by saying "we will be doing interviews today based on your reading of the materials" (Lecturer 5

Observation notes Site C, p. 1). The lecturer then asked the students to take out their printed materials since she was happy for them to refer to these materials during the interview.

Body:

They had a group discussion, which the lecturer led by asking questions. Some students responded voluntarily, and sometimes she prompted particular students to respond. For the purposes of assessment, she made sure that they all participated in the discussion and she made notes. She asked several questions, many of which she had prepared, but others which emerged from the flow of the discussion. These questions are given in more detail below.

The lecturer started the discussion by asking:

- What is the inclusive education policy? What in this policy is important for us to be aware of as teachers?
- What are the factors that can affect learning?
- What are the strategies for coping with diverse learner groups in a class? (Lecturer 5 Observation notes Site C, p. 1)

This led into a discussion of the theories that can be used to explain (and understand) learners with special educational needs:

- What are the key factors in each of the theories? First the environmental theory, then the maturational lag theory and then the ecosystemic theory. (Lecturer 5 Observation notes Site C, p. 2)

The next focus of the discussion was the idea of barriers to learning, and how to deal with these barriers:

- What are the barriers to learning?
- What did you learn from Unit Six about dealing with disability as a barrier?
- What are 'high expectations' and how does this fit in with teaching learners with special educational needs? (Lecturer 5 Observation notes Site C, p. 3)

In the final part of the discussion the students spoke about the 'case study' learners from Unit Six and what the students had learnt about coping with classes with diverse learner groups.

Conclusion of session:

Throughout the discussion the students drew both on the theory in Unit Six and on their experience gained in schools while on teaching practical. The lecturer pushed them to think about applications of the theory in practice. In closing, she encouraged them to go back to the text and make further links between what they had seen in the classrooms and what they had read in Unit Six.

4.3.3.4 Assessment

Assessment for both courses was based on discussions in class such as the one described above. Both groups of students also had to complete a major assignment for submission on completion of the course. The B Ed 3 assignment did not specifically refer to the ACEMaths materials although it followed the content of Units One and Two closely. Students used the units together with other resources as reference material when completing their assignments. The lecturer said very definitely that students should not only refer to the ACEMaths materials in completing the assignment, but the links between the itemised topics in the assignment and the ACEMaths unit were strong. This can be seen by the page references showing links between assignment topics and Units One and Two (added in brackets to the assignment statement below):

Figure 4.13: Extract from assessment artefact, Site C

B Ed 3 Mathematics Didactics Assignment 2007

You are expected to write a critically reflective essay based on Units One and Two of Teaching and Learning Mathematics in Diverse Classrooms.

The essay should consider the following topics:

- an historical overview of mathematics education in South Africa [Appendix M, pp. 1-4]
- the traditional approach to teaching mathematics and the constructivist approach [Appendix M, pp. 5-10]
- "mathematics as a science of pattern and order" [Appendix M, pp. 10-11]
- the classroom environment [Appendix M, pp. 17-19]
- constructed learning as opposed to rote learning [Appendix N, pp. 2-9]
- 'understanding' in terms of the measure of quality and quantity of

connections [Appendix N, pp. 9-11]

- the two types of knowledge in mathematics: conceptual knowledge and procedural knowledge [Appendix N, pp. 19-26]
- the role of models in developing understanding in mathematics [Appendix N, pp. 32-38]
- the uses of models in a developmental approach to teaching [Appendix N, pp. 38-41]
- the foundations of a developmental approach based on a constructivist view of learning [Appendix N, pp. 26-28]
- strategies for effective teaching [Appendix M, pp. 20-28; Appendix N, pp. 28-32]

The essay should thoroughly explore what it means to 'do' mathematics and to develop understanding in mathematics. It should be more than a summary of the units and should critically engage with the key issues mentioned above. You are encouraged to include other literature that `supports your essay. The essay must be presented in such a way as to demonstrate sophisticated reasoning and in a manner which is clear, well-focused and cogent.

A checklist for teachers to use to ensure that they had satisfied all of the conditions for the assignment, and two rubrics designed to give feedback to the students on their essays and the bibliographies were given out together with the assignment statement.

Many students referenced the ACEMaths in their bibliographies, and there was evidence of their use of the materials in their assignments. The external marker's comments indicated that the students had reached an adequate level of understanding of the main points:

> I actually got an external person to mark them, and he felt that they had actually got the essence, so in the reading and the discussion, I think they had picked out the main things. There were some things that they really didn't grasp at all and they sort of struggled with… and that comes more in the second unit. (Lecturer 5 Interview Site C, p. 8)

In her discussion with the external marker they concluded that the students' had a polarised view of the construction of knowledge which may have been encouraged to a certain extent by the ACEMaths materials:

> What he found, and it was interesting … because I found the same thing in discussion, his observation, was that the students … think that the theory of mathematics and how you construct knowledge … is black and white…

> They think it's about behaviourism versus constructivism. (Lecturer 5 Interview Site C, p. 9)

She thought that Unit Two could be improved by creating less of a stereotypical view of a traditional mathematics classroom. Lecturer 5 did however comment that "I wouldn't add any more materials because they are already dense" (Lecturer 5 Interview Site C, p. 10), suggesting that it could be useful it to "take out the things that are maybe sort of peripheral" (Lecturer 5 Interview Site C, p. 10).

4.3.3.5 Student Questionnaire

Positive comments from this student (learner-teachers at this site) group included:

- The way of teaching was more interesting than the rest of the didactics done in the course.
- The activities helped me to reflect on the text.
- It has a lot of information based on the new curriculum.
- We enjoyed the information about the history of maths as a subject.
- All the materials were useful as it explains what to do when it comes to your learners with similar problems.

An interesting negative comment from a student at this site was:

- The text tended to repeat itself, which was interesting to read, but when choosing information for essays the repetition made it difficult.

But this comment could be interpreted in either a positive or a negative way. The positive, from an educational viewpoint, was that careful reading was required when using the text as reference material. The negative relates to the amount of information in the ACEMaths materials, which at times was found to be overwhelming by the students.

4.3.3.6 Lecturer interview and questionnaires

Lecturer 5 ran discussion groups with her third year students on a combination of readings from Units One and Two and another selected reading written by a colleague of hers. She said that "they all said to me at the end of this … this was the best thing that we have done" (Lecturer 5 Interview Site C, p. 17). She had asked them to rate

their knowledge and understanding of the readings before and after the discussion sessions and they noted a marked improvement as a result of the discussion. She said that "when you are dealing with dense material like this … to allow people to engage and for you to ask questions and to ask questions of them … or to clarify meaning, there's a huge difference" (Lecturer 5 Interview Site C, p. 18).

She spoke enthusiastically about her use of the ACEMaths materials which had raised questions on the nature of curriculum development in South Africa. The third year students had commented on the political aspect of curriculum development. This was exciting for her, as well as surprising, since she thought that she had covered these ideas in previous courses but "suddenly … students were going… maths is political… and maths is social… and then it led to so many other discussions" (Lecturer 5 Interview Site C, p. 25).

Lecturer 5 commented on her use of Unit Six with her fourth year students, saying "I have been aware that they need to know more about the kinds of theory that talks about diverse learners" (Lecturer 5 Interview Site C, p. 4). The fourth years seemed to have enjoyed the reading and learned a lot from it as observed by the researcher who noted that "the students spoke about the theories of teaching and learning, their implications for diverse classes and how these ideas could help them to cope with diverse classes" (Lecturer 5 Observation notes Site C, p. 5).

The length and complexity of the ACEMaths materials was presented by Lecturer 5 as potentially problematic. The researcher observed that "the discussion moved very fast and there was not always enough time to follow up answers in depth" (Lecturer 5 Observation notes Site C, p. 5). This was because the lecturer was trying to cover so much material (all of Unit Six) through discussion in one 45 minutes session. Lecturer 5 made several comments noting the length and complexity of the ACEMaths materials.

- Students found the text long and complicated. There is a lot in the materials. It is a heavy text and requires a high level of thought and reflection. (Lecturer 5 Questionnaire 2 Site C, p. 2)
- It is very dense… and difficult to read. (Lecturer 5 Interview Site C, p. 7)

- Volume. I mean there is just a lot of stuff there. (Lecturer 5 Interview Site C, p. 22)

Lecturer 5 saw the community of practice established through the collaborative platform which was set up by SAIDE for the development of the ACEMaths materials as useful and helpful. At the end of her interview she spoke at some length about this. She said that:

> We all have common understandings, but we don't have shared understandings… We don't communicate, we don't have a collegial kind of thing, and this created that opportunity to be able to meet everyone … it was wonderful!" (Lecturer 5 Interview Site C, p. 31)

She said that through the meetings and discussion you could confirm that you were "on the right track" (Lecturer 5 Interview Site C, p. 32) and you could also learn new ideas to use in your lectures.

In 2008 Lecturer 5 used the materials with the third and fourth years again. This time she adapted the units so that they fitted in better with her other course materials. She also planned to use the other units where appropriate in her B Ed 1 and B Ed 2 didactics courses, building more of them into the overall B Ed (GET Maths) programme. She said that she would discuss the modules with other colleagues and encourage them to make use of the materials in their courses. She added that she would like to use parts of the ACEMaths materials with the PGCE students at some point:

> I haven't used it with my PGCEs yet because their knowledge of content is so, so weak, that I have been kind of trying to work on knowledge and changing their experience … [but] there are bits of it that I would like to use … especially on the theories. (Lecturer 5 Interview Site C, p. 12)

4.3.4 Case 4: Site D

4.3.4.1 Background

The University at which Site D is situated offers a wide range of courses, with teacher education taking place on the Education Campus. Three different teacher education colleges were merged with a university to create the new institution which now exists

at Site D. Legally and administratively, the incorporation of the merged university was completed in 2001. English is the language of instruction at Site D where the home languages of the students are predominantly English, Sesotho, Setswana or isiZulu.

This site offers an ACE course with a specialization in Learners with Special Educational Needs (LSEN). In 2007 there were about 35 students in the class, coming from South Africa, Swaziland and Lesotho. They teach in urban as well as rural areas. The ACE (LSEN) programme is a mixed mode, block release programme. The lecturers give the students materials and assignments to study and complete independently during term time, but the students also attend contact sessions at the university during school holidays. These contact sessions are known as residentials since the students are resident at the university during these periods. Lecture sessions during a residential are two hours in length.

The Education Campus in which Site D is situated is ideally equipped to provide quality tuition to thousands of students. Lecture rooms have overhead projectors and boards, some have data projection facilities and computer laboratories are also available for use by lecturers and students. The lecturer (Lecturer 6) involved in the implementation at this site has 18 years of experience as a tutor of second language English, 10 years of experience in tertiary teaching: predominantly in the areas of LSEN, Language Enrichment, English and History. She has a masters degree from a South African university and is presently completing a doctoral degree at a South Africa university.

4.3.4.2 Materials

Lecturer 6 used the whole guide, all six units, together with their appendices, as produced by the collaborative team. The contribution of Lecturer 6 to the development of the ACEMaths materials was based on her expertise in the field of learners with special educational needs. Although she felt rather out on a limb as a special needs expert in a group of predominantly mathematics education specialists, she made her mark early in the discussions, during which the focus of the materials was being considered as can be seen in the name of the ACEMaths guide: *Teaching*

and Learning Mathematics in Diverse Classrooms. Everyone present at the initial materials development workshop agreed that it was not sufficient to prepare a guide simply about teaching and learning mathematics which did not give insight into dealing with the diverse learner groups that teachers have to cope with in South African Schools today. Hence the "diversity" element was introduced in the title of the guide and was kept in mind for the planning of all of the units that make up the guide.

The materials development team discussed ways of integrating this information into a maths teaching unit guided by Lecturer 6 and other participants who had experience in the field of special needs education. Two ACE (LSEN) chapters from Module 3 *Understanding Cognitive, Emotional and Motivational Differences in Development* of the materials were used in Unit Six (Appendix R). One was adapted and incorporated into the main body of the unit and the other was used as an additional reading for the unit. Lecturer 6 was used as an expert guide in the selection and adaptation of extracts from her materials. Since there are such different ways of talking about learners with special educational needs, she suggested that some theoretical background and critical comment on what this theory has to offer needed to form part of the materials. Lecturer 6 commented positively on the collaboration and development of the ACEMaths materials, saying:

> I just think that the process of collaboration, from the very beginning and the way that it was filtered in and the way that it was structured… The product was exceptionally well brought together, it flows, and I like that it can be adapted to fit in with the layout of another programme. I really liked that. (Lecturer 6 Interview Site D, p. 4)

The theories which are described in the ACE (LSEN) materials and which were incorporated into the ACEMaths materials are:

- the medical model theory,
- the environmental theory,
- the maturational (developmental) lag theory and
- the ecosystemic theory.

The inclusive education policy (DoE, 2001) and the expectations it has of teachers form the other substantial part of the content presented in Unit Six (Appendix R).

Aspects of this policy and their implications for classroom teachers addressed in Unit Six are:

- Understanding and responding to barriers to learning and development,
- The importance of high expectations and
- Attitudes to difference.

The ACE (LSEN) course materials had recently been fully accredited by the CHE with two commendations. They had also been awarded the NADEOSA courseware award (2006) and the COL Award of Excellence in Distance Education (2006). In spite of this Lecturer 6 still felt that their mathematics module needed improving. She said:

> I was very excited about the whole module. I think, it had… we've been trying to do this for a long time, many years… and we didn't have maths specialist knowledge. So these are all the things that came together. (Lecturer 6 Interview Site D, p. 2)

She explained that the ACEMaths materials met the requirements that she had for her module, saying, "So basically your maths module as a whole fitted in with all the other modules in the ACE (LSEN) because it had learning theory, it had a diverse approach, it had the notion of language in the use of maths" (Lecturer 6 Interview Site D, p. 2). When asked if her expectations for the course materials were met she replied, "No, they were exceeded! They were far exceeded" (Lecturer 6 Interview Site D, p. 5). The ACE LSEN module in its old form was entitled *Understanding Numeracy Based Learning: Problems in the Classroom and Ways in which we can help learners overcome them* but Lecturer 6 renamed it *Teaching and Learning Mathematics in Diverse Classrooms*, in line with the name of the ACEMaths module.

4.3.4.3 Session observation

In this programme lecturers introduce and complete a module over two residential periods. They introduced the *Teaching and Learning Mathematics in Diverse Classrooms* guide to their students in the April residential (when they had six 2-hour sessions), and the students then had to go away to work on their portfolio and journal activities, as well as their assignments and examination equivalent task for this course, all of which were due for submission at the next residential in July. At the July

residential they then had five 2-hour sessions where they could review the materials in a structured way, guided by the lecturer. In these sessions students could raise questions about the content and discuss these with the whole group.

In the observed session on decoding, Lecturer 6 referred to all of the units, but primarily to Unit Three, which focused on problem solving in the mathematics classroom.

Session introduction:

Lecturer 6 selected some decoding activities from the residential guide that she had prepared for this module to accompany the ACEMaths materials. The group set about solving these problems, working in groups. "There was a buzz of activity in the class as the students worked enthusiastically on the decoding activities" (Lecturer 6 Observation notes Site D, p. 1).

Body:

After the decoding activities, they moved into a whole class discussion on the activities. Here is an example of some of the questions taken from the residential guide prepared by Lecturer 6.

Figure 4.14: Extract from residential guide, Site D

Here are some secret messages to decode. Once you have discovered how each code works, you can use it with your friends.

In this message, numbers are obviously used for letters. Here's a hint – everything is in the proper order:

4 5 3 15 4 9 14 7 9 19 6 21 14

Look very carefully at this message:

ITI TALLIN HO WYO ULOO KATIT

The clue for this message is – backwards:

GSV ZOKSZYVG RH GFIMVW ZILFMW

Lecturer 6 asked guiding questions as they worked though the activity as a whole class, such as:

- Does the question make a link between the letters of the alphabet and numerals?

- Can you identify the code that creates the link between the letters of the alphabet and numerals?
- When would you use such an activity?
- Who would you use this activity with?
- How is this different from other problem solving activities which you would use with the whole class?
- What was the basic mathematical concept needed to complete the problem? (Lecturer 6 Observation notes Site D, pp. 1-2)

These questions prompted discussion on different learner types and when and why scaffolding is needed to help them to work through mathematical problems. The discussion also enabled the students to realise that maths is not just about numbers and counting, it is about doing all sorts of things with those numbers, including making links and solving problems.

Lecturer 6 then made links to other theory in the course. For example, she directed the students to the page where barriers to learning are mentioned in the guide, giving them the page reference. She asked them to think of examples of poor socio-economic status as a barrier to the learning of mathematics. She asked them how they think they could assist learners with these barriers to learning to cope with mathematical problems such as the ones they had just worked through in the lecture. The students raised and discussed several responses which the observer noted, such as

- Make it fun;
- Motivate;
- Get them involved;
- Make it relevant to the learner;
- Make sure its stimulating and at the right level;
- Offer support in the form of manipulatives, mediation, scaffolding;
- Give them pens and paper if they need them;
- Love and respect them and
- Bridge the gap. (Lecturer 6 Observation notes Site D, p. 2)

The theory of constructivism and how it applies to teaching learners with barriers to learning was then discussed. Lecturer 6 put forward the idea that "teaching in the ways they had just discussed is constructivist teaching in practice" (Lecturer 6 Observation notes Site D, p. 3). The final question discussed was "How does this

apply to assessment and working with the LOs from the NCS?" (Lecturer 6 Observation notes Site D, p. 3).

Conclusion of session:

Teachers spoke about the need for support specialists in all schools, as part of school or site based support teams and as part of district based support teams for the promotion of an inclusive education and training system that would accommodate all learners. They discussed how this should be the case but that in reality in South Africa very few schools have this type of support. They spoke about the importance of fair assessment based on questions which are set at the correct level, and which are properly scaffolded, to enable all learners to access the questions and answer them to their best ability.

4.3.4.4 Assessment

Students enrolled for the ACE (LSEN) course have to submit several journal and portfolio activities, two assignments and an examination equivalent task. In the third assignment for the ACE (LSEN) Module 6, entitled "Transforming teachers, transforming education" students are called on to indicate what they have gained through their study of each of the modules that make up their ACE (LSEN) programme. The students indicated that they had benefited greatly from Module 5, as the following extract from one of the submissions indicates:

Figure 4.15: Extract from assessment artefact, Site D

Transforming teachers, transforming education

In this report I am going to carefully and critically state what I have learnt from the ACE LSEN course as a whole. … My discussion will be in sequential form, starting with what I have gained from the first module up to the last one. …

In module five I have learnt what mathematics is and why it is taught in schools. Before reading module five I viewed mathematics as a subject which is all about learning a collection of rules arithmetic computations, mysterious algebraic equations or geometric proofs an individual must learn in order to pass an examination. However module five has helped me to develop a better understanding of mathematics. I now view mathematics as a subject which involves making sense of mathematical ideas, patterns and information. It is also a learning area which involves how to approach problems, find and explore regularity in patterns and make sense of relationships.

This module has helped me to learn that mathematics is taught to empower learners with mathematical skills such as problem solving, estimation to assess reasonableness of answer, computation skills, investigatory, exploration of rules and logical thinking as well as self discovery and formulating expressions as a mathematical model.

I have also learnt that teaching mathematics in schools helps learners to construct their own understanding of new concepts. Through relational understanding a learner is able to associate an idea with others in a rich network of related ideas. Instrumental understanding helps learners to retain information they have learnt through rote which is loosely connected or isolated from each other. Through group work, learners are able to help each other and construct their own understanding of new concepts. In this way schools enable learners to use the mathematical skills they have acquired not only in class but also apply them in real life situations. The module has also taught me how to instruct or teach more effectively and inform parents about how best they can support their children's learning.

In conclusion, module five has also helped me to prepare tasks to suit learners with diverse needs so that every learner benefits. Therefore I teach mathematics to all learners to help them form mathematical concepts and be able to solve problems they encounter in the classroom situations as well as in everyday life experiences.

4.3.4.5 Student Questionnaire

The views of students (teacher-learners at this site) from Site D confirmed the use of the materials at this site as successful. Students said things such as:

- The materials are better than a text book.
- They have let me understand so many things I didn't understand previously.
- It assisted me to change my way of teaching.
- They are thought provoking, challenging, bring change in my lesson and task planning.
- They promote creative thought.
- I liked the problem-based approach.

There were also negative comments from students at this site, relating to the amount of time available for the course in relation to "bulk", complexity of the material, and the level of the mathematics tasks:

- I would like to spend more time on the material in the course.
- The Data Handling activities were very time consuming.
- The module has too many activities.
- Only do you understand when reading this book?

- Some of the activities are not easily understood.
- Modify to apply to grade, to cater for all levels.
- Not using the algebra because teaching Foundation Phase.
- Material needs to cater for Foundation Phase learners too.
- Give necessary background material for non-specialists.

Some comments from Site D are interesting since the ACEMaths materials are OER and will be available to any user after the pilot phase.

- The questions are directed to maths specialists while it has to reach even those who are not specialists.[57]
- The policy documents referred to were South African policy documents which are difficult/not relevant for us to read.[58]

These comments point to areas where adaptation to the materials may be needed by users from a non-mathematics, non-South African user-group.

4.3.4.6 Lecturer interview and questionnaires

When Lecturer 6 had an evaluation session at the end of Module 5 with her student group, initially the overwhelming response to the ACEMaths materials was negative. She noted that the students "found it challenging and difficult regarding the number of activities, not all of the students finished" (Lecturer 6 Questionnaire 2 Site D, p. 2). There were negative comments about the amount of reading it entailed, the amount of time they had had to spend on doing activities from the text and on the difficulty that they had had with the mathematics content. As she put it, "They all started with what they hated, and they hated quite a few things" (Lecturer 6 Interview Site D, p. 7). Then as their evaluation discussion continued, she noticed that the positive comments began to flow, and as a group the students concluded that the guide had been remarkable – they had learnt so much and grown so much, through all the hard work (that caused the initial complaints) – that they were very pleased to have been exposed to this material and to have been forced to come to grips with ideas that they had never imagined were within their grasp. "Yes, but they loved much more than what they hated" (Lecturer 6 Interview Site D, p. 7). But the negativity had disturbed Lecturer 6 who said, "I was feeling a little bit… because it was such a good module

[57] Not all of these students have a mathematics background.
[58] Many students in this group are not South African.

and the students were like, we didn't like this and we didn't like that and…and they all said 'It's so hard'" (Lecturer 6 Interview Site D, p. 7). She said that only when she marked their assignments did she know for certain that the decision to use the materials had been a good one, because even for her there had been moments of anxiety, when she saw and heard about the struggles of the students. "[We] were basically finding out what was happening as it went along… and when I read their assessment, of module 5, … I was happy" (Lecturer 6 Interview Site D, p. 7). She commented the "the overwhelming response was that they wished that they had been taught like that themselves, earlier" (Lecturer 6 Questionnaire 2 Site D, p. 2).

Similarly to some of the lecturers at other sites, Lecturer 6 said that she herself had benefited from using the ACEMaths materials. "I have learnt from it, my students have learnt from it, and it has brought about change in the way they think about [maths]" (Lecturer 6 Interview Site D, p. 13). For her the gain was in relation to what she learned about mathematics from the guide. She felt that the students had benefited most from Unit Six and its readings, but for her group this was because of the way it linked to their other ACE (LSEN) materials. As she said:

> That particular group of students because they already knew those learners, and then to have activities subtly changed to put a maths emphasis worked extremely well, and made them feel, I think… I think a few of them felt a bit isolated in the beginning, but when it came to the end and they saw how they could link what they had been studying before, everything fitted together. (Lecturer 6 Interview Site D, pp. 13-14)

Lecturer 6 used the entire ACEMaths guide again in 2008, but in a revised format which was the same as the format of the guides for the other modules in the ACE (LSEN). Part of the panic induced in the students was as a result of the number of "activities" in the text. These activities were not all complex, some just called for a little time to "stop and think", others required discussion with peers, and others required reading and research which would take more time. In her revised version of the materials, Lecturer 6 labeled as "activities" only those tasks which she expected her students to spend more time on and for which she expected written submissions, since this is the style in her other modules. She also took out some of the more complicated mathematical activities that she thought were not necessary for her students, and replaced them with more suitable activities. She said of her revisions:

> I wouldn't say there are major differences, I would just say it was a layout choice. We chose to have a particular layout. (Lecturer 6 Interview Site D, p. 9)

She was confident that the revised format would be well received by the ACE (LSEN) students. She commented that she sees revision as "one of the strengths of the materials, that each institution, or each grouping, can actually do its own thing" (Lecturer 6 Interview Site D, p. 9).

4.3.5 Case 5: Site E

Site E is the site at which I was one of the lecturers (Lecturer 9) and I was also co-ordinator of the Maths ACE programme. I worked with two part time lecturers in the delivery of the course in which the ACEMaths materials were used. They lectured the FET groups and I lectured the GET group. I observed a session led by both Lecturer 7 and Lecturer 8 for the purpose of this research. Student questionnaires were completed by all three of the groups and I have included the GET questionnaires in the analysis of the student questionnaires.

4.3.5.1 Background

Site E is situated in an independent NGO affiliated to a university. The NGO was established in the 1980s. At that time, the focus of its work was to assist with bridging the gap between school and university level mathematics and science for disadvantaged learners, but staff members at Site E became involved in a variety of teacher education projects soon after the inception of the organisation. Site E moved more into the area of teacher education when the School of Education at the university asked the NGO staff to take responsibility for the development and implementation of the ACE programmes for Mathematics and Science. Initially the majority of the students enrolled for the ACE programmes at Site E came from rural areas, but there have also always been some students from urban areas. English is the language of instruction at Site E where the home languages of the students are predominantly English, Sesotho, Setswana or isiZulu.

Site E used the ACEMaths materials in two ACE mathematics programmes (specialising in FET or GET mathematics teaching). Each specialisation has about 30 students per class, with 60 in each year, although registration does vary from year to year. The ACE programme at Site E is a mixed mode, block release programme[59]. In addition to study materials students at Site E receive a fully itemized weekly programme to help them structure their independent study time. Site E also offers support workshops. These are additional weekend contact sessions, where lecturers return marked assignments and discuss them with students, give additional teaching in areas where they have identified that students have difficulty and give the students further opportunities to raise their own questions in discussion.

The lectures at Site E take place on the campus of the university to which the NGO is affiliated[60]. The Site E NGO facilities on the campus are also used by some lecturers during residentials and support workshops. Students are able to contact their lecturers and visit them during periods of independent study between residentials. Lecturer 7 has 10 years of school mathematics teaching experience, 6 years of mathematics teacher education experience, 20 years of experience of teaching mathematics at a tertiary level and a doctorate from a South African university. Lecturer 8 has 6 years of mathematics school teaching experience, 6 years of mathematics teacher education experience and an H Dip Ed and a B Sc degree from a South African university. Lecturer 9 has 6 years of school mathematics teaching experience, 15 years of mathematics teacher education experience and is currently registered for a masters degree at a South African university.

4.3.5.2 Materials

The lecturers at Site E used the whole guide, all six units, together with their appendices of the ACEMaths materials, as produced by the collaborative team. They had previously been using the published book *Getting Practical about Outcomes – based education (SAIDE/OXFORD)* as their course materials for their course on Learning and Teaching Mathematics. This book is a general book about teaching and

[59] The contact sessions at Site E are residential sessions that are run in the same way as the residential sessions at Site D, since these two sites are situated at the same university.
[60] This is the same campus at which Site D is situated.

learning, written for all learning outcomes in the South African curriculum. Lecturers had always supplemented the content of the book by providing activities or references specific to the mathematics curriculum when these were not provided in the published book. Lecturers had made the decision that the book was becoming too expensive[61], and that they would have to develop a course guide of their own. It was exactly at this time that SAIDE initiated the ACEMaths OER project. The timing was perfect, and the lecturers at Site E were able to use the ACEMaths materials to replace the published book instead of having to develop a whole guide themselves. At the workshop where all lecturers had to give their commitment to be involved in the pilot implementation process, Lecturer 9 said the reason for intending to use the whole guide was because, "we usually present our courses with a guide or book which is substantial and covers the content we would like to cover in the course" (Lecturer 9 Questionnaire 1 Site E, p. 3).

The content of the *Teaching and Learning Mathematics in Diverse Classrooms* guide covered all of the aspects that the lecturers at Site E considered important. Lecturer 8 said that, "I think each unit had something that my students had to cover in this module so I think it was important" (Lecturer 8 Interview Site E, p. 2). She also commented that, "I looked at last year's course book and this one was miles ahead of that one, I think because it is so much more focused on maths" (Lecturer 8 Interview Site E, p. 5). Lecturer 7 said that "the content is good and everything here is important for students to know" (Lecturer 7 Interview Site E, p. 10). The added focus presented in Unit Six on diversity added to the scope and richness of the course.

> I think in terms of actual practical implementation of teaching in a diverse classroom, Unit Six was definitely one of the strongest points of the textbook. And I think in terms of psychological evaluation of all the learners, it was really insightful. (Lecturer 8 Interview Site E, p. 13)

Additional FET and GET mathematical activities for use in the residential were selected by Lecturers 8 and 9 respectively. The FET lecturers both commented that for the purposes of their student group it would have been better if the guide had been adapted more to suit the FET level. Lecturer 7 referred to one activity:

[61] Not only was the published book becoming expensive but supplementing the content was also time consuming and confusing to some of the students.

> … for example activity seven on page 137 with the nets and the box without the lids and that. I know I was pressed for time, but even with this, they just didn't want to really engage with this activity. They didn't see the use of it you know. (Lecturer 7 Interview Site E, p. 3)

This particular activity was a geometric activity that required the students to make nets of 3-dimenstional shapes. This is GET level content, and although FET teachers should be able to do the activities, Lecturer 7 said that they were not familiar with the content and not able to do the activity.

> When you are doing things like nets and volumes and all that, and they are not familiar with it, they feel threatened. … They don't want you to come around and look what nets are they drawing what they are doing. Whereas with the others [FET level activities] they were quite open with their activities. (Lecturer 7 Interview Site E, p. 3)

She said a little later in the interview, "now that I am more familiar with this material, I would probably adapt some of these activities" (Lecturer 7 Interview Site E, p. 4). Lecturer 8 said that "I think I actually did adapt some of the activities, because I was teaching FET" (Lecturer 8 Interview Site E, p. 2). But she also spoke about the need to adapt the text further, referring to the OER nature of the ACEMaths materials – that they are adaptable by users and that users can adapt them for their own purposes.

> I think my only problem was a few more practical FET level examples and activities for my teachers would have been great. … but I guess that is our duty as lecturers to now take this and adapt it further for our own classes and add our own activities. (Lecturer 8 Interview Site E, p. 5)

4.3.5.3 Session observation

The residential programme at Site E is run in the same way as the residential programme at Site D[62]. The planning of the sessions based on the ACEMaths materials was done predominantly by Lecturers 8 and 9, since Lecturer 7 did not have as much time available. All three lecturers discussed the plans before teaching commenced, and the two FET lecturers were in daily contact during the residential to discuss ongoing delivery and issues that arose during the presentation of the lecturers. Lecturer 8 prepared all of the summaries for the sessions. Lecturer 9 cross-checked these summaries and finalised them before they were printed as overheads and hand-outs for the students.

[62] See 4.3.5.3.

4.3.5.3.1 Lecturer 7

Assessment was the focus of the observed lesson led by Lecturer 7. This related to Unit Five. Lecturer 7 handed out summaries of the theoretical content which is structured around the answer to four key questions in relation to assessment:

1. Why assess?
2. What to assess?
3. How to assess?
4. How to interpret assessment? How to report? (Appendix Q, p. 3)

Session introduction:

Lecturer 7 started by calling on the students to brainstorm the meaning of the word assessment. She wrote down all of their ideas and then discussed each in greater depth. This led into a discussion of the first question: "Why assess?" During this discussion she referred to the overhead, the hand-out and the opening brainstorm at every opportunity. The teachers were then given some time to read pages 152-153[63] of their guide (Appendix Q, pp. 9-10) in order to prepare for the next activity.

Body:

The reading dealt with a form of diagnostic testing, known as Piaget's conservation tests. The lecturer led a general discussion on conservation testing. She then asked the students to do Activity 3 from Unit Five. She adapted the activity which is given below in Figure 4.16 by saying to the students that they had to think of any concept from LO3 (Space, Shape and Measurement) in the FET curriculum in the place of "the teaching of measurement in the intermediate phase" (Appendix Q: 11). She put the students into ten groups with about three students per group.

Figure 4.16: Adapted activity used in session, Site E

Activity 3
How would you use the conservation tests in the box above in your teaching of measurement in the intermediate phase[64]?
Describe a lesson where you use one (or more) of the conservation

[63] Page references given at Site E are from the consecutively numbered version of the full guide which was one of the forms of the pilot ACEMaths materials. The attached appendices (M - R) are the individual units making up the full module, and hence the page numbers differ from those given for the full guide.

[64] Note the adaptation of this activity referred to above, which was given as a verbal instruction to the class. It was not done in the text, as it could have been.

tests.

1) Write down your observations on learners who have achieved an understanding of conservation of the concept you chose.
2) Write down your observations on learners who have NOT achieved an understanding of conservation of the concept you chose.
3) What will you do to help the learners who have NOT achieved an understanding of conservation of the concept you chose?

Groups all reported back to the whole class on several different concepts from the FET curriculum and the lecturer was evidently pleased with their ideas. The lecturer commented on each of the responses during the presentations.

Lecturer 7 then referred to the hand-out and discussed more of the theory of assessment, in answer to the next two questions: "What to assess?" and "How to assess?" There was a general whole group discussion. The students worked in their groups on a further activity from Unit Five, shown in Figure 4.17 below. This activity is about using observation for the purposes of assessment. The observation sheet is given in the text (Appendix Q, p. 25):

Figure 4.17: Session activity, Site E

Activity 10

1) Which of the criteria in the observation sheet above relate to content issues?
2) Which of the criteria in the observation sheet above relate to problem solving skills?
3) What are some of the valuable contributions that observation can make to assessment?
4) How could you adapt the observation sheet above to make it possible to use the sheet for a whole class? Draw up the sheet with the names of the learners in your class.
5) Compare the usefulness of an individual observation sheet with a whole class observation sheet indicating strengths and weaknesses of both types of sheet.

Conclusion of session:

The final questions, "How to interpret assessment? How to report?" were discussed in relation to points raised in the discussion throughout the lecture. Specific reference was made to the kinds of things assessment tasks can expose and ways in which teachers can respond to these things.

In her interview, Lecturer 7 commented on the quality of the student responses during this session, saying:

> I didn't say you must do a topic from Grade 12, or whatever, and I thought that many of them were going to stick to the very simple topics and I was surprised when they went into, you know the similar triangles and congruency and the Euclidean geometry, and all that kind of stuff so it is not like they chose the very basic Grade 8 curriculum, they actually did move further. (Lecturer 7 Interview Site E, p. 4)

4.3.5.3.2 Lecturer 8

The observed lesson led by Lecturer 8 dealt with Unit Six and diversity in a mathematics classroom. Lecturer 8 used an additional mathematical activity that she brought to the class. She also handed out summaries of the theoretical content from Unit Six and Appendix B of Unit Six to the students.

Session introduction:

Lecturer 8 asked the students to write up descriptions of the different types of learners, based on their prior reading of *Understanding Intrapersonal Characteristics*[65]. They had their materials with them and referred to them when necessary during their group discussions. They worked in groups of four or five.

Body:

Group representatives presented their flip-chart summaries to the whole and other members of the group contributed where necessary. The lecturer facilitated the presentations. She then used an overhead to summarise all of the discussions about the four different learner types represented by Thomas, Joyce and Libuseng[66], Patience and Joseph. Copies of this overhead were handed out. The students were responsive to each other and to the lecturer.

Throughout the remaining part of the lesson, discussions about the different barriers to learning were made more personal through the reference to one or more of these characters, and students could think of them as real members of a class rather than theoretical possibilities. The group discussed the following barriers to learning, their impact and how to respond to them:

[65] This is Unit Six Appendix B.
[66] Joyce and Libuseng together represent one learner type.

- Temperament which affects personal and social flexibility (adaptability); task orientation (distractibility) and reactivity (threshold of response);
- Brain functioning which affects potential for coping with input, elaboration and output;
- Learning styles (activist, pragmatist, reflector and theorist): these styles require different input, cope with elaboration differently and their output varies;
- Cognitive differences which affects ability to plan, pay attention and process information; and
- They also spoke about some strategies for support for these learners: how to teach and assess in a way that would be fair to all learner types. (Lecturer 8 Observation notes Site E, pp. 2-3)

The lecturer referred to several overhead transparencies during this discussion copies of which were given out to the students. This led into the final activity for the lesson, where students had to adapt a given task to make it more accessible to a diverse learner group, bearing in mind the four case study learner types and all of the theory they had discussed. Students worked in the same groups.

Conclusion of session:

There was not enough time for teachers to complete their task adaptations. The lecturer took ideas from work which had been done to highlight the kinds of things that one needs to do to try to make a task accessible to all learners.

- Give clear instructions
- Add questions to scaffold
- Make it more concrete
- Add or clarify diagrams
- Allow learners to make their own models
- Add a challenging question (Lecturer 8 Observation notes Site E, p. 4)

The lecturer wrote these on the board and teachers noted them down with a view to completing the task in their period of independent study. This made the students aware of the amount of work involved in preparing activities in such a way that they are accessible to all learners. They commented on this, but many seemed motivated to try it out.

4.3.5.4 Assessment

The students work on and submit portfolio activities and assignments between residentials. Marking of the assignments was done by Lecturer 8 (FET) and Lecturer 9 (GET). The students also submit an examination equivalent assignment. This assignment called for the planning of teaching and assessment for a series of lessons, catering for all learner types in an integrated manner. A template for the lesson plans was included. The evaluation criteria in the form of a detailed rubric were given to the students together with the assignment statement. The students were required to complete the rubric (with criteria relating to methodology; assessment; teaching and learning resources; diversity/barriers to learning; and activities) as a self-evaluation task for submission with the final examination equivalent.

Marking of the final examination equivalent was done by an external marker and Lecturer 9. The two markers met, discussed the marking process and developed a concise rubric for recording mark allocations so the marking would be consistent. Lecturer 9 marked the GET scripts and the external marker marked FET the scripts. Examination equivalents were further scrutinised by an external examiner. The examination equivalent statement is given below but the rubric is not included since it is too long.

Figure 4.18: Extract from Assessment Artefact, Site E

Examination Equivalent Assignment

Learning and Teaching Mathematics (EDUC 1011) November 2007

Part A

Identify knowledge, skills, attitudes and values for the topic 3-D shape for any phase from grade R to 9. Indicate the phase for which you are completing this task.

Once you have compiled the above lists:

1) what do you notice is different in each of the grades in the phase?

2) what do you notice is the same in each of the grades in the phase?

Write down these reflections below your list.

Part B

Now choose a specific grade and design a series of **6 progressive lessons** around 3-D shapes. Please use the lesson template attached for the purposes of your planning. You will be penalised if you do not use this template, as we would like to see planning for all of the categories itemised in the template.

Please attach your activity handouts or assessment tasks that are printed separately to the lesson plans.

You need to consider the AS for each lesson as well as the following:

knowledge and skills

1) the different levels of learners' understanding and cater for them
2) types of problems – routine and non-routine
3) learning styles
4) assessment
5) organisation of classroom
6) barriers to learning and development.

The external examiner and Lecturer 9 noted a marked improvement in students' awareness of the need to plan for diverse classes and generally higher quality of lesson planning than in the previous years' assignments. From a review of the 2007 examination assignments it was apparent that many students were still unable to draw up good quality lesson plans. This motivated the development team to add lesson plan exemplars, with annotations, to the text of the ACEMaths materials. Many student comments in the questionnaires had pointed to this as well.

4.3.5.5 Student Questionnaire

Positive comments from students (teacher-learners at this site) at Site E refer to ideas from all of the units in the ACEMaths materials.

- The most useful thing was the lists of assessment strategies.
- Problem solving is given in a way that can work with a diverse learner group.
- To understand the different types of learners and to cater for them all.
- The constructivist approach.
- Group work allows learners time to interact with their peers and develop their understanding.
- Lessons tasks must be prepared with multiple entry points so as to cater for diversity.
- The material is so useful to me therefore I recommend the material.

The level of the mathematics tasks was raised as a concern by some students, particularly those from the FET Maths ACE group. Some students commented that

there were too many activities while others commented that there were too few. Several requested further input with more specific examples on lesson planning.

- FET level of activities, would be nice to have more of them.
- The module has too many activities.
- To have lists of valuable material that would help us to teach efficiently.
- It has many ideas but the time we took to go through that during content session is so little.
- Give some more examples generally to aid understanding.
- Give more examples of lesson plans.
- Give more examples of problem solving.
- The examples are too general.
- Put more activities.
- The materials should have memos for the activities.

4.3.5.6 Lecturer interviews and questionnaires

The materials were well received and formed a solid platform on which to base the course. Lecturer 8 commented that, "the fact that this material focused on mathematics and not a general focus on learning and teaching in all subjects made this a powerful medium to begin debate and discussion at the level and interest of the students" (Lecturer 8 Questionnaire 2 Site E, p. 1). She added that:

> I really liked that about Unit One, the way it explained the whole thinking behind the NCS and the new syllabus. My students found it was much easier to understand because of the way it was written; it was in quite simple English and they appreciate that. … As we went through that unit specifically they started understanding the whole idea of doing mathematics and being involved in the mathematics. (Lecturer 8 Interview Site E, p. 3)

Both lecturers commented positively about Unit Five:

> Unit Five was for me the most successful based on the fact that assessment is a huge issue to every teacher, and you know they thought they knew it all and all of a sudden there were so many other ways, when, how, what, and they were excited. They liked this chapter very much. (Lecturer 7 Interview Site E, p. 12)

> Strangely enough my teachers did actually enjoy the assessment unit, even though it wasn't a very dynamic unit. They enjoyed it because it was practical, and they were looking for practical things, things that they could actually use in their classes. (Lecturer 8 Interview Site E, p. 4)

Lecturer 8 commented positively regarding Unit Six:

> Especially Unit Six, that was obviously the strength of the book … as they went through the unit, they realised the richness of their own classes, with the different kinds of learners, in terms of personality and differences. You could just see them lighting up as they discovered these ideas and they realised that there is something that they can do about it, that they don't just have to sit back and take it. (Lecturer 8 Interview Site E, p. 4)

Lecturer 7 also commented about the students' positive attitude towards ideas that were familiar to them, saying:

> When you touch on stuff that they are familiar with, they are confident to work with it and they come up with the most amazing things that they themselves didn't think they would be able to think beyond, but the thing is you started off from a premise that they were familiar with. (Lecturer 7 Interview Site E, p. 3)

The students had a lot of time between residentials to read through the materials, but some of them still had not managed to do so. Lecturer 7 felt quite strongly that the students had not done the required reading. "Well my sense was quite honestly that they were arriving at the residential without being prepared" (Lecturer 7 Interview Site E, p. 8). This is an ongoing problem, since for some the gaps (in time) between residentials are seen as constructive and a chance to study independently, while for others the lack of support during this time makes independent study difficult. Lecturer 7 added that, "I think that possibly this whole concept of working independently isn't well understood by the students themselves … I don't think that they're quite as independent as what we would like them to be" (Lecturer 7 Interview Site E, p. 11). Both lecturers hoped that all of the students would refer to the guide in due course, since they have it in hard copy as a resource which should serve them for years to come.

At this site, lecturers planned to use the whole guide again, in the same two courses. They mentioned the need to think of ways to get all of the students to engage with the materials more fully. Lecturer 7 said:

> Ja, but they really struggled with that whole concept of planning. … when I gave them that activity they had no idea what to do to get a multiple entry point. I had to do something and then they only knew what to do, but the theory, just reading this, didn't show them what to do. (Lecturer 7 Interview Site E, p. 13)

They thought it would be valuable if they could allocate more sessions during the residential to this course since they had both felt pressurised by time. Lecturer 8 said, "I wish I had more time to do it really well, although I skimmed through most of it, I would liked to have spent a lot more time on some of the modules" (Lecturer 8 Interview Site E, p. 2). Lecturer 7 said, "what we taught them was excellent, the content, but it was just too much and not enough time … , but we all say that, I mean, … we always do try to teach too much in too little time" (Lecturer 7 Interview Site E, p. 14).

4.3.6 Case 6: Site F

4.3.6.1 Background

The institution in which Site F is situated officially came into being on 1 January 2005 as a result of the general national restructuring of the higher education landscape in post-apartheid South Africa, mentioned in relation to the formation of the institutions at which the other sites in the study are located. Two universities and one technikon merged to form the university in which Site F is located. English is the language of instruction at Site F where the home languages of the students are predominantly English, Afrikaans or isiXhosa.

At this site, students are trained in Mathematics education via a range of undergraduate programmes including an ACE, as well as B Ed programmes. Students enrolled at the site come from urban and rural areas. In the first year of implementation, the lecturer (Lecturer 10) used the ACEMaths materials in the *Remedial Assistance (Mathematics)* course of an ACE Special Needs Education (SNE) programme. Class numbers vary depending on the number of applications per year at the site, but there were 43 students in the class in the year of the pilot implementation project. The ACE (SNE) programme is offered as either a full-time programme over one year or a part-time programme that extends over two years. Students enrolled for the course are thus either full-time students (pre-service training) or part-time students who are already teachers (in-service training). The *Remedial Assistance (Mathematics)* module is allocated one weekly lecture of 75

minutes. The students are expected to read and prepare for lectures and work on assignments independently.

The campus facilities at Site F are excellent, with well equipped lecture rooms and computer laboratories. Lecturer 10 has 10 years of mathematics school teaching experience, 15 years of mathematics teacher education experience and is currently registered for a masters degree at a South African university.

4.3.6.2 Materials

Lecturer 10 used the whole module of the ACEMaths materials, all six units and all of the appendices. She felt that the units fitted together well and that she would be able to use them in conjunction with the other materials used in the ACE (SNE) programme. She said:

> I thought it's actually covering so many different aspects of special needs and seeing that we are doing special needs education, we can just as well, you know, actually use the module as a whole and then try and link more practical ideas according to the needs of the specific group of students and then just take it from there. It also nicely linked up and made connections with other modules in the program. … So for me it has a very nice holistic feel to it. I think it will actually lose its impact in this specific program and module with our teaching currently, to actually leave out specific sections, because then it will not be a complete picture anymore. (Lecturer 10 Interview Site F, p. 2)

Lecturer 10 liked the approach in the materials and the activities that challenged the students to apply what they had learnt and compare and connect their new knowledge with their prior knowledge and experience. She said that this was in line with the ACE (SNE) programme, "Our specific course is much more a practical based course because it's an ACE, than a very heavy theory course" (Lecturer 10 Interview Site F, p. 6). She said that the ACEMaths materials "definitely" (Lecturer 10 Interview Site F, p. 6) helped the teachers to make the link between theory and practice. She liked the ACEMaths materials because they were different from her other course materials. She said that the students noticed this difference:

> The SAIDE material doesn't really spoon feed them that much. They have got to think about it, so they've got to read, and then they have got to think about it, especially with some of the activities. (Lecturer 10 Interview Site F, pp. 17-18)

She printed each of the units separately and handed them out, one at a time, to the students as they progressed through the material. She did this because she was not sure if the students would manage all of the reading in the time that was available. Activities from the materials were set for the students to work through in preparation for lectures, so that they would have given them some thought before coming to the group discussions. She thought that she would not put pressure on the students and expect them to get through all of the ACEMaths units, but she was amazed at their eagerness and the way in which they finished unit after unit, asking for the next one with great anticipation each time. Ultimately, she discussed all of the units with the students during lectures.

4.3.6.3 Session observation

The observed lesson was at the end of the period during which Lecturer 10 had covered the content of Units One and Two. This was a lesson designed to pull together ideas learnt from these two units, and link these ideas to a practical teaching activity. She said that, "this specific lecture today was more a practical lecture where they actually had to apply what they had learned from the semester" (Lecturer 10 Interview Site F, p. 8).

Session introduction:

Lecturer 10 briefly recapped some of the key ideas that had been covered in Units One and Two. Three handouts were given: one with an outline of the content (main points) of the theory and one explaining the task for this session. An extract relating to fractions from the National Curriculum Statement (NCS) Learning Outcome One (LO 1) was also given to the students. Students had to draw on this content in the group discussion that followed. The lecturer set groups to work immediately and began circulating to facilitate the group discussions.

Body:

The scenario set in the hand-out was as follows:

Figure 4.19: Extract from session handout, Site F

> A grade 6 learner was referred to you for individual attention regarding the mathematical concept of fractions. According to the classroom teacher, this learner knows "nothing".

The hand-out also contained the following instructions for the students, with some pointers to guide them:

Figure 4.20: Extract from session handout, Site F

> Plan a sequence of possible sessions with this learner.
>
> Indicate what you will include in each session. (You decide how many session-focuses you might need.)
>
> Remember: Only implementation of these theoretical planned sessions in practice will determine how many sessions will really be needed.
>
> - Mention what the learner will do.
> - Mention what the teacher will do,
> - Mention the teaching aids that you will use.
> - Keep the following in mind.
> - Keep in mind what you have studied in Unit One and Unit Two of the materials.
> - Use the NCS copies provided to you. This copy is an extract from LO 1 only.
>
> The following are possible question that you could use to check your planning:
>
> - Are you following a "traditional" approach or a "constructivist" approach or a "combination of these two approaches"?
> - Is the learner "doing" mathematics?
> - Is the focus on "understanding" mathematics?
> - Will the learner eventually benefit from these sessions in the long run? (Think of the seven benefits.)

Each group was given several large sheets of paper and coloured pens on which to record their remediation programme, since they would report back to the whole group once the activity was completed.

The groups had fruitful discussions, but were unable to complete the activity in this lesson. All groups indicated that to remediate properly, one had to start with a discussion of basic fraction concept dealing with wholes and parts of wholes. Some

groups went into greater detail on the basic concept formation, while others recorded session outlines that extended right up to operations with fractions. Several groups explained confidently that the progression for the teaching plan should be from concrete to abstract.

Conclusion of session:

There was not enough time for groups to complete their planned remediation sessions, so the lecturer took in all of the teacher work to keep for the following session where it would be completed and the report backs to the whole group could be given. In the interview (which was after the observation) the lecturer commented:

> So basically what we have started today was trying to see how they are implementing the process of what they have learned from unit one and two, and then the follow up from this … will guide them into unit three, which is problem solving." (Lecturer 10 Interview Site F, p. 9)

4.3.6.4 Assessment

The students have to submit written assignments and do oral presentations during the course of the year. There is also a final examination which contributes 50% to the overall year mark for the course. The students need to complete another parallel module in the *Remedial Assistance* programme, which requires practical work. They are required to report on two case studies. One focuses mainly on Mathematics and the second mainly on Language. This forms another part of the assessment programme for the ACE (SNE) in which students can draw on and apply concepts learned from the ACEMaths materials. The following questions were set in the November exam, which drew not only on the ACEMaths materials, but also on other concepts that they dealt with during the course of the year:

Figure 4.21: Extract from assessment artefact, Site F

Remedial Assistance (PRED 206) November 2007 Examination

Time : 2 hours **Marks : 50**

1) One often experiences that teachers, learners and parents have negative beliefs and feelings regarding Mathematics. Name these negative beliefs and feelings. Illustrate with appropriate examples. Indicate how the remedial therapist can handle these issues. (15)

2) Constructivism brought new insight in the teaching and learning of Mathematics. Discuss what the ideas of constructivism include and

how it influences the teaching and learning of Mathematics. (10)

3) The three different ways of learning, namely competitive learning, individualistic learning and co-operative learning will have some or other influence on the teaching and learning of Mathematics. Write explanatory notes for each of these ways of learning. Discuss the influence each of these ways of learning could have on the teaching and learning of Mathematics. Give your opinion regarding these ways of learning and which of these you will implement in remedial sessions. Motivate your opinion. (15)

4) Define "drill" and "practice". Discuss the advantages and/or disadvantages of "drill" and "practice". (10)

Considering that students had been exposed to the whole ACEMaths module, the exam questions do not draw on the materials extensively, but Lecturer 10 explained that this was because she had not been certain at the time of setting the exam[67] how much of the ACEMaths material would have been covered and did not want to set questions which students would not have been able to answer had they not completed the full set of units.

4.3.6.5 Student Questionnaire

The student questionnaires from Site F were mailed to me by Lecturer 10 after the students had completed them at the end of the year, but they never arrived. Unfortunately Lecturer 10 did not keep a copy of the questionnaires and so responses from this set of student questionnaires cannot be included in the data.

4.3.6.6 Lecturer interview and questionnaires

Lecturer 10 thought that the ACEMaths materials helped the students to understand the need to move away from traditional "chalk and talk" teaching. She said that, "we are looking at the curriculum from different perspectives and I find that Units One and Two actually assist us to make a mind shift" (Lecturer 10 Interview Site F, p. 9). She commented again about this "mind shift" in relation to the students' work in the observed lesson:

> [for] the same module or the same content that was discussed with them prior to this, I could already see the mind shift, comparing with where they

[67] See 4.3.6.2. The university requires that exams are set and moderated by July in readiness for the November examination.

> were February, March and where they are now at the end of May. (Lecturer 10 Interview Site F, p. 12)

She added that some teachers had commented to her about this: "they [have said] to me, they have adapted their own classroom practice" (Lecturer 10 Interview Site F, p. 13).

Some of the students struggled with the content in the ACEMaths materials. Lecturer 10 said that she was not sure whether the struggle that students had to get through the reading material was because of actual problems with the material or more because of their difficulty in adapting to being a student and dealing with work and home commitments:

> I don't think it is just the material that they struggle with, I think it is self discipline and in adapting to being a student again. I think that is part of the problem so one needs to actually eventually get them to indicate to you whether they struggle with the materials, or whether they just struggle to adapt as a working mother and a working full time teacher to being a part time student. (Lecturer 10 Interview Site F, p. 3)

Lecturer 10 said that the ACE (SNE) group was a diverse group with diverse needs which she tried to accommodate by providing them with summaries. She said, "what I did was to create a list of key ideas simply to assist them to work through the material" (Lecturer 10 Interview Site F, p. 3). She did this in response to the difficulties that she identified in some students who she thought were indeed struggling with the text, which she indicated by saying:

> There are certain words that don't exist in their vocabulary and they have no idea what it means and they actually can't even understand it by reading it in context. (Lecturer 10 Interview Site F, p. 3)

> I think certain of the activities for a student, some of them are just above their heads. They struggle to understand them, especially if it is a foundation phase teacher, and now suddenly the examples mainly focus on intermediate phase. (Lecturer 10 Interview Site F, p. 5)

She overcame this is by having class discussions where the students had to identify other examples:

> So what I normally say to them is if the example doesn't make sense to you, that's fine ignore it, come up with you own example, and then we normally have a class discussion where we share that. And that works very nicely. (Lecturer 10 Interview Site F, p. 5)

Lecturer 10 explained that one of the things that she hopes to achieve through her lectures and through using the ACEMaths materials is to help the students address their own special needs. As she put it, "It is not just a special need that the learners are experiencing, they themselves as teachers have special needs and we need to first solve their special needs and cater for that before they can pass it onto their learners" (Lecturer 10 Interview Site F, p. 15).

The community of practice formed through the collaboration was something that Lecturer 10 was particularly pleased about:

> I think it is a brilliant idea that we finally got to this stage where some universities get together and work in a direction to try and get sort of a more generic message in this country. (Lecturer 10 Interview Site F, pp. 6-7)

Her expectations of the collaborative meetings were exceeded by the time the development process was over:

> I think when I initially got involved in the project I didn't think I would leave with so much. I actually didn't know what to expect. So I definitely received much more than what I actually was hoping for. I mean I now have a whole study guide which I didn't have to write. (Lecturer 10 Interview Site F, p. 7)

As with other lecturers who were part of the collaborative team Lecturer 10 was gratified to find out that her courses were in line with the courses being presented by other mathematics teacher educators in South Africa:

> You now suddenly have this collaborative work of other people's ideas as well, which to me has great value. And it is nice to know that there are so many of us, although living in different cities in the same country working at different universities, there is sort of a generic message, although we don't even realise it, which is actually quite nice. (Lecturer 10 Interview Site F, p. 8)

At Site F lecturers planned to print all of the units together as a complete guide for use in the same course in 2008. Having piloted the material, Lecturer 10 was happy to re-use them:

> It is really written for South Africa today. It is very much the new approach. I think it mixes very nicely with the current national curriculum statements in the country. (Lecturer 10 Interview Site F, p. 4)

She thought that in 2008 she would discuss this content over the full year, and she hoped that this would allow the students the opportunity to get even more out of the material. She also used planned to use the guide with the B Ed (Foundation Phase) teachers as supplementary materials to the existing materials for the module on Foundation Phase Methodology (Numeracy). Lecture 10 was pleased with the adaptability of the ACEMaths materials (as OER):

> It is not rigid, there is lots of room to add your own practical ideas, replace some of the ideas in with their own ideas or ask the students to think of another appropriate, practical example, which I enjoy. (Lecturer 10 Interview Site F, p. 4)

4.4 Student ownership and access to computers

Responses from the student questionnaires to the questions about computer ownership and access were tallied and are recorded in Table 4.3 below.

Table 4.3: Student ownership and access to computers (2007)

Site		Number of students		Students who own a computer	Students who have easy access a computer	Students who do not have easy access a computer
Name	**Course**	**Total**	**Tally**			
A[68]	Course 1 Course 2	15 (15)	11	6	1	4
B		45	40	4	9	27
C[69]	Course 1 Course 2	(20) 6	n/a 5	n/a 0	n/a 0	n/a 5
D		35	30	9	10	11
E	Course 1 Course 2	30 60	24 47	4 13	4 7	16 27
F[70]		(40)	n/a	n/a	n/a	n/a
Total		**191**	**157**	**36**	**31**	**90**
Percentage				**23%**	**19%**	**57%**

The table indicates that few students own or have easy access to computers. Only at one site (Site A) did more students own a computer than not. For the majority of students (57%) access to a computer is not easy.

[68] The same students were registered for Course 1 and Course 2 at Site A, and only completed one set of questionnaires.
[69] When the site visit was carried out at Site C the lecturer had completed the teaching of Course 1 (which was a first semester course) and so only the students from Course 2 completed the questionnaire.
[70] Tallies from this set of student questionnaires cannot be included here since I did not receive them, see 4.3.6.5.

Chapter 5 Cross-case Analysis of Data

OER has the potential to catalyze a positive change in the way teaching and learning take place within the HE sector in Sub-Saharan Africa. However, one of the key issues yet to be fully addressed by the OER movement is how to draw out the potential of OER within campus-based HE programs and how HEIs can use them as a catalyst to revamp the entire curriculum development process regardless of the mode of delivery. (Bateman, 2008, p. 36)

5.1 Introduction

In this chapter I draw on the data presented in Chapter Four to present a cross-case analysis on take-up at the six sites. The ACEMaths OER were designed for a specific purpose and this analysis brings out, amongst other things, the ways in which it served that purpose. The analysis is presented in three sections, the first focusing on the actual take-up, the second on the strengths and potential of the ACEMaths development process and materials and the third on obstacles to take-up. This is in accordance with the aim of the research project which is re-stated below.

The broad aim of this research project is to investigate the take-up in multiple sites of the OER module *Teaching and Learning Mathematics in Diverse Classrooms.*

5.2 Take-up of the ACEMaths materials

This section addresses the first three of the five research questions:

a) How did teacher educators in the six sites intend to use the pilot OER material with teachers?
b) Which parts of the pilot OER material did the teacher educators in the six sites select, and what factors influenced this selection?
c) How did the teacher educators use the pilot OER in the teacher education programmes and how did the students respond to these materials?

5.2.1 Parts of the module selected for use

Influenced by the work of Lave and Wenger in the area of communities of practice, (Lave & Wenger, 1991; Wenger, 1998), development of the SAIDE OER module for the pilot phase involved a collaborative process, building on participants' existing materials and expertise. This led to the participants being willing to integrate the new materials into their existing programmes as can be seen in the table below. Despite having all been equally involved in the development process, not all participants used the materials in the same way. Some participants had greater autonomy and therefore flexibility in their choices[71]. Others were constrained by existing course structures[72]. The table below summarises the materials selections at the six pilot implementation sites and compares the intended take-up with the actual take-up at the various sites.

Table 5.1: Proposed and actual take-up of ACEMaths materials

Site	Programme for intended use	Units for intended use	Take-up programme and units piloted	Period
A	ACE FET Maths Literacy (mixed mode)	Unit 6 Unit 3 and 4	ACE FET Maths Literacy 2nd year (mixed mode). Unit 6 (with appendices). Unit 4 with sections taken from Units 1, 2 and 3.	July and Sept 2007.
B	ACE GET Maths 1st year but possibly 2nd year (mixed mode)	Selected activities from Units 2, 3, 4, 5 and 6	ACE GET Maths 1st year (mixed mode). Unit 3 and parts of Unit 2.	Jan and July 2007.
C	PGCE for GET (contact) B Ed for GET (contact)	PGCE Units 2, 3, and 4 B Ed 3rd year - Units 1, 3, 4 B Ed 4th year – Unit 6	B Ed for GET 3rd year (contact). Units 1, 2. B Ed for GET 4th year (contact). Units 6 (with appendices).	During 2007.
D	ACE LSEN (mixed mode)	Whole module	ACE LSEN 2nd year (mixed mode). Whole module (Units 1 – 6, with all appendices).	July and Sept 2007.
E	ACE FET and GET Maths (mixed mode)	Whole module	ACE FET and GET Maths 2nd year (mixed mode). Whole module (Units 1 – 6, with all appendices).	March, July and Sept 2007.
H	1st and 2nd year B Ed FP (contact) ACE Special Needs/Remedial Education (part time)	Whole module	ACE Special Needs/Remedial Education (part time). Whole module (Units 1 – 6, with all appendices).	Over next 2 years (2007 and 2008)
G	PGCE GET and FET	Various activities,	Withdrew from	

[71] See 4.3.4 and 4.3.5.
[72] See 4.3.1, 4.3.2, 4.3.3 and 4.3.6.

	(contact) B Ed (Sc Ed) (contact)	particularly from units 1, 3 and 6	implementation phase.	

The information about intended use was given by the participants at the final workshop of the materials development phase of the project. The information on the actual use of the materials was obtained during the site visits. As can be seen in Table 5.1 above, there was excellent follow-through of materials selected for use in the pilot implementation study, demonstrating the potential value of OER for individuals and institutions as discussed in 2.2.3 (Hylén, 2007; Joyce, 2006).

Lecturers at six of the original seven sites followed through with their plans to use the materials. Three of the seven sites used the materials for the pilot study exactly as they had proposed. These three sites all used the whole module. Lecturers made their choice based on the quality of the material and for financial reasons. It was argued in the literature review in Chapter Two that quality assurance of materials is a by-product of collaborative development in a community of experts (Benkler, 2005; Geser, 2007). The ACEMaths materials were contributed to in different ways by the different team members, with all contributions adding to the quality of the materials. The financial savings resulting from receiving materials free of charge as OER are self-evident[73]. This was highlighted by one of the lecturers[74] and given as a reason for use, demonstrating the incentive for the user of the collaborative end-product. Even in production, collaboration and sharing of existing materials has the potential to contain cost and lead to optimal use of existing materials (Geser, 2007; Hylén, 2007; Joyce, 2006). This is demonstrated by the take-up at all sites.

Another three of the seven sites used some of materials selected in one out of the two programmes which they had earmarked for the pilot implementation. In most cases, the reasons given for lecturers not using the materials as they originally intended related to time constraints. The time between the materials being completed and courses being run at the sites was short, and in some cases too short to allow for implementation. At some sites lecturers indicated that they had experienced difficulty

[73] For the end-users of the ACEMaths materials there was no financial cost as the cost of development was borne by the research project.
[74] See 4.3.5.2.

getting others in their departments to use the materials, especially with the given time constraints.

Only at Site G were lecturers not able to pilot the materials and they withdrew from the pilot implementation study because the programmes in which they intended using the materials, PGCE Maths GET and FET and B Ed (Sc Ed), were not yet operational. The two lecturers from Site G, who attended all of the development workshops, also attended the final revision workshop, and again expressed an interest in using the materials, should the opportunity for them to do so arise. Table 5.2 below gives a comparison of sites according to programme and whether or not the programme for proposed and actual use was established or not at the sites.

Table 5.2: SAIDE ACEMaths use (2007)

Site	Programme	Established/Not established	Proposed/Implemented
A	ACE FET (Maths literacy) Course 1 Course 2	Established (both) – first time implementation	Proposed and implemented
B	ACE GET (Maths)	Established – ongoing implementation	Proposed and implemented
C	3rd year B Ed for GET 4th year B Ed for GET	Established (both) – ongoing implementation	Proposed and implemented
D	ACE LSEN (Learners with Special Educational Needs)	Established – ongoing implementation	Proposed and implemented
E	ACE GET (Maths) ACE FET (Maths)	Established (both) – ongoing implementation	Proposed and implemented
F	ACE SNE (Special Needs Education)	Established – ongoing implementation	Proposed and implemented
G	PGCE GET and FET B Ed (Sc Ed)	Not established	Proposed but not implemented

Implementation of selected materials was only possible in established programmes. Only at one site were the materials used in courses which were being implemented for the first time. It was at this site (Site A) that one of the lecturers (Lecturer 1) did the most extensive adaptation of the materials prior to use. This could have been because she was in the process of developing the materials for the new course. The adaptation and use of the ACEMaths materials at this site[75] demonstrates that one advantage of using OER is that such a resource can be integrated seamlessly (global attribution is sufficient) into new material, avoiding the necessity for cumbersome quoting. At the other sites where lecturers integrated the materials into ongoing programmes, most of

[75] See 4.3.1.2 Customisation One: Lecturer 1.

them used the selections unadapted, independently or in conjunction with other materials.

The ACEMaths materials were used predominantly in ACE programmes (see Table 5.2 above), but at one site they were used in a B Ed programme. The site which withdrew had intended to use the materials in B Ed and PGCE programmes. There was great variation within the ACE programmes in which the materials were used. One was for a specialisation in Mathematical Literacy, two were for specialisation in Learners with Special Educational Needs, another two were for a specialisation in GET Mathematics and one for a specialisation in FET Mathematics.

5.2.2 Programmes in which the module was used

A comparison of take-up at sites according to the different courses offered, the numbers of students enrolled for each course, the languages spoken by students and the time allocated to meditation of the ACEMaths material within the course in which it was used is presented in Table 5.3 below.

Table 5.3: ACEMaths materials, programme information (2007)

Site	Programme	Number of students enrolled	Language of instruction/student home languages	Time allocated to ACEMaths material
A	ACE FET (Maths literacy) Course 1 Course 2	15 (Both courses)	ENGLISH / English, isiZulu, other	54 hours' contact time, spread over two four-day blocks in school holidays, and about five Saturdays during the term Overall – 54 hours contact time.
B	ACE GET (Maths)	40	ENGLISH / English, isiXhosa, other	90-minute lectures Lectures during set periods (contact sessions) – 5 lectures. Overall – 7,5 hours contact time.
C	3rd year B Ed for GET 4th year B Ed for GET	B Ed 3rd year: 20 B Ed 4th year: 6	ENGLISH / English, Afrikaans, isiXhosa, other	45-minute lectures 24 lectures (per group). Overall – 18 hours contact time (per group).
D	ACE LSEN (Learners with Special Educational Needs)	35	ENGLISH / English, Sesotho, Setswana, isiZulu, other	2-hour lectures Lectures during set periods (contact sessions) – 11 lectures. Overall – 22 hours contact time.
E	ACE GET (Maths) ACE FET (Maths)	FET: 60 GET: 30	ENGLISH / English, Sesotho, Setswana, isiZulu, other	2-hour lectures Lectures during set periods (contact sessions) – 9 lectures. Support workshops – 8 hours. Overall – 26 hours contact time.

F	ACE SNE (Special Needs Education)	43	ENGLISH / English, Afrikaans, isiXhosa, other	75-minute lectures Two lectures per week for two terms (16 weeks). Overall – 40 hours contact time.

The numbers of students enrolled for courses in which the ACEMaths materials were used in the 2007 pilot were all relatively small, ranging from 6 students to 60 students. Per site, the number of students exposed to the materials was a little higher, ranging from 15 to 90 students. The language of instruction at all of the sites was English, but across the sites all 11 of the official languages as well some other African languages are spoken by students and lecturers. The materials are English medium and were mediated in English, but used by many students whose home language is not English. There were comments from students that implied they had some difficulty with the language of the test, but the overwhelming response to the materials was positive and that more such materials should be produced and distributed for use by South African teachers[76]. The three differing modes of delivery were described in Chapter Four[77].

The time allocated to mediation of the ACEMaths materials varied greatly across the sites. At Site B, where only 7,5 hours of contact time was allocated, only one unit and short excerpts from another unit were used. At Sites D, E and F where the whole module was used, time allocations were 22 hours, 26 hours and 40 hours respectively, but with differences as to how this time was distributed over the year. Site A used only two full units (in conjunction with other material) with students but allocated the highest amount of contact time – 54 hours. At Site C one unit was given 18 hours, spread over two terms. Feedback from students at all of the sites was positive, in relation to the materials, but at most sites, some students indicated that they would like to have spent more time on the materials. There is always a tension about the time one can allocate to the teaching of a course (Lecturers' comments in interviews[78] and questionnaires also alluded to this problem) and continued efforts need to be made to allocate time optimally (Korthagen, 2001; Loughran, 2006).

[76] See student comments at all sites.
[77] See 4.1.
[78] See for example 4.3.5.6.

5.2.3 Different materializations/physicality of the materials

In the pilot SAIDE OER initiative, the technological challenges were dealt with only at the most rudimentary level. The OLCOS vision of nurturing open educational practices (Geser, 2007) extended only to licencing and collective curriculum and materials development, rather than to technologically facilitated engagement in course adaptation. It was only after the conclusion of the pilot that decisions were made about how and where to store and tag the materials and to track engagement and further adaptation[79]. In spite of this, participation in the pilot did show that the materials were easily reusable and adaptable for use in different programmes. There is evidence of this in the variety of programmes in which the materials were used. The manner in which the materials were reproduced and presented to students also varied across the sites.

According to Wiley's taxonomy (2000), the SAIDE OER would not offer high re-use potential in the pilot format since they were not broken into small enough bits (i.e. the granularity was low[80]). But the reusability about which he writes is through electronic means, for reuse by computers[81] which would access the information and combine it in sequences with other information to produce materials. On a human level, and as can be seen from the take-up at pilot sites, reusability of the SAIDE OER was good. The material was available electronically as word documents which could be re-versioned by the lecturer who is an expert in his/her field. The availability of a printable resource that can be used as core material for a course proved useful to several lecturers. This was evidenced at all of the sites except for the one which withdrew.

5.2.3.1 Form of and purpose for selection

A comparison of the parts of the materials that were used, whether they were used without adaptation or were modified and of the purposes for which they were used,

[79] Further analysis of technological challenges and how they were overcome in the ACEMaths project follows in 5.3.4.
[80] See 2.2.4.1.
[81] The agent here is the computer since theoretically learning objects could be put together electronically in response to a search request..

gives further insight into the different materialisations/physicality of the materials that emerged at take-up sites. Table 5.4 below shows this comparison.

Table 5.4: ACEMaths materials selected, how used and for what purpose (2007)

Site	Materials selected for use	Modified/Intact	Purpose
A	Course 1: Unit One, Unit Two and Unit Three (selected parts) and Unit Four. Course 2: Unit Six (whole unit).	Course 1: Modified Course 2: Intact	Course 1: Course materials, reference for assignments and to be examined. Course 2: Course materials and reference for assignments and examination equivalent.
B	Unit Three (whole unit) and parts of Unit Two.	Intact (one), Modified (one)	Reference in lecture and for assignment.
C	Unit One and Unit Two (whole units). Unit Six (whole unit).	Intact Intact	Course materials and reference material for assignments (both years).
D	Whole module.	Intact and then modified	Course materials and reference for assignments and examination equivalent.
E	Whole module. Whole module.	Intact Intact	Course materials and reference for assignments and examination equivalent (both courses).
F	Whole module.	Intact	Course materials and reference for assignments and to be examined.

At three sites (and in four programmes) the whole module was used, without adaptation. It was subsequently modified for one of the programmes. At sites where single units were used, the following emerged: Units One, Three and Six were used at two sites; Units Two and Four were used at one site and Unit Five was not used individually at any site. Single units were used without adaptation at three sites while at two sites modified single units were also used. This demonstrates the flexibility of the OER for inclusion in a range of courses with different designs.

Table 5.4 also demonstrates the different purposes for selection of the ACEMaths materials. The materials were used as course materials at all sites except for one, (Site B), where the materials were only used for reference purposes in lectures. At all sites course materials were mediated in contact time. Students also had to refer to them for both examination purposes and assignments at all sites, again except for one (Site B) where reference to the materials was only for the purpose of completing a coursework assignment. This demonstrates the flexibility of the OER for inclusion in a range of courses for different purposes.

5.2.3.2 Customisations

In the SAIDE OER project the adaptation of an existing source module was done at two levels. The first level was the adaptation of curriculum design carried out by the collaborative team for the module as a whole. This is an essential part of course design (Lockwood, 2001; Rowntree, 2001). This adaptation led to:

- a stronger focus on inclusive education and teaching of diverse learners;
- the systematic identification and inclusion of core mathematics content into the module, so that it could serve the purposes not only of students who are studying mathematics teaching, but also those involved in courses related to special needs/inclusive education/barriers to learning.

The second level, carried out on take-up, was undertaken individually by the lecturers as they designed their own courses which incorporated the ACEMaths materials. The pilot research revealed that customisations by lecturers at the sites took various forms as shown above in Table 5.4. Only two lecturers made substantial adaptations to the materials[82]. The other lecturers used them without adaptation although all of them gave recommendations for adaptation at the materials revision workshop in February 2008. Table 5.5 below presents an overview of the adaptations to the ACEMaths materials used at the various sites. The table also indicates other materials used in conjunction with the ACEMaths materials to make up the full course material "package" at each site.

Table 5.5: Adaptation and combinations with other materials used

Site	Materials selected for use	Adaptation	Other materials used together with ACEMaths materials
A	Unit 6 (with appendices). Unit 4 with sections taken from Units 1,2 and 3.	ACEMaths materials combined into two separate stand-alone guides for two different modules in the ACE FET Maths Literacy programme. Module 1 Guide – Unit 4 used in full with an extract from Unit 3 combined with other materials. Module 2 Guide – Unit 6 used in full combined with other materials.	Guides (as indicated in "Adaptation" column) included additional theory and activities, course information and assessment tasks.
B	Unit 3 and parts of Unit 2.	No adaptation. ACEMaths materials used as an additional resource to compliment existing ACE GET programme materials. Used as reference material.	Mathematics activity booklets on various topics.
C	Units 1, 2 and 6 (with	No adaptation. ACEMaths materials used as resources for two PGCE for GET programme	3rd year and 4th year – Additional readings as

[82] One further substantial adaptation was done after the pilot in 2008 by Lecturer 11 from Site G.

	appendices).	modules. 3rd year - Units 1 and 2 used in full, exactly as presented by SAIDE. 4th year – Unit 6 used in full, exactly as presented by SAIDE.	separate handouts.
D	Whole module (Units 1 – 6, with all appendices).	All units used in full without adaptation in 2007. Units presented in a single guide with consecutive page numbering. All units have now been adapted to align presentation with that of the other courses in the LSEN ACE programme, to be used in 2008.	Residential programme booklet with additional activities. Assignment booklet.
E	Whole module (Units 1 – 6, with all appendices).	All units used in full without adaptation in 2007. Units presented and handed out in a single guide with consecutive page numbering as produced by SAIDE.	Course outline Separate handouts with content summaries. Additional maths activities.
F	Whole module (Units 1 – 6, with all appendices).	All units used in full without adaptation in 2007. Units handed out separately one at a time as produced by SAIDE.	Other materials produced by lecturers were used during the first half of the year since the ACEMaths materials were not yet ready then.

These different combinations in Table 5.5 show that by taking into account the recommendations of the CURVE project (2003) to ensure that the materials were transferable, multiple uses of the materials were facilitated. The strategy chosen by the ACEMaths materials to promote transferability was that of a modular structure with a wrap-around narrative (Kubiak, 2003). Each lecturer determined his/her own course design, including course work, assignments and examinations. This demonstrates the flexibility of the OER for inclusion in a range of courses[83] with different designs. In relation to Wiley's discussion on granularity and learning objects (2000), the use of the ACEMaths materials at the different sites indicates that the larger "objects" (units or even a whole module) were re-usable in spite of their size.

Adaptability was mentioned as a strength of the materials by lecturers at several sites[84], some just spoke about this freedom, while others made use of it. One adapted the materials to meet the reader's expectations in terms of layout[85]. Some realised that it was necessary to adapt the material so that the mathematical tasks in the text were at

[83] Refer to Appendix L for the full course prospectus of each programme in which the ACEMaths materials was used. This shows the range and variety of the different course programmes represented in the pilot study. It also shows which year (e.g. 1st or 2nd) in the programme the ACEMaths materials were used.
[84] See 4.3.1.6, 4.3.4.6, 4.3.5.6 and 4.3.6.6.
[85] See 4.3.4.6.

the appropriate level for the course in which the materials were being used[86]. Lecturer 5 gave extensive input relating to the revision of the materials but did not carry out any adaptation of her own[87]. Lecturer 3 spoke of his intention to adapt the materials for future use[88].

The OER effectiveness cycle presented in 2.2.4.4 suggests the cyclic nature of use and re-use of OER. One user (Site A) significantly reworked the units that she used. Her adaptation was put back into the community for others to evaluate, learn from and use at their discretion. Another user (Site D) revised the entire module after using it unadapted in the pilot phase. She realised that it would fit in better with her other modules if she adapted the layout to make it more like that of her other modules. This revised version was also put back into the community for re-use[89].

5.2.3.3 Assessment

Another aspect of course design involves assessment (Lockwood, 2001; Rowntree, 2001; Welch & Reed, 2005). Course designers need to decide what kind of assessments should form part of the course, when assessment should be included and marks assigned to students and finally how the course evaluation should be carried out. Table 5.6 below indicates the assessment activities at each of the sites and the corresponding material which formed part of the assessment.

Table 5.6: Comparison of assessment by selection and site (2007)

Site	Units/ sections of SAIDE ACEMaths used	Assessment
A	Unit 6 (with appendices). Unit 4 with sections taken from Units 1,2 and 3.	Course 1 Assessment tasks (two) and an Examination. Course 2 Continuous assessment and an Examination Equivalent: Research project.
B	Unit 3 and parts of Unit 2.	Continuous assessment made up of assignments, an extensive portfolio and an Examination Equivalent.
C	Units 1, 2 and 6 (with appendices).	3rd year and 4th year Continuous assessment, a formal assignment and an Examination Equivalent.
D	Whole module (Units 1 – 6, with all	Journal activities, Portfolio activities, three

[86] See 4.3.1.6, 4.3.4.6 and 4.3.5.6.
[87] See 4.3.3.6.
[88] See 4.3.2.6.
[89] This revised version of the materials was used by one of the "new" users to join the community in 2008, see 5.3.8.

	appendices).	assignments, and an Examination Equivalent.
E	Whole module (Units 1 – 6, with all appendices).	Two assignments, a Portfolio assignment and an Examination Equivalent.
F	Whole module (Units 1 – 6, with all appendices).	Two assignments and an examination (year end).

An overview of the assessment programmes presented in Table 5.6 shows the potential for variety in assessment across different courses. At the sites, students were assessed through continuous assessment (3 sites), assignments (4 sites), portfolio assignments (2 sites), journal activities (1 site), examinations (2 sites) and examination equivalent assignments (6 sites). The institutional requirements, rather than the materials selected (whole module/individual units), determined the assessment activities forming part of the course design. Assessment at the different sites was fairly similar in spite of different materials selections. Table 5.7 below gives further detail of the extent to which the ACEMaths materials were drawn on in the assessment activities.

Table 5.7: Assessment activities (2007)

Site	Assessment activities	Extent to which assessment required use of ACEMaths materials	Marks allocated
A	Course 1 Assessment tasks (two) and an Examination. Course 2 Continuous assessment and an Examination Equivalent: Research project.	Course 1: Assessment based entirely on selected ACEMaths materials and other coursework materials Course 2: Theoretical base for action research project linked to inclusive education and diversity.	Course 1: Assignments: 50% Examination: 50% Course 2: Action research project: 100%
B	Continuous assessment made up of assignments, an extensive portfolio and an Examination Equivalent.	ACEMaths materials a resource for the answering of some of the questions contained in the assignment.	Assignments: 50% Examination Equivalent: 50%
C	3rd year and 4th year Continuous assessment, a formal assignment and an Examination Equivalent.	Course 1 and 2: ACEMaths materials a resource for the answering of some of the questions contained in the assignment.	Course 1 and 2: Assignments: 50% Examination Equivalent: 50%
D	Journal activities, Portfolio activities, three assignments, and an Examination Equivalent.	ACEMaths materials a resource for the answering of the questions contained in the assignments and portfolio activities as well as for the writing of a journal and completion of the Examination Equivalent assignment	Assignments: 50% Examination Equivalent: 50%
E	Two assignments, a Portfolio assignment and an Examination Equivalent.	ACEMaths materials a resource for the answering of the questions contained in the assignments and portfolio activities as well as for the completion of the Examination Equivalent assignment	Assignments: 50% Examination Equivalent: 50%
F	Two assignments and an examination (year end).	Application of theory in the ACEMaths materials in several of the CASS activities. Knowledge of the ACEMaths materials a	Assignments: 50% Examination:

		required for the answering of some of the questions in the examination.	50%

Analysis of the assessment activities presented in each of the Case Studies in Chapter Four, in conjunction with the information shown in Table 5.7 shows the extent to which fundamental concepts in the ACEMaths materials were taken up by lecturers in their courses. All courses except for one (at Site A) allocated 50% of their year marks and 50% of an examination mark to the overall course marks. The 100% allocated to the action research project at Site A was broken down into smaller allocations, some of which were made in the course of the year, so it did not represent a simple one-off 100% mark allocation. Both lecturers at Site A fully incorporated the ACEMaths concepts from the units they had selected into their assessments. The examination set by Lecturer 1[90] comprehensively covered the material and the examination equivalent assignment gave students the opportunity to integrate their learning from both modules based on the OER material.

At Sites B and C, the ACEMaths materials were only one of the resources to be used by students in the completion of the assignments and examinations. The assessment task from Site C,[91] however, indicates a fuller and more in-depth take-up of concepts from the ACEMaths materials than that at Site B[92].

The lesson planning in the examination equivalent at Site E[93] was an activity that gave students the opportunity to integrate all of the concepts presented in the ACEMaths materials and apply them in the context of their own classrooms. The evidence in the student assignments showed that the concept of planning for a diverse learner group (core ACEMaths concept, Unit Six) had been taken up by students.

At Site D assessment was based strongly on the ACEMaths materials, indicating that the materials were a substantive part of the course design. The portfolio and journal activities for submission by students were taken directly from the ACEMaths materials. The assignment and examination equivalent are integrated assignments covering all modules in the ACE (LSEN) programme. Lecturer 6 reported that

[90] See 4.3.1.4.
[91] See 4.3.3.4.
[92] See 4.3.2.4.
[93] See 4.3.5.4.

evidence from these assignments indicated deep student learning and one example[94] of a student response to this assignment was included in the case study.

Assessment at Site F was the least strongly related to the ACEMaths materials. Lecturer 10 explained that this resulted from her uncertainty at the time of setting the exam (in July) as to how much of the materials she would have covered with her students by the end of the year examinations (in November)[95]. Lecturer 10 reported[96] that her students had eagerly read each unit and asked for the next one at such a pace that by the end of the year they had read all of the units, but this work was not all included in the final exam.

Assessment tasks varied across sites but at most sites the style of the assignments was in accordance with good assessment principles – including the specification of assessment criteria together with the assignment statement (DoE, 2000; Welch and Reed, 2005). Lecturers were able to use assessments to inform their course evaluations which is in accordance with one of the NADEOSA criteria for assessment design: assessment should be "used to inform teaching practice and improve the curriculum" (Welch & Reed, 2005, p. 30).

5.2.4 Mediation

It is in the assessment and mediation that the approach of the lecturer and his/her take-up of the ideas can be determined. The ACEMaths materials were used in different ways in the different sessions[97], but all of the sessions did relate to and refer to the ACEMaths materials to a greater or lesser extent. The materials were used predominantly in mixed-mode programmes, but one contact mode programme was also observed[98]. In the observed sessions lecturers used a variety of presentation and mediation methods, all of which allowed for high levels of student participation, in small or large group discussions, small group or pair activities with report-back by students to the whole group, and/or question and answer sessions led by the lecturer.

[94] See 4.3.4.4.
[95] See 4.3.6.4.
[96] See 4.3.6.2.
[97] This was demonstrated in the session observation notes for each case in Chapter Four.
[98] See 4.1 Table 4.1 for full details on mode of presentation per site.

According to Korthagen (2001) this more interactive style of teaching mathematics and involving learner participation should impact positively on the effectiveness of the materials. By placing an emphasis on interaction with others, such mediation is in accordance with Vygotsky's social constructivist view of learning.

In some sessions, activities from the ACEMaths materials were used for small group activities and to guide general whole group discussions, while in other sessions alternative activities were brought to the classes. The alternative activities were brought in for a variety of reasons. In one case it was because the student group were FET students[99], and an activity more appropriate to this level was used. In other groups, at the discretion of the lecturers, alternative activities were used since they were part of the full set of materials for the course being presented[100] and appropriate for use in a contact session. All such activities demonstrated a move away from the "traditional approach" to maths teaching in line with Korthagen's (2001) views. This indicates both the flexibility of the lecturers and the potential of the ACEMaths materials.

In some sessions, time was given to students to allow them to read relevant parts of the ACEMaths[101] materials needed for discussion or group work. In other sessions, readings from the ACEMaths materials had evidently been given prior to the session[102]. Hand-outs summarising theoretical content in the ACEMaths materials were distributed in some cases[103], indicating a possible need to assist students to cope with the amount of theory presented in the ACEMaths materials on certain topics. Lecturers spoke about the kind of material they believed could stand alone (for pure distance use) as opposed to face-to-face use and whether or not the ACEMaths materials were an example of materials that could be used in distance education. None of them felt the ACEMaths materials could stand alone. All of them felt that the materials needed mediation (to varying degrees) while some suggested that the materials could be adapted to enable them to be used independently by students.

[99] 4.3.5.
[100] 4.3.1.
[101] 4.3.2 and 4.3.5.
[102] 4.3.3; 4.3.4; 4.3.5 and 4.3.6.
[103] 4.3.5 and 4.3.6.

Lecturers all commented on the limited amount of mediation they were able to provide in the courses in which they used the ACEMaths materials, compared to what they would like to have given. For most of them there was time pressure, with insufficient time in relation to the needs of the course and the students. At most sites, students[104] noticed this time pressure and commented on it. This is an ever-present tension for lecturers but particularly for those mediating mixed-mode delivery courses, where students are not on campus full-time and do not have easy access to their lecturers when they are not on the campus.

Lecturers used activities from the ACEMaths materials to encourage the students to start to think about problem-solving strategies while engaging in a problem-solving activity themselves. This was a good way to promote meaningful reflection on a strategy, while at the same time allowing students to develop their own mathematical content knowledge. Lecturers could then circulate and answer questions relating to content as well as teaching strategies in relation to this content[105].

5.2.5 Summary

Analysis of the data revealed that lecturers used the OER materials in the pilot very much as they originally stated they would when they specified their intended use of the materials. These uses were located in mathematics teacher education courses (pre-service and in-service) and learners with special educational needs teacher education courses (pre-service and in-service). Lecturers selected parts of the OER that suited their institutional needs and their course curricular requirements. Key factors which influenced the selection were the form and purpose for selection, necessity of and capacity for customisation of the materials, course assessment requirements, and course time constraints. Mediation across sites varied: the OERs were used to catalyse discussions in both large and small group activities but they were also used as resource materials for both lecturers and students. Students responded positively to the materials. Many of them indicated that they would have liked to spend more time actively engaging with them. A more detailed analysis of the strengths and weaknesses of the materials follows in the next two sections.

[104] See 4.3 student questionnaire sections in each case presentation.
[105] See 4.3.2.3 and 4.3.6.3.

5.3 Strengths of the ACEMaths development process and materials

This section addresses the fourth of the five research questions:

d) What are the strengths of the materials development process and of the OER materials produced?

5.3.1 Most useful ideas – strengths of the materials

According to the users, one of the main strengths of the ACEMaths materials is the focus on pedagogy for mathematics in conjunction with mathematical content. Iredale's (1996) comment on the need for a focus on more than just content in teacher development programmes and Adler's (2004) research in the QUANTUM project, both affirm the importance of this dual focus. The OER module is essentially a pedagogic module but it includes what the collaborative team identified as "fundamental mathematical knowledge" (Appendix M, p. 16) which is integrated into different parts of the text. One lecturer commented very positively on the focus in the ACEMaths materials[106].

Many of the lecturers commented on the value of the ideas about diversity present throughout the ACEMaths materials, culminating in Unit Six which focuses on teaching mathematics in diverse classrooms and illustrates how teachers can adapt mathematical activity plans to cater for different learners' needs. Lecturers found the technique of multiple entry points[107] particularly useful when adapting activities for diverse needs. The emphasis throughout the text that "all children can learn maths" was seen as positive – lecturers commented[108] that students were receptive to this idea.

As was shown in the case studies in 4.3 where certain individual comments from students were included, there were many positive responses. At many of the sites, students commented that the materials should be made available to all teachers in all schools, because of their general usefulness and relevance. The comments of students

[106] See 4.3.5.6.
[107] Students also identified this as useful, see 5.3.2.
[108] See 4.3.1.6, 4.3.3.6, 4.3.4.6, 4.3.5.6 and 4.3.6.6.

across the sites on the most useful parts of the materials are summarised in Table 5.8 below.

Table 5.8: ACEMaths – most useful content according to students across sites[109]

Student comment	Tally
Practical ideas for teaching in the classroom	**78**
Designing and using problem solving activities	33
Method for designing lesson plans/three part lesson plan/tips for lesson planning	27
Assessment strategies and applications	18
Dealing with diversity	**58**
How to teach in diverse classrooms and dealing with learners with difficulties/ To value that maths is for everyone and relevant to all learners	43
Problem solving is given in a way that we can work with diverse learner groups, how to adapt activities (multiple entry points)	15
Ideas for teaching mathematical content	**57**
Drill and practice – when to use it	12
Making nets and teaching about 2-D and 3-D shapes	9
Teaching fractions in a more practical way	9
Using practical activities	8
The use of grid paper and concrete materials	6
Different strategies for operations	4
Have good hands on examples	4
How to use modelling	3
Using patterns when teaching	2
Theoretical ideas that have classroom applications	**54**
Group work and how to group learners	15
Outcomes based teaching helps me to move from traditional way of teaching to new way of teaching	12
The constructivist approach	10
The importance of relational understanding	5
Knowing the history of maths	5
Reflective teaching	4
Integrating maths and language	3

The highest number of students valued the practical ideas for use in the classroom, with the next three aspects of the materials being almost equally valued. Students indicated that the message that "maths is for everyone" was communicated clearly by the guide. Some commented that this message would help them to cope better with diverse classes of learners, since the beginning of any successful activity is the belief that it can be achieved. Many varied comments that could be clustered under the category "ideas for teaching mathematical content" indicate that the mathematical content, which is spread across the six units, particularly the more "hands-on" aspects

[109] A total of 157 student questionnaires were collected from a possible 191 students. Questionnaires from two student groups (Site C, Course 1 and Site F) were not received as explained in 4.4.

of the mathematical content, was valued by students. There were also several different theoretical ideas that have classroom applications that received positive student comments.

5.3.2 Empowering students through independent reading

Student-learning through independent reading is an important theme in the design of distance education materials (e.g. Lockwood, 2001; Welch & Reed, 2005). Ridge and Waghid refer to the need for a "consistent commitment to creating space for the student to act autonomously and thus be directly involved in the learning process" (2000, p. 91). The ACEMaths materials were designed with "distance education" materials standards[110] in mind, with the aim that they could be used for self-instruction by students. Many lecturers commented on the feasibility of using the ACEMaths for independent study, with some arguing that the materials required a lot of mediation while others thought that they could be used for independent study [111]. The following comment from a lecturer at one of the sites indicates that she felt that this aim was achieved:

> I think that the level of language is probably a little bit higher than what I normally choose to put in, but it wasn't too high that it excluded access. … It's accessible, it's user friendly, and it promotes independent study.
> (Lecturer 6 Interview Site D, p. 12)

This view was corroborated by other lecturers[112].

Many students also commented on the ease of reading/working through the units, although they were not unanimous on this point. One student's powerful comment in this regard was "the materials are better than a book" (Site D). Although the materials were designed to be suitable for distance learning, they were found to be useful in face to face courses as well. The positive comments about the accessibility of the materials came from students across all sites.

[110] The SAIDE criteria for quality course materials (2002) were used as a guideline in the development and review of the ACEMaths materials.
[111] This has been discussed under mediation in 5.2.4.
[112] See 4.3.1.6, 4.3.3.6, 4.3.5.6 and 4.3.6.6.

5.3.3 Lecturers' own learning through the ACEMaths materials

As indicated in 2.2.1 there is already a considerable body of literature in which ethical and philosophical issues in relation to OER are debated (e.g. Atkins et al, 2007; Benkler, 2005; Geser, 2008). Staff at SAIDE considered that for ethical and philosophical reasons OER should be designed and produced for South African teacher education programmes. They therefore initiated the ACEMaths project, giving a group of people the opportunity to get involved in the production of OER South African mathematics education. OER have changed from being virtually unheard of in academic circles in South Africa to being far more widely acknowledged in the period from the time of inception of the project to date. This is in line with international experience (Geser, 2007; Joyce, 2006; McAndrew, 2006, Moon, 2004; Vest, 2004). All members of the ACEMaths team grew in their knowledge, understanding and appreciation of OER.

The levels of technological knowledge and skills of the ACEMaths team members varied. The ACEMaths project took place in an environment of rapid technological change and gave the lecturers who joined the team the opportunity to extend their awareness and understanding of available technology. Most team members did not actively engage with the new technology, but for some there was significant personal technological skill development[113].

Some lecturers commented that they learnt from the content of the ACEMaths materials. One lecturer[114] noted that she had learnt a lot of mathematics by using the guide with her students. Two lecturers[115] spoke about their learning from Unit Six, which was used at five of the six pilot institutions[116]. The emphasis in this unit is on how to teach mathematics in a diverse class – the reality of most South African classes today. Lecturers felt that not only the student group had benefited from the content of Unit Six, but that they themselves had gained insight into their own diverse student groups when working through this unit.

[113] The project coordinator and content expert were the team members who experienced this growth in knowledge and skill.
[114] See 4.3.4.6.
[115] See 4.3.1.6 and 4.3.6.6.
[116] At Site B, where Unit Six was not used during the pilot implementation phase it was used in 2008. Several new users (after the pilot) have used Unit Six. See 5.3.8.

5.3.4 Ideological and technological challenges overcome

SAIDE presented the development team with a proposal for the development of an OER. This was a new idea to most people and presented an ideological challenge to many. There were technological challenges, as mentioned in the literature review[117], which the team considered and addressed during the development, pilot implementation, review and final dissemination stages of the project. One of the strengths of the ACEMaths development process (and the outcome of this process which was the materials) was the way in which the ACEMaths team responded to and overcame the challenges discussed below.

5.3.4.1 SAIDE ACEMaths as an OER initiative

The first challenge was the "identity" of the materials as OER. The SAIDE OER initiative was a small collaborative community based model with a centralised approach[118] to quality assurance. The collaboration was limited in the development phase to ACEMaths team members and selected SAIDE staff only. In the pilot phase this was extended to include a critical reader and all of the users (lecturers and students) of the materials.

At the first workshop there was a lengthy discussion[119] about OER and CC licences. It took some time before there was agreement on the licencing arrangement to be made for the module to be developed. But finally there was consensus that an OER module with an open licence would be produced. While there are different ways of mapping OER initiatives, participants in the OECD study of OER came to the conclusion that OER could most usefully be mapped in terms of a set of five descriptors:

> 1. *Scope*: from narrow to broad – measured according to range of disciplines, levels of education, and intended audiences.
> 2. *Authorship*: individual or collaborative.
> 3. *Licensing:* choice of licensing structure, and specific licence within structure.
> 4. *Granularity*: the size of resource produced.
> 5. *Teaching duration*: teaching time needed for resource (from lesson activity to whole course). (Joyce, 2006, p. 5)

[117] See 2.2.4.
[118] See 2.2.3.5 for the description of different approaches to quality assurance.
[119] See 1.5.

It is possible to use each of these descriptors to understand how the ACEMaths materials developed an identity as an OER:

1. *Scope*: One module that could have multiple applications in courses for learning and teaching of mathematics in diverse classrooms.
2. *Authorship:* Collaborative effort of a team of experts in the fields of mathematics teacher education and materials design, based on core existing materials from a single institution.
3. *Licencing*: Creative Commons-Attribution-NonCommercial-ShareAlike 2.5 License[120].
4. *Granularity:* The materials were developed and presented as Microsoft Word documents in two forms for pilot implementation[121]:
    - six separate units which could be used independently (although it is also possible to extract parts of any of these units and then use them independently) to complement other course materials; and
    - one single whole module, with six units.
5. *Teaching duration*: One full module which could be used in part-time or full-time study programmes with the type of programme determining the time allocated to the module. The module could take anything from four months to a full year for students to complete. For a single unit, the duration would be reduced further[122].

5.3.4.2 Software alternatives for development and communication

The software alternatives that were considered for the development and distribution of the pilot ACEMaths materials ranged from the more advanced Wikis and Blogs to the very simple use of word documents and email correspondence. The choice of software can have implications for materials development as well as collaboration and communication among team members. Although there were good examples of teams developing materials successfully using more technologically advanced methods (such as the very large scale Wikipedia operation), the ACEMaths team chose to go

[120] The licencing of the ACEMaths materials is discussed in more detail in 5.3.4.4.
[121] The discussion in the OECD study of OER usefully points out that a resource with low granularity (a whole module or course) can at the same time have highly granular content (many individual items that can be extracted from the course as a whole and reused). Granularity of the materials was also discussed in 5.2.3 and 5.2.3.2.
[122] The different courses and teaching duration of these courses was discussed in 5.2.2.

low-tech and used Microsoft Word and email. This did not impact negatively on the communication among team members, because the choice was the one that was most suitable for all of them, and the materials were successfully developed and disseminated by the end of the pilot project. Project managers have to create incentives for collaboration (Atkins et al, 2007) which is what the SAIDE OER management did in the ACEMaths project by hosting the development workshops and ultimately providing a set of materials for lecturers to use. The workshops were essential in the materials development process. This extract from the final project report expresses the role of the workshops (in comparison to the role of technology)

> The experience of the project was that the teacher educators in the project used the website materials minimally, preferring the paper versions distributed at the workshops. There was also minimal professional conversation over email. The conversation tended to be restricted to organizational matters. The workshops were the place where professional engagement happened. (Welch & Sapire, 2008b, p. 18)

Software can facilitate collaboration but only when people get involved with projects and use the software for the purposes of interacting and producing open content. It could be argued that the project allowed participants to remain in their comfort zones rather than be stretched. However, the correct choice of software (low tech), in conjunction with workshops, was identified in the project report as one of the strengths of the ACEMaths materials development project which facilitated its successful completion.

5.3.4.3 Production/Placement – management and dissemination

Initial uncertainty as to where to place the materials once they were developed eventually became a strength of the ACEMaths project. In the course of 2007, SAIDE assumed responsibility for the management of OER Africa, a project of the African Virtual University designed to build capacity in African higher education through open development and sharing of ideas. The OER Africa website is being developed as an OER platform with appropriate course design and communication resources and tools. This website was chosen as the portal for the ACEMaths materials. OER Africa is now in the process of developing a Teacher Education Space. This will house a Maths Teacher Education page with a link to the ACEMaths materials. It is hoped that

through this the ACEMaths materials will have a life beyond the existence of the initial project that gave birth to them.

5.3.4.4 Licencing: copyright considerations

The copyright of material determines the way in which it can be used. The issue of copyright in relation to open educational resources was extensively researched for the ACEMaths project. The decision was taken to request institutions (and particularly the institution providing the core module) to release their materials under a Creative Commons licence[123]. A letter from the institution, retaining conventional copyright protection over the original module, but permitting SAIDE to relicence the adapted/derivative material was issued. The following are the relevant clauses:

> Site H hereby grants to the South African Institute for Distance Education (SAIDE), the non-exclusive, non-transferable, perpetual right, worldwide and free of charge, to make adaptations and to create derivative works, and to reproduce and publish said works, or parts thereof, in any format whatsoever, for the duration of the copyright term, in the English language only.
>
> The permission granted may not be transferred, ceded or sub-licenced to another person, without the written authorization of Site H. The parties agree however that derivative and adapted works may be sub-licenced. (Letter from Site H, November 2006).

The project was advised by other developers of OER that the best option to take was the CC-BY-SA-2.5 licence for a variety of reasons. However, because Site H was anxious that the work might be taken and used for commercial gain, the decision was made to include the non-commercial restriction. The licence chosen was thus a CC-BY-NC-SA-2.5 licence. This turned out to be another strength of the ACEMaths materials. The licencing choice facilitated rather than blocked the progress of the development of the materials, as explained in the project report:

> Intellectual property is a complex terrain, and the Open Educational Resources movement is challenging conventional notions in ways that many academics and institutions find threatening. There are some hard line OER proponents who argue for no compromise on the use of open source software and non-proprietary operating systems as well as particular licences. The approach taken in the ACEMaths project was that the major goal is to increase openness and accessibility of educational resources, and any move towards greater openness should be supported. (Welch & Sapire, 2008b, p. 9)

[123] See 2.2.2.3.

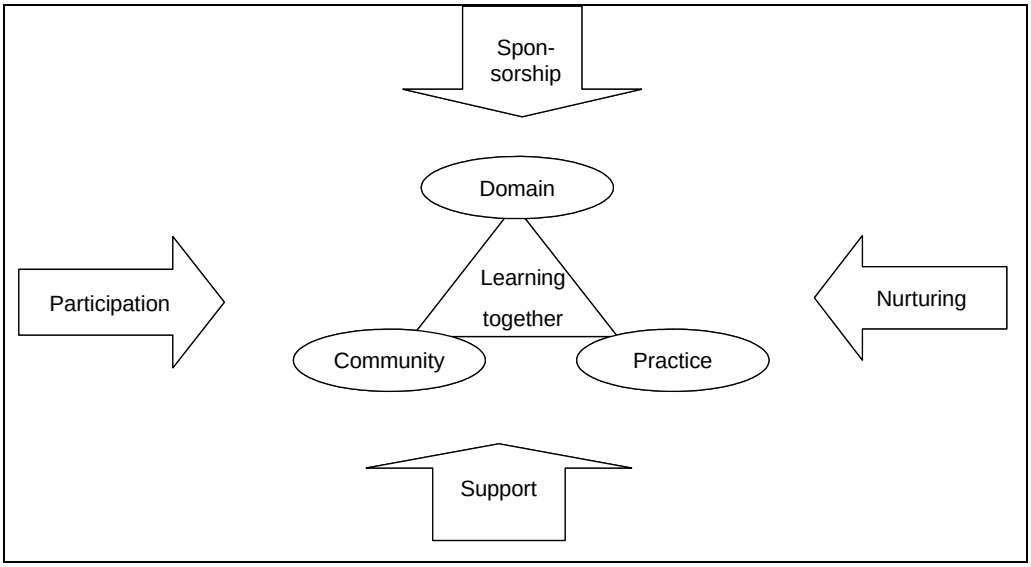
The final version of the ACEMaths materials was released digitally as well as in print format so the licence statement includes a graphic link as well as a web address:

Figure 5.1: Licence for the final version

5.3.5 Development of communities of practice

What was learned from the pilot endorsed the insights from the work of Etienne Wenger (2007) into how a community of practice (CoP) works. According to Wenger, a CoP needs a clear domain with relevant participation from active practitioners in the field/domain and this was possible in this project. Yet this is not all that is necessary. A CoP needs nurturing from within, as well as sponsorship and support from without. The participating institutions supported/sponsored the involvement of maths teacher-educators from their institution in the team. There was funding for the project from the Royal Netherlands Embassy. The community was nurtured both by dedicated content-expert time and by a project leader from SAIDE and supported by the SAIDE infrastructure and later, the technical expertise of the OER Africa team.

Figure 5.2: **How a community of practice works (Wenger, 2007: 23)**



There was a strong emphasis in the SAIDE OER project on inter-institutional collaboration as a means of professional development. Participant perceptions of benefit from the project indicated that the formation of the CoP was highly valued[124]. However, equally, in at least one case, participants, though willing, withdrew from the pilot because their own institutional environments were simply not conducive to participation[125]. Lave and Wenger's concept of legitimate peripheral participation outlined in 2.4.3 can be used to understand the different levels of participation in the ACEMaths CoP. It was accepted that not all CoP members would participate in the same way and because of this membership was stable and growth and participation of all members according to their level of participation was facilitated.

Participants valued the fact that the team consisted of teacher educators from different institutions. Linking of institutions created room for collaboration and set common "standards" for mathematics teacher education across South Africa in a positive way. In addition because of the stable membership of the ACEMaths team[126] good working relationships developed between team members which had a positive effect on the materials. The fact that there was a common task and that collaborative effort was required, encouraged conversations among professionals in the field. In addition,

[124] See 4.3 comments from lecturer interviews and questionnaires, in particular 4.3.3.6, 4.3.4.4 and 4.3.6.6.
[125] See 3.2.1 and 4.1.
[126] The team membership did not change much over the development period. Two members withdrew after the first workshop. One member sent a representative to the second workshop but attended the other workshops. One member did not attend the final revision workshop. One new member joined and attended only the final workshop.

participants were of the opinion that the size and representivity of the team was beneficial to the project[127]. The participation of lecturers from a range of institutions contributed to lively debate, while at the same time allowing for the building of professional relationships.

Lecturers at three of the sites commented on the value of initiating and sustaining the CoP. Their comments indicated an awareness of the value of both inter-institutional[128] and intra-institutional (Lecturer 2 below) communities that developed and of which they became members.

> And then I had that reading that [Lecturer 1] gave me, you know, about Thomas and all those people, and then I have tried to bring that in, to my thing… (Lecturer 1 and 2 Interview Site A, p. 7)

Collaboration is a defining feature of the design and use of OER (Geser, 2007; Vest, 2004). The insistence on contribution and participation by all team (community) members in the ACEMaths pilot was critical in achieving meaningful engagement in the workshops. With regard to resources, even though not all members of the team contributed, the final module was greatly enriched by the additional activities and materials contributed. This supports the claim in the OER literature that "collaborations will spur innovations in all kinds of interdisciplinary education" (Vest, 2004, p. 3). The workshops were very effective in creating a space where the team could meet and discuss the materials and give their input. The most important contribution came in the third workshop when specific activities and assessment tasks for inclusion in Unit Six were developed. This not only provided material for the unit, but also was an instance of real professional engagement around the integration of inclusive education principles into the teaching of mathematics.

The ACEMaths community has the potential to develop and hence further the aims of effective teacher education through collaboration. The sustainability of the inter-institutional community has proven difficult, requiring further nurturing and support. In Chapter Two Wenger et al.'s seven principles for cultivating communities of

[127] Lecturers from nine institutions initially worked in the team. There was ongoing active participation by lecturers from seven institutions, with lecturers from five institutions (at six sites) who were ultimately involved actively in the piloting. See 3.2.1 and 4.1.
[128] See 4.3.1.6, 4.3.3.6, and 4.3.5.6.

practice are outlined[129]. In the development phase the ACEMaths community functioned and was maintained through the ongoing efforts of the project manager and content-leader, in accordance with the first six principles:

- Design for evolution: SAIDE conceptualised and initiated the project, which could then evolve.
- Open a dialogue between inside and outside perspectives: the first workshop hosted a wide range of participants from a number of institutions with more than just mathematics teacher education experience.
- Invite different levels of participation: the ACEMaths team was formed, with a SAIDE project leader, a maths content expert team leader and other participants who participated to the degree that they chose throughout the process.
- Develop both public and private community space: workshops were hosted at SAIDE, email correspondence was carried out and a website (initially private and then public) was established.
- Focus on value: the project outcome was a set of materials that could be used by all participants as well as other interested parties.
- Combine familiarity and excitement: the focus of the project, being the development of materials for mathematics teacher education, was familiar to the participants. Excitement resulted from the new experience of developing an OER and to some extent, to different degrees for different participants, using new technologies.

In the pilot implementation and review phase, maintenance and support of the community continued in line with these principles. Since the dissemination of the ACEMaths materials the ACEMaths CoP has been less active and communication between members of the community has been drastically reduced. Research commissioned by SAIDE found that:

> The value of OER Africa to the ACEMaths CoP was regarded simply as a repository for the material and unless dedicated funding was allocated to drive the facilitation and management of the ACEMaths space, little further development in terms of collaboration would be realised. (Hoosen, 2008, p. 6)

[129] See 2.4.2.

The inactivity of the ACEMaths CoP could be seen as a consequence of a lack of the "creation of a rhythm for the community" in accordance with the seventh of Wenger *et al*'s design principles for communities of practice. Since there is no longer a rhythm of activity that keeps the community active, it has become a community where the "beat is too slow, the community feels sluggish" (Wenger et al., 2002, p. 63). The SAIDE project coordinator's comment on this was that "the point is that it was conceived as a project not a community that would exist after the end of the project" (Conversation with Coordinator, 28 December 2009). But for all members of the ACEMaths community, including the coordinator, the value of the community was evident and the value of its continued existence undeniable[130].

5.3.6 Learning according to the participation and acquisition metaphors

Two communities of practice emerged in the study, firstly one of developers of the materials and secondly one of users implementing the materials at the sites[131]. Sfard's (1997) participation and acquisition metaphors[132] referred to in the literature review apply in both communities. Her cautioning against the choice of just one metaphor for learning is justified in the evidence presented below of lecturer learning from the ACEMaths CoP that corresponded to both the participation and acquisition metaphors.

The lecturers who participated in the ACEMaths project all indicated that they valued this participation and that it contributed to their teacher education practice. Through the project they participated in the development of materials, thus gaining materials development experience. Through participation in the workshops where technological advances and methods of sharing were discussed, an awareness of technological advances was also gained by all members of the community. Thus it can be said that there was learning (on the part of the lecturers) according to the participation metaphor within the ACEMaths community of practice.

[130] SAIDE has now embarked on a large scale OER initiative in association with the International Association for Digital Publications (IADP) with its launch of the Teacher Education Space. The Maths Teacher Education Space will be launched in 2010 and it is hoped that this will inject new life into ACEMaths project and revitalise the community of practice.
[131] See 5.3.5.
[132] These Sfard (1999) metaphors for learning are outlined in 2.4.4.

There was another level of learning that occurred for lecturers at the workshops when team members discussed certain mathematical concepts together. On one occasion at least, it was evident to the SAIDE project coordinator that the lecturers were actually teaching each other mathematical content. She commented about this after the workshop[133]. The discussion was about number concept, where the terms "place value, face value and total value" were clarified. Some team members were able to share and clarify mathematical concepts and terminology for others. There were some who said they had never known about the distinction between place, face and total value before. This was an example of learning (on the part of the lecturers) according to the acquisition metaphor, in an open workshop with all team members participating.

5.3.7 Fostering change in educational settings

The ACEMaths materials provided a means for sharing and re-use of educational material resulting, to a certain extent, in changes in practice for the participants. All participants changed at least one course to incorporate the ACEMaths materials. In addition to this, their new knowledge of OER and the related technology fostered openness to the changes which these developments can bring.

In 5.5.3 lecturers' own learning through the ACEMaths materials was discussed. Adler's (2002) definition of teacher change as "teacher learning" in Chapter Two applies in that there was learning and therefore change at the institutions where the ACEMaths materials were used.

Another aspect of OER is that through promoting innovation and change in educational practices, benefits are passed on to students. The ACEMaths community brought new materials to students in several institutions. Observation of the ACEMaths materials being used in the field showed that to a certain extent, lecturer participation in the ACEMaths project provided the basis for rich learning experiences for students. At Site F the lecturer pointed out that the materials were more

[133] Since I was the co-leader of the workshops the project coordinator and myself had informal discussions after every workshop and it was in one of these discussions that she made this observation. I agreed with the observation. This was very interesting to note since the lecturers present at the workshop were all highly qualified and experienced.

challenging than some of the other institutional course materials and that "the SAIDE material doesn't really spoonfeed them that much" (Lecturer 10 Interview Site F, p. 17). She commented that when her students had complained about the relative density and difficulty of the ACEMaths materials in comparison to their other course materials, she had responded to them by explaining that the ACEMaths materials were good for them, and more challenging, and that they should think harder about the activities and grow through using the materials[134]. This is an example of a change in approach brought about through inclusion of the ACEMaths materials in a course. The constructivist design of the materials contributed to opportunities for more active student learning in accordance with the acquisition metaphor.

5.3.8 Scaling up of programmes

OER facilitate the scaling up of programmes. The pilot data (2007) provide a base from which scaling up can be observed, in the example of the ACEMaths OER. All of the six institutions which piloted the materials in 2007 used the materials again in 2008 and 2009. Some of have used them in exactly the same way, in the same courses. In addition to this all of them have found a place for the use of additional material which they were not able to use in 2007. All of the institutions that did not use the whole module in 2007 indicated that they would be using more of the materials in 2008/2009. One lecturer suggested that as many people as possible should be told about, and encouraged to use the materials[135]. Table 5.9 below summarises the post-pilot use of the ACEMaths materials in 2008/2009. This table is included to give an indication of the increase in the use of the OER after the pilot phase, showing how the number and range of programmes in which the ACEMaths materials are being used has expanded.

Table 5.9: SAIDE ACEMaths use 2008/2009

Site	Programme	Materials selected for use
A	ACE FET (Maths literacy) Course 1 Course 2 **ACE GET (Maths, Science, Technology) **PGCE (Foundation Phase)	Course 1: Unit Four (modified) and Units One, Two and Three (selected parts) Course 2: Unit Six **Units One and Two **Units One and Two
B	ACE GET (Maths)	Units Three and Six and parts of Unit One.

[134] See 4.3.6.2.
[135] See 4.3.3.6.

	**ACE GET (Science) **B Ed (In-service) *PGCE	**Unit Three **Unit One and Unit Three (selected parts) *Unit Three
C	**1st year B Ed for GET **2nd year B Ed for GET 3rd year B Ed for GET 4th year B Ed for GET	**Unit One and parts of Unit Two **Unit Two Units One and Two (**Unit Five 2008) Unit Six
D	ACE LSEN (Special Needs) *ACE Foundation Phase (Numeracy) **PGCE (Maths and Mathematical Literacy)	Whole module (adapted)[136] *Whole module (adapted)[137] **Unit Six
E	ACE GET (Maths) ACE FET (Maths) **Short Course (Limpopo Maths Educators)	Whole module Whole module *Units Three and Five
F	ACE SNE (Special Needs Education) **2nd and 3rd year B Ed FP	Whole module printed in a guide **Whole module, printed in separate units
H	**B Ed (learning area didactics) **Mathematics Certificate Programme (FET)	**Unit Six **Whole module (adapted)

Analysis of the "new users" gives insight into some of the issues around dissemination of the materials. The users at the sites marked with a ** represent new uses by people who were involved in the development of the materials. The users at Sites A**, B**, C**, D** and F** were also involved in the pilot implementation of the materials and have now identified additional uses for the materials with different student groups.

The user at Site H** was involved in the development workshops but did not participate in the pilot implementation due to logistical constraints. In 2009 however, the lecturer at Site H sent an email to me to indicate that she had now found two courses in which she was using the ACEMaths materials. One of her uses required a substantial adaptation of the whole guide, which she had completed. Here is an excerpt from her email:

> And you know what??
> First: I used your ACE for our Math Learning area 'didactics'. I reworked it a little bit, but we have acknowledged all the parties.
> AND
> I have also used it for a FET Math Programme in our Certificate Programme. I had to make some fairly major changes to adapt it for FET. (Lecturer 11, personal communication, 4 May 2009)

The users at the sites marked with a * represent new users who have joined the community in 2008/2009. They were not involved in the development or pilot implementation. These users were exposed to the material by word of mouth. At Site

[136] This lecturer is started using her adapted version from 2008 onwards.
[137] This user used the adaptation produced by the lecturer from Site D after the pilot phase.

B* the user participated in a workshop led by the SAIDE team. He sent an email expressing his thanks and explaining how well the session in which he had used the materials for the first time had gone.

> One of their tasks during the year is to write an essay on Constructivism and the Teaching of Maths. As a lead in I asked them to read Unit Two in preparation for a discussion. I prepared myself by copying all the suggestions for reflection in the rectangles just in case I needed to jolly the conversation along. It was nice and easy. The session was two hours. We had a great discussion, the two hours flew by. My feeling is that this year I had the most painless and efficient attack on this topic. The reading is great, short to the point and easy enough to understand, just like Maths and Science graduates want things. Thanks for your work. (New user, personal communication, 23 April 2009)

At Site D* the user heard about the materials through one of the pilot implementers. The lecturer at Site D wrote an email to enquire about using the ACEMaths materials before she made her decision to use them:

> I am involved in developing the ACE Professional Studies A (Numeracy) materials. I managed to get the SAIDE mathematics programme (developed in 2007 by you and other colleagues) and I am using it to inform our ACE Numeracy programme. I need to meet with you to discuss issues around the use of your materials. (New user, personal communication, 17 July 2008)

At Site E* the user found out about the materials when she joined the staff at the site. She has used the materials to teach existing courses (ACE GET), used an activity from the materials at an AMESA[138] conference and has now introduced a new course (Limpopo Educator's Short Course) in which she is using Units Three and Five.

The numbers of students now working with the ACEMaths materials at the sites has also grown considerably. Table 5.10 below summarises the numbers currently using the materials at the sites[139] compared to the pilot implementation numbers.

[138] AMESA is The Association of Mathematics Education of South Africa. The lecturer reported that after using one of the ACEMaths activities in her Maths GET ACE orientation programme, she decided to use it for an AMESA workshop. The workshop was successful and there were teachers who phoned her after the workshop to ask for copies of the materials she had presented.

[139] This information was obtained by contacting all of the ACEMaths CoP members as well as new users of the ACEMaths materials. It represents the full use of the ACEMaths materials to date, but there may be other users of the materials of whom I am not aware, since the materials are available as OER on the ACEMaths website.

Table 5.10: SAIDE ACEMaths: overall student numbers (2007, 2008, 2009)

Site	Programme	2007	2008	2009
A	ACE FET (Maths literacy) Course 1	15	591	404
	ACE FET (Maths literacy) Course 2	15	591	404
	**ACE GET (Maths, Science, Technology)	n/a	n/a	300
	**PGCE (Foundation Phase)	n/a	n/a	44
B	ACE GET (Maths)	45	45	40
	**ACE GET (Science)	n/a	35	n/a
	**B Ed	n/a	n/a	7
	*PGCE	n/a	4	3
C	**1st year B Ed for GET	n/a	82	90
	**2nd year B Ed for GET	n/a	43	64
	3rd year B Ed for GET	20	13	n/a
	4th year B Ed for GET	6	6	13
D	ACE LSEN (Special Needs)	35	150	209
	*ACE Foundation Phase (Numeracy)	n/a	n/a	65
	**PGCE (Maths and Mathematical Literacy)	n/a	18	n/a
E	ACE GET (Maths)	30	45	65
	ACE FET (Maths)	60	65	45
	**Short Course (Limpopo Maths Educators)	n/a	n/a	49
F	ACE SNE (Special Needs Education)	40	45	106
	**2nd year B Ed FP	n/a	65	44
	**3rd year B Ed FP	n/a	43	63
H	**B Ed (learning area didactics)	n/a	n/a	198
	**Mathematics Certificate Programme (FET)	n/a	n/a	20
TOTAL NUMBER OF USERS		**266**	**1841**	**2233**

The total number of student users increased from 266 in 2007 to 1841 in 2008 and 2233 in 2009. This represents an increase in 1575 student users from 2007 to 2008. Total student users increased again from 2008 to 2009, by 392, in spite of the large drop in student numbers at Site A (nearly 200 fewer students).

When there are large registration numbers (such as at Site A), Lecturer 1 indicated that students are assigned to tutors with about 20 to 30 students per tutor and the teaching is done, in part, at various learning centres spread throughout the province. The lecturers reported that another value of the OER was that they could be used in the training of the tutors[140]. At Site D, large student groups are also divided into smaller groups of about 30 students per tutor. Comments from lecturers at sites where increased numbers of students are now registered confirm that the ACEMaths materials do facilitate the scaling up of programmes. An ACE coordinator at Site D (who was an ACEMaths team member) recommended the materials to several course coordinators and lecturers when the university had to scale up its ACE programme

[140] See 4.3.1.6: tutors to be given ACEMaths materials as readings for advance preparation and discussion in training.

significantly to absorb the large numbers of students enrolled on departmental bursaries in 2008 and 2009. This resulted in one of the additional new uses of the materials.

The sustainability of OER initiatives may be at risk if there is insufficient buy-in to the OER movement. This relates not only to the individual, but also to the institutions in which they are located. Without institutional backing, it is difficult to sustain collaborative efforts (Atkins et al., 2007). Wiley (2007) argues that "open educational resource projects must be explicit in stating their goals and tenacious in focusing on them" (p. 19) in order to increase their chances of long-term survival. The management of SAIDE sustained the ACEMaths project successfully and the user group has grown over the two years following the pilot implementation of the materials. The long term sustainability of the project will depend on the revitalisation of the ACEMaths CoP.

5.3.9 Summary

The ACEMaths materials were found by users (both lecturers and students) to be of a high quality and to contain many useful ideas about the teaching of mathematics. Practical ideas about teaching in the classroom were most highly valued by students while content on dealing with diversity in the classroom was rated highly by both lecturers and students. The resource was seen as accessible, with the potential to empower students through independent reading because of its nature as a stand-alone text. Lecturers indicated that they themselves had learnt through engaging with the materials. In the ACEMaths project lecturers were able to overcome both ideological and technological challenges. They made choices about use of software, licensing and dissemination that both suited and extended the lecturers' and the project's aims. The activity of what became the ACEMaths community of practice yielded not only a product but also fostered relationships with a life beyond the original project goals: however sustenance and further development of this community was found to require ongoing and additional input. The ACEMaths materials were shown in some cases to have potential as a catalyst for change in educational settings and in many cases to facilitate the scaling up of programmes.

5.4 Obstacles to take-up

This section addresses the last of the five research questions:

e) Are there obstacles to the use of the OER and if so, what are these and how can they be overcome?

The initial invitation to participate in the ACEMaths project was sent to the deans of all of the Faculties of Education at South African tertiary education institutions. As reported in 1.5, the project launching workshop was attended by 25 lecturers from 12 institutions who responded to the invitation. Ultimately lecturers from five institutions piloted the materials. One institution only came on board later in the process after hearing about the project from a colleague by chance. Participants reported that messages sent to the Dean of a faculty do not always reach the right people, and there need to be other ways of communicating in relation to participation in projects of this kind. This indicates that take-up was inhibited to an extent right from the outset before the materials were even produced. Viewing the project from the perspective of the completed materials and ways in which these materials were used in the pilot, can give further insight into obstacles to the use of OER and how they can be overcome.

5.4.1 Logistical constraints

There were four sites that did not implement the pilot materials although they had been involved in their development[141]. At one site lecturers chose parts of the material to implement and had wanted to participate in the pilot implementation but were prevented from doing so because the courses for which they had ear-marked the materials were not yet operational. This constraint can only be addressed over time (allowing for the courses to become operational) and is beyond the control of the materials development project[142]. Lecturers from the second site that did not pilot the materials failed to do so as a result of logistical constraints, but lecturers from this site did use the materials in two courses later in 2009[143]. The lecturer from the third site that did not pilot the materials withdrew from the collaborative development

[141] See 3.2.1.
[142] This constraint can be seen as more than just a logistical constraint: certain institutions are still very under-developed and need materials for more than just one course. In the case of this institution, had materials for a whole course been available, these materials would all have been used and would have facilitated the opening of a new programme at the institution.
[143] See 5.3.8.

workshops after the second workshop. This lecturer stopped responding to invitations to workshops and to submit comments as a result of the busy schedule at her institution. Lecturers from the fourth site that did not pilot the materials attended only the first workshop and did not participate further in the project. Whatever the reason for their withdrawal from the community (which I have attributed to logistical constraints), these lecturers demonstrate that membership of a community will change over time.

5.4.2 Density of text: Potential for independent study without mediation

Many lecturers commented on their doubts that students would be able to work though the material independently and there was some evidence[144] that they had not done so. One lecturer raised this concern in her interview, saying "that's what I wanted to talk to you about in terms of the ACE students, that it is very dense" (Lecturer 5 Interview Site C, p. 7). Another lecturer commented that coming to grips with the content of the materials may be difficult for students without opportunities for peer discussion or interaction with lecturers while they are working independently through the material[145]. As Lockwood (2001) has argued, mediation of materials (learner support) is important, even when mediation has been designed into the materials. Lecturers who use the ACEMaths materials should provide adequate personal mediation to supplement the mediation designed into the text.

Many lecturers commented on the difficulty of language in the text although there were some who said it is (or parts of it) are good, and that despite the density it was beneficial to students. One lecturer commented that her initial fears that the materials had been too complex for the students[146] were set aside when she marked their final assignments and had the final course evaluation discussion with the students.

One student at Site D commented with a question: "Only do you understand when reading this book?" perhaps implying that he/she did not understand the content. Several other students commented on the density of the text, yet many said the

[144] See 4.3.2.3 and 4.3.5.6.
[145] See 4.3.2.6.
[146] See 4.3.4.6.

material was user friendly and easy to read. The potential of the materials for providing students with the opportunity for independent learning has been put forward as one of the strengths of the materials[147]. So this is a contentious point which is partly related to the next obstacle, time, discussed below.

5.4.3 Time constraints

Many lecturers spoke about constraints in relation to time available for mediation of the ACEMaths materials[148]. Lecturers also commented on the length of the material, and the problems this might pose for students[149]. Many students mentioned the volume of the material in relation to the amount of time available to them to work through it[150]. They also wished for more mediation time in their course programme in relation to the materials. The amount of time a lecturer can spend on a course is set by the institutional programme and will always present challenges to lecturers in relation to the content they would like to address and the content which they are able to address[151]. This happens with all courses and is not unique to the ACEMaths materials.

Observation at more than one site confirmed this problem where the observed sessions were very full and there was not time for in-depth discussion or completion of all tasks selected for the sessions[152]. The researcher observed at one site that because of the content overload of the lesson, the potential for the students to absorb all of the input was not optimal[153]. This is a problem with block-release programmes (such as at Sites A, B, D, and E): time is limited and so face-to-face sessions are very intense. According to lecturers comments[154] at all sites, between session reading and preparation is lacking. Even at Site E, where a weekly timetable for periods of independent study is issued[155] lecturers complained that students did not come to

[147] See 5.3.2..
[148] See 5.2.4.
[149] See 4.3.1.6, 4.3.3.6, 4.3.4.6, 4.3.5.6 and 4.3.6.6.
[150] See 4.3.2.5, 4.3.4.5 and 4.3.5.5.
[151] See 4.3.5.6.
[152] See 4.3 all individual case study lesson observations.
[153] See 4.3.2.3.
[154] See 4.3.1.6, 4.3.2.6, 4.3.3.6, 4.3.5.6 and 4.3.6.6.
[155] See 4.3.5.1.

sessions prepared[156]. The problem of students engaging independently with materials is bigger than just the density of the text, it also relates to student time constraints, and other factors.

5.4.4 Colleagues – uncertainty

In some institutions where one member of staff had been involved in the materials development, it was felt that there might still be difficulties in getting other staff members involved in using the materials (fostering ownership of the materials) especially where the materials differ in style from those with which they are familiar. Only at one site (Site A) did a member of the collaborative team bring in a "new" user who adapted and used the ACEMaths materials. At another site (Site E) a lecturer worked with two other lecturers using the ACEMaths materials, but the "new" users did not adapt the materials in any significant way, although in their lectures they both supplemented the materials where they saw the need to replace the ACEMaths activities with other activities more appropriate to an FET student group.

At the end of 2008 the SAIDE management team contacted the participating lecturers to find out if they thought a "road show" to show case the ACEMaths materials at their institutions would be useful to expand the user group of the OER. All lecturers contacted agreed that it would and so SAIDE organised a workshop to introduce the materials to colleagues of participating lecturers. As a result of the road show some new users joined the group and so this was one way of overcoming this obstacle. But such a process is expensive. If the virtual community of practice could be more active via the OER website, this could be a more far reaching and cost effective way of drawing new members into the group.

Lack of knowledge about OER is another issue experienced in the ACEMaths project which has also been reported by other OER projects. The OpenLearn Research Report states that "It has proven surprisingly hard to convince people that OpenLearn material is free, and that it can be reused" (McAndrew et al., 2009, p. 61). This results from the newness of the idea of OER and a lack of understanding of the creative commons licence under which much OER (including the ACEMaths materials) is

[156] See 4.3.5.6.

licenced. The Deputy Dean of an institution wrote an email on behalf of a lecturer to SAIDE in early 2008, requesting permission to use the ACEMaths materials. It was explained to him that the licence (CC-BY-NC-SA-2.5) allowed free use of the materials without the necessity of permissions but that the licence restrictions[157] should be adhered to. At the "roadshow" workshops (mentioned above) participants discussed the free availability of the materials. Many were amazed to hear that the ACEMaths materials, the COL template that was used for the final layout of the materials, and in fact most OER (depending on their licences) are available for use by anyone, without the need for permission seeking. This lack of knowledge could be an inhibitor to the take-up of OER.

Some lecturers commented that they wished their colleagues would use the materials but that it was it difficult to get them to do so. One comment was

> Colleagues I work with are hesitant, not sure why. I think it is the language idea – too much extra to read when their emphasis is on the content only. (Lecturer 3 Questionnaire 4 Site B, p. 2)

This difficulty in convincing colleagues to use the OER is more than likely because it will be some time before there is general acceptance of and involvement in the provision and use of OER (Joyce, 2006; Geser, 2007). The inertia which constrains change is difficult to overcome (Fullan, 2001) but in relation to a new idea which is gaining acceptance, this obstacle is likely to become less of a hurdle with time.

5.4.5 Student ownership and access to computers

This research project did not focus directly on student take-up, but it did probe student ownership and access to computers since this has implications for the dissemination of OER. The research took place in the context of students being given access to the ACEMaths materials in hard copy form by virtue of their being registered at tertiary institutions for a variety of teacher initial and up-grading qualifications. The findings from the group of students involved in this research indicate that it would not have been feasible to expect them to download the ACEMaths materials from the web[158].

[157] See 2.2.2.
[158] See 4.4.

Materials which are made available as OER are published on the web, where electronic access to these materials is ostensibly not limited. But in a country such as South African this access is limited by lack of ownership of or access to a computer[159]. The potential for take-up on the part of the student body for whom the materials are designed is limited if a high percentage of them do not have access to a computer. Access to a computer with internet was not probed in this research, but has also been shown to be low in South Africa (StatsSA, 2009). This needs to be considered by developers of OER, particularly in contexts where computer and internet access is limited (StatsSA, 2009).

5.4.6 Summary

Obstacles to the use of the OER that arose in the context of the pilot project illustrate that OER are both similar and different to other educational materials. Take-up in the project was limited at the outset by the deans' extension (or lack thereof) of the invitation to their staff members to participate in the project. This problem of limited participation as a result of poor communication is not limited to OER projects. Obstacles that emerged in the pilot related to student ownership and access to computers, logistical constraints, hesitancy of colleagues, the density of the text, and time constraints. As can be seen from this list, these obstacles also do not all relate to the OER nature of the materials. The lack of computer access and ownership will change over time and as this happens electronic materials will become more accessible. Most logistical constraints are beyond the control of the OER developers. The hesitancy of colleagues to join in the use of an OER is likely to diminish with time as OER become more generally known and accepted. Density of the text is the obstacle that needs to be most carefully considered by the developers of OER, pointing to the need for development of well written, accessible, stand-alone materials. Time constraints exist in all courses independent of the materials being used. The pressure placed on lecturers to use the OER within a certain time after they had been released was unusual, with both positive and negative outcomes. In some cases it spurred lecturers to greater output but in other cases it inhibited the take-up of the OER since lecturers did not feel ready to take on the full OER offering.

[159] See 2.2.4.3.

Chapter 6 Conclusions and Recommendations

If I give you a penny, you will be one penny richer and I'll be one penny poorer. But if I give you an idea, you will have a new idea, but I shall still have it, too.
(Albert Einstein)

6.1 Introduction

The goal of the project was to pilot a collaborative process for designing, sharing, adapting, and redesigning learning materials for teacher education in an OER environment. The challenge of OER relates to the sharing of ideas and the social, political and moral aspects of this sharing (e.g. Bateman, 2008; Geser, 2007; McAndrew et al., 2009; OECD/CERI, 2007). Tertiary education is often experienced as a competitive, dog-eat-dog environment, where protection of intellectual property rights has led to the development of a multi-dimensional copyright industry. Individuals caught in this situation experience the tension between making their ideas known (sharing) and ensuring that others do not steal these ideas. Conventional copyright licences do allow for the sharing of ideas within prescribed constraints. OER, licenced more openly under creative commons licences, enter the territory with a fresh approach to sharing. Under open licences authors still retain copyright but allow more free use of their ideas. This approach is in line with the contention that "there are no unique ideas" and that education has always been about the sharing of ideas (Bateman, 2008; Geser, 2007; McAndrew et al., 2009; OECD/CERI, 2007). In an arena where so many people want to talk about and use the same ideas, there will inevitably be an overlap in what they say, especially if they all situate themselves in the same academic literary tradition. Within the overlap there will be "new" ideas, which can be disseminated and developed further if there is open sharing. In addition to facilitating the proliferation of ideas, OER have "the potential to catalyze a positive change in the way teaching and learning take place within the HE sector in Sub-Saharan Africa" (Bateman, 2008, p. 36). The OER which were the focus of this study are materials for use in mathematics teacher education. The findings show that collaboration and sharing of resources is a real possibility that can enrich the teaching of mathematics teachers across institutional boundaries.

6.2 Models of OER use

The collaborative process was discussed briefly in Chapter One in the introduction to this dissertation. The data presented in Chapter Four which were collected at the various implementation sites gave some insight into the potential for reuse of the materials, based on take-up of the ACEMaths materials in the pilot phase. The analysis of the data presented in Chapter Five highlighted several aspects of the take-up potential of OER and also revealed some inhibitors to take-up. Adaptation/reuse varied according to the needs of users and the constraints under which they were operating. The experience of the user also played a role in the extent to which he/she used and adapted the materials, although such use/adaptation was also subject to operating constraints.

In this concluding chapter, five different models of take-up of the ACEMaths materials are put forward. One way of categorizing these models is in terms of the four main types of activity enabled by OER:

> Reuse - Use the work verbatim, just exactly as you found it
> Rework - Alter or transform the work so that it better meets your needs
> Remix - Combine the (verbatim or altered) work with other works to better meet your needs
> Redistribute - Share the verbatim work, the reworked work, or the remixed work with others. (Wiley, 2008, p. 1)

There was no example of redistribution in the pilot study. Only at the end of the pilot were the materials redistributed through the OER Africa website. The take-up of the materials is discussed below, where each different form of take-up is put forward as a potential model for the use of OER. The six different models described below are examples of reusing, reworking and remixing. The main point about OER culture is that it facilitates this use, but added to this is the notion of "share-alike" so that improved/adapted versions are being contributed back into the commons all the time so that the cycle of use results in new OER (McAndrew et al., 2009). Analysis of the variations of use in this project reveals a more complex picture where design features as the controlling element in take-up.

6.2.1 Reuse - Use the work verbatim

Reuse means simply using the ACEMaths materials in the form in which they have been produced by the collaborative team from SAIDE without any adaptation.

In the first model of *reuse* of the OER materials, the lecturer who used the materials maintained his existing programmes without change, but brought in the ACEMaths materials to consolidate and elucidate concepts being taught in his courses. The lecturer used one unit as an additional reading. No existing material was dropped to accommodate the new material – it was simply added to the existing body of material given to the students. At this site (Site B) the course is a mixed mode, block release programme, but it is not structured for distance education since all of the delivery is concentrated in the limited contact time available. Design at programme level allowed the lecturer very little autonomy for change or incorporation of the ACEMaths materials into his course and materials design. This limited the potential for self-instruction through well designed materials which could have further enhanced student learning through the course.

In a second model of *reuse* of the materials the lecturer replaced the existing course materials for a part of one of her courses. Here the lecturer (at Site C) had greater freedom to make decisions at the course and materials design levels. The content of the ACEMaths materials was very close to the curriculum of the target course. This lecturer used two units after she had decided that the quality of the materials was good enough and that they were applicable for use in the identified component of her course. The design example evident in this model is one where scaffolding of readings and formative assessment of students allowed for more critical engagement with the ACEMaths materials in a face to face course. The final assessment also integrated the readings and the course curriculum.

A third model of *reuse*, in this case of the full set of ACEMaths materials, was evident at three sites. The full set of materials was used exactly as produced by the collaborative team. Lecturers using the ACEMaths materials in this way made full use of the availability of the materials to replace or create materials for an entire module within a course programme. But these three sites illustrate different examples of

programme and course design which lead to take-up of the materials on different levels.

In a face to face course, the lecturer at one site (Site F) chose to use the full set of materials because she thought that all of the content was relevant to and useful for her student group. At programme level this lecturer had limited autonomy and was not able to plan the incorporation of the materials until she was able to show them to other members of her department. This meant that her implementation was delayed slightly and resulted in her using the materials later in the year in an unstructured way. She handed out the units one at a time, uncertain whether or not she would get through all of them before the examination period. A positive response to the materials was evident in the way the students "devoured" the units and kept asking their lecturer for the next one. In this way they worked through all of the ACEMaths materials. Course design decisions resulted in assessment at this site that did not fully reflect the scope of the material covered.

A second use of the full module was in a mixed mode programme at another site (Site E) where programme and course design facilitated optimal use of the ACEMaths materials. One strong design feature here was the management of learning both at contact sessions and between contact sessions in ways which fostered independent learning. Assessment was integrated into the course design and the final assessment task was an integrated lesson planning activity which drew on all concepts presented in the course and called for application of theses concepts in a practical classroom context.

A unique example of take-up in a "non-mathematical" LSEN programme was provided at a site (Site D) where the lecturer was the programme, course and materials designer. The lecturer had identified her need for an improved mathematics module in her programme and elected to use the entire module. The lecturer designed the overall programme framework to incorporate the mathematics module into the LSEN programme. This functioned well at the levels of programme and course design but she identified elements in the materials design that were not satisfactory. This led to her completely reworking the ACEMaths materials in the manner discussed in the next section.

6.2.2 Rework - Alter or transform the work

Rework means using the ACEMaths materials but revising them as needed to make them better suited to their application in the given programme.

At one site (Site D), after the lecturer had used the full set of materials for one of her modules, she decided to *rework* the materials, to bring them more in line with the presentation of her other course material. In this model the lecturer made excellent use of the ACEMaths materials, while at the same time ensuring greater uniformity of all of the materials presented to students enrolled for her courses. This was seen as an improvement in design since it resulted in less stress in the student group.

6.2.3 Remix - Combine the (verbatim or altered) work with other works

Remix means using the ACEMaths materials unadapted or in a revised form and including them together with other material to produce a substantially different final set of materials ready for application in a programme.

At Site A lecturers did not have much freedom on the level of programme and course design, but were able to make choices for their materials design within given constraints. In the model of *remixing* of the materials, the lecturer rewrote her existing course materials, adding to them substantial excerpts from the ACEMaths materials. This lecturer was the most active in materials design in her use of the ACEMaths materials, having decided not only to supplement the parts she chose from the ACEMaths materials but also to customise the materials. This customisation was possible because of the nature of the OER which allowed for seamless integration of sections of the ACEMaths materials into a new course, avoiding cumbersome quoting through global attribution.

Reuse was the most popular model. Reuse requires the least materials design effort on the part of the lecturers using the ACEMaths materials although lecturers reusing OER still have to carry out the necessary course design and programme design to accommodate and use the materials effectively. The large volume of data summarised in the models of OER take-up above leads to the conclusions which are presented below as responses to a series of questions.

6.3 Conclusions

OER facilitate building on the past through collaboration to improve education in the future, or at least, to reduce the cost and time of producing materials.

6.3.1 What is it about OER that facilitate reuse?

As a result of the licencing arrangements and electronic formats, OER are freely available for adaptation and reuse without the cumbersome and often expensive process of permission seeking. The licencing choice made by this project enabled several different uses of the ACEMaths materials. There is no limitation on how much of the material is used. OER can be used with relative ease, because they are presented in electronic formats that facilitate reuse.

6.3.2 Does the existence of freely available and freely adaptable material help?

Through this project it was possible to test the variety of ways in which these particular OER were taken up, and whether or not they were perceived to be of value to those who used them. Positive feedback from both the lecturer and the student user groups indicated that the materials had a lot to offer. All lecturers, whether they used the full guide or only part thereof, indicated that the materials had been used in an area of need. They were distinctly helpful.

6.3.3 How does adaptation and reuse vary?

Adaptation and use varies according to the needs of the users and the constraints under which they are operating. The experience of the user also plays a role in the extent to which he/she uses and adapts the materials though this usage and adaptation is also subject to operating constraints.

6.3.4 Should the focus be on a single module or a whole programme?

Participants thought that focusing on a single module was the right approach for a number of reasons. Firstly, the development of a single module is a more manageable task for a collaborative team. Secondly, a single module is less prescriptive and more interesting to the HEIs which can then make their own course design decisions and

incorporate the module more freely into an existing course. Thirdly, a single module has the potential to start the process of programme development and develop connections which can be taken further. Finally, development of a single module provides "power courses" that have multiple applications. The advantage of the ACEMaths materials was evident in the wide range of uses of the module, and in particular, the fact that it could be used in both inclusive education and mathematics education courses.

There was an example of a site (Site G) that had to withdraw from pilot implementation because they needed more than just a module. This could point to the need for more OER from which institutions could source materials to establish an entire programme (Bateman, 2008).

6.3.5 Do OER facilitate scale-up of programmes?

It is useful to have materials which are already developed for up-scaling, since this allows lecturers to plan elements of course design and programme design (such as programme delivery, assessment activities and co-ordination of tutors at dispersed sites) by relieving them of the task of materials design. In addition to this the findings revealed that OER can be used effectively to train tutors in large-scale teacher education programmes.

6.4 Recommendations

The recommendations presented below are based on findings from the research.

6.4.1 Technology should be used but not fore grounded

The experience of the ACEMaths project shows that it is not necessary to use the latest technology to develop OER in a distributed community of practice. The low tech choices (of email and Microsoft Word) combined with carefully timed workshops were sufficient to bring the materials to completion. Placement on the web does require the use of Web-2 technology but this can be done with the assistance of the appropriate professionals when the time is right. With the on-going advances in

technology it is becoming easier for individuals and institutions to set up their own websites and manage on-line communication.

6.4.2 Collaborate using existing materials

The choice of adaptation rather than development of materials from scratch, in a collaborative forum where all participants could contribute, proved motivational from a participation and implementation point of view. It also allowed for savings in time and cost. The recommendation that follows from the study of the ACEMaths project is that high-quality materials (from all or as many as possible of the participants in the collaboration) should be chosen for collaborative adaptation.

6.4.3 Infuse sound course design principles

Quality assurance needs to be high on the agenda of developers of OER so that the materials provided are instrumental in maintaining or improving standards at take-up sites. But users of OER still make their own course design decisions relating to mode of delivery, timing, mediation and assessment and so final quality cannot be assured by the OER. The aim should be development of self-instructional materials that can be used “as is” by all users including those with less academic or teacher education experience. The development team should be guided by sound course design principles such as the SAIDE criteria for materials design (1998) and informed by the NADEOSA quality criteria (2005). The team should engage in critical peer review and expert review should also be invited if funding and time allow.

6.4.4 Copyright protocols need to be researched

Fundamental to the provision of OER is an appropriate licencing choice. The ACEMaths project chose a creative commons licence which allowed users adequate freedom to take-up and adapt the materials according to their needs. Open licencing tools are an OER themselves and so developers of OER can research and choose the open licence best suited to the demands of their project.

6.4.5 Establish and nurture a community of practice

Embryonic communities of practice will form when projects get people together to develop materials but sustaining these communities requires funding and effort. Take-up of materials requires knowledge of course design and support in the improvement of course design can be assisted through CoPs. The ongoing and increasing take-up of OER which have been produced needs to be nurtured or the "levering up of funding" and "reduced costs of reuse" are rendered invalid. The ACEMaths project illustrates the need for continued nurturing of an established community in order for it to be sustained and to grow.

6.5 In closing

At the six sites where the SAIDE ACEMaths materials were used, five different models of use of the materials emerged. This variety of take-up as well as the high level of engagement of the participating institutions in the process showed that the potential of OER can be realised in practice. The free availability of the ACEMaths materials meant that where they were seen to meet a need, they could be used without the usual time and money entailed in developing new materials. The availability of the materials as OER eliminated the need for purchasing published materials. This was particularly important for the institutions that used the full set of units.

Adaptability of the ACEMaths materials (made possible through licencing and availability in electronic format) gave users the freedom to customise the materials to meet their own particular needs. This is a distinguishing feature of OER materials licenced to allow derivatives, since conventionally licenced published materials cannot be customised and can only be supplemented where they do not meet a particular need. The fact that the ACEMaths materials were OER meant that they could be integrated into other materials, enriching these materials, without distracting from the general flow of the materials. This was also made possible by the electronic Microsoft Word format of the materials in which cutting and pasting can be done. As OER, the ACEMaths materials could be re-used in whatever form suited the user, without limitation on the amount of material re-used. This allowed for a better fit of the materials into existing programmes according to the needs of these programmes.

This mathematics teacher education project does have a message for other developers of OER: good quality materials which are developed and made available will be used if people are made aware of the existence of the materials and if they are free to use them in the courses and in the manner of their choice.

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Appendix A: Lecturer Questionnaire 1

Note that spaces (larger boxes than in this form of the document) were left between questions in which the lecturers could write their comments.

Questionnaire on use of units from pilot module, Teaching and Learning Mathematics in Diverse Classrooms

Name: Institution:

PROGRAMME INFORMATION

Please provide the following information about the programme in which you intend to use the pilot units/module.

1) Programme name and credits

Name of programme	**Total credits**	**Phase specialization/s**	**Subject/learning area specialization**

2) Target audience for programme

3) Geographical location of teachers

4) List of modules in programme – in sequence in which offered

Name of module	**Credits**	**Semester**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Name of module	Credits	Semester
9.		
10.		

5) Description of course materials provided for each module (please tick)

☐ study guide intended for independent learning

☐ text book

☐ workshop materials for contact sessions

☐ readings

☐ other (please specify) …….

6) Contact sessions

Duration of each session	
Dates/months offered (i.e. frequency)	
Total hours of contact per module	
Sites offered	
Ave no. students per tutor	

7) Assessment strategy for module

Number of assignments per module	
Examination for module	YES/NO
Examination equivalent assignment per module	
Weighting of year mark and examination mark per module (%)	
Integrated assessment for programme as a whole	YES/NO

8) Feedback given on assignments (please tick)

☐ standard tutorial letter

☐ individual oral feedback

☐ individual written feedback

INTENDED USE OF ACE MATHS UNITS

1) In the programme you have just described, are you intending to use

   ☐ the whole module (all units)
   ☐ selected units
   ☐ selected activities/exercises/sections?

2) If you are going to use the whole module, please indicate your reasons for wanting to do this.

3) If you are going to use only selected units, please specify which units, and your reasons for selecting these units.

4) If only selected activities, please give some examples of activities/exercises/ sections, and the reasons selecting these exercises, and for not wanting to use whole units.

5) Where in your programme will you be using the ACE Maths material?

6) Are you intending to adapt the materials further? If so, please give an indication of the reasons for this, and how you are intending to do so.

7) Will you be dealing with one or more units in a contact session/s? Could you give the date/s of that contact session?

8) Will you be setting assignments on any of the ACE Maths units? If so, at what stage of the programme?

Appendix B: Lecturer Questionnaire 2

Note that spaces (larger boxes than in this form of the document) were left between questions in which the lecturers could write their comments.

Questionnaire on use of units from pilot module, *Teaching and Learning Mathematics in Diverse Classrooms*

Name: **Institution:**

1) What idea(s) from the SAIDE OER course materials, if any, did you find most useful in your course presentation? Which material did you actually use with your teachers?

2) How was the SAIDE OER material presented and mediated as part of your course?

3) How did the teachers respond to the SAIDE OER material?

4) What idea(s) from the SAIDE OER course materials will you **not** use and why?

5) What further comments would you like to make about the SAIDE OER materials? List them here.

Appendix C: Lecturer Questionnaire 3

Note that spaces (larger boxes than in this form of the document) were left between questions in which the lecturers could write their comments.

Actual and intended use of the SAIDE MathsACE materials

Institution:
_____

Lecturer(s) who used the materials:
_____

1. Intended use: Why did you think you would use the materials as indicated in the initial questionnaire?

2. Actual use: Why did you use the materials as indicated in the next questionnaire?

3. Compare your actual use with your intended use of the materials. Is there any further insight you could give into the difference/similarity between the two?

Appendix D: Lecturer Questionnaire 4

Note that spaces (larger boxes than in this form of the document) were left between questions in which the lecturers could write their comments.

Presentation and mediation of the SAIDE MathsACE materials

Institution:
_____

Lecturer(s) who used the materials:
_____

1. What aspects of your own presentation and mediation of the SAIDE MathsACE materials would you use again?

2. What aspects of others' sessions (using the SAIDE MathsACE materials) would you be able to try out in your situation?

3. What aspects of others' sessions (using the SAIDE MathsACE materials) would you like to try out, but would N OT be ABLE to in your situation as it is at present?

4. How would you use the SAIDE MathsACE materials differently (to the way you used them in 2007) if you used the ideas mentioned above?

5. Is there anything that prevents you from using the SAIDE MathsACE materials as fully as you may like to? Please explain.

Appendix E: Student questionnaire

Note that spaces were left between questions in which the students could write their comments.

SAIDE OER materials questionnaire
Learning and Teaching in diverse classrooms

Please answer the following questions as fully as possible.

1) Please answer the questions below, and where possible explain how the SAIDE OER course materials have helped you in achieving the knowledge required to answer each question.

    a) What is mathematics? What is mathematics learning and teaching in South Africa about today?

    b) How does mathematical learning take place?

    c) How can we teach mathematics effectively, particularly in diverse classrooms?

    d) What is 'basic' in mathematics? What is the fundamental mathematical knowledge that all learners need, irrespective of the level of mathematics learning they will ultimately achieve?

    e) How do we assess mathematics learning most effectively?

    f) How do we use teaching and learning resources in a mathematics lesson?

2) What idea(s) from the SAIDE OER course material, if any, will you find most useful in your teaching at school?

3) Which ideas from the SAIDE OER course material will you **not** use and why?

4) What further comments would you like to make about the SAIDE OER materials? List them here.

5) Do you have a computer of your own that you use when you study?

6) If you don't have a computer, do you have easy access to a computer that you can use when you are studying?

Thank you!

Appendix F: Interview Schedule – focus points

The interview is semi-structured in that I have a clear idea of the focus of some of the questions I will be asking. Although I have written several questions down, I may not use them in that form or order depending on the circumstances and what I have observed in the lesson and read in the completed questionnaires. There are two focus areas for the questions. I will try to find answers to questions relating to each of these areas in the interviews.

Focus Area 1: Content of the OERs to be used in teaching
These questions will have been answered to a large extent in the written questionnaire, but I may wish to probe further for information and explanations. I will have read the responses to the questionnaire and have an idea of which of the following questions I would like to follow up on in the interview. In each case I will try to get expanded answers following on from lecturers' written responses.

1. What are your reasons for wanting to use the whole module?
2. What are your reasons for wanting to use only selected units, and what are your reasons for selecting these units?
3. If you want to adapt the materials, what are your reasons for wanting to adapt the materials further?
4. What are the most useful idea(s) from the SAIDE OER course materials? (probe for content vs. pedagogy)
5. What are the least useful idea(s) from the SAIDE OER course materials?
6. Are there any further comments would you like to make about the SAIDE OER materials?
7. Were your expectations of this course and the course materials met?

As a follow up to the observation, I may wish to ask some of the following questions.

8. Why did you select these particular activities/sections? [Please give us a sense of how they fit into your teaching as a whole, and why you thought they would be helpful to the students, and what particular course/module outcomes they would help with]
9. How did you use the activities/sections? [Please give a plan of your contact session– what you did and what your students did in the contact session, what additional resources/equipment and if the students had to prepare something for the contact session, please describe that as well]
10. How did the session work? [Describe the successful and not so successful aspects of the session. Was there anything that surprised you in the responses of the teachers? Was there anything that pleased you? Did you learn anything from the process? etc]
11. Would you use the activities/sections again? Why? Why not?
12. How consistent is the SAIDE OER material with your existing material
13. Are you interested in knowing about the differences between The SAIDE OER materials and other materials that you have used?
14. Have you found out about student impressions of differences in the material?
15. What do you think is the role of materials in teacher education?
16. Please could I have a full copy of the course materials used? (make arrangements)

Focus Area 2: Quality of the OERs
I will ask for reasons to support the responses given to the questions below

1) Which of the units have you read?
2) Will your students/teachers be able (or have they been able) to study the units independently?
    a) What in the materials helps/helped them to do this?
    b) What in the materials makes/made it difficult for them to do this?
3) Do you think that the units:
    a) adequately address the necessary content for learning and teaching mathematics?
    b) present up to date content?
    c) model a progressive approach to teaching and learning mathematics?

For the next questions, I will have the OER materials to refer to, and ask the lecturers to point out examples in support of what they say.

4) Which is the most successful unit? Why?
5) Which is the least successful unit? Why?
6) Can you suggest any ways in which the units/module as a whole could be improved?

Appendix G: Observation notes

Space was left under each of the items for observation notes

Lecturer Name	
Group being taught	
Date and time of observation	
Location of session in full residential programme	
Lesson focus	
Number of teachers present	
Venue	
Copy of handouts attached	

Progression of lesson (general notes and description)
(blank page)

Progression of lesson (general notes and description) continued
(blank page)

Progression of lesson (general notes and description) continued
(blank page)

- the teachers' responses to the material being presented.
- the teachers' receptivity to the material being presented.
- the type of material being dealt with in the class, is it predominantly mathematics, or is it the theory of teaching and learning mathematics, or a combination of the two?
- the specific references to the issue of diverse classrooms and how these are raised and dealt with in the class.
- the level of understanding of the SAIDE OERs in terms of the subject content and the pedagogic content demonstrated by the lecturers.
- the type of activities in the lesson.
- the interaction between the lecturer and the teachers.
- Any other observations that are useful and interesting for the purposes of this research.

Appendix H: Letter of consent - students

To whom it may concern:

My name is Ingrid Sapire, and I am conducting research for the purposes of obtaining a Masters degree at the University of the Witwatersrand. My area of focus is on the take-up of materials developed as Open Educational Resources (OER) for Advanced Certificate in Education (ACE) programmes. I would like to investigate how these can be designed effectively for use in a wide range of programmes for teacher professional development. This particular research project will examine the materials developed as part of a South African Institute for Distance Education (SAIDE) OER pilot study. I would like to invite you to participate in this study. The research involves six institutions who are piloting the SAIDE materials.

One aspect of the research will entail completing a questionnaire. The questionnaire will take approximately 20 minutes to complete. Participation is voluntary, and no student will be advantaged or disadvantaged in any way by choosing to complete or not complete the questionnaire. You may refuse to answer any questions you would prefer not to, and you may choose to withdraw from the study at any point. While questions are asked about your personal circumstances, no identifying information, such as your name or I.D. number, is asked for, and as such you will remain anonymous. Your completed questionnaire will not be seen by any person other than myself. Your responses will only be looked at in relation to all the other responses. This means that feedback will be given on the basis of group responses and not individual perceptions.

If you choose to participate in the study please complete the questionnaire as carefully and honestly as possible. Once you have answered the questions, place the questionnaire in the envelope provided and deposit it in the sealed box provided. I will collect the questionnaires from the box. No one will have access to the completed questionnaires except myself and my supervisor, and I will ensure your anonymity. If you do return your questionnaire, this will be considered to be consent to participate in the research.

With your permission I would also like to observe one of the classes in which your lecturer uses the SAIDE materials.. I will sit in the room and observe what takes place. I will make notes of my observations. I will not interfere with the teaching in any way.

Your name will not be recorded in any way and you will not be disadvantaged if you choose not to participate in the study.

Attached to this letter is a form on which to indicate whether or not you agree to being a participant in a class that I observe. Please complete and sign the form and return it to your lecturer.

Kind Regards

Ingrid Sapire
011 717 6070/011 646 1801
Ingrid.sapire@wits.ac.za
RADMASTE Centre
University of the Witwatersrand
Private Bag 3, Wits 2050, Johannesburg, South Africa

Student consent form (Observation)

I _____ consent to being a participant in a class observed by the researcher for her study on Open Educational Resources. I understand that:

- My name will not be revealed to anybody
- I will not be disadvantaged if I choose not to participate

Pleas fill in your name and then sign next to your name in the table below to indicate your consent.

Name	**Signature indicating consent to observation**

Name	**Signature indicating consent to observation**

Appendix I: Letter of consent - lecturers

To whom it may concern:

My name is Ingrid Sapire, and I am conducting research for the purposes of obtaining a Masters degree at the University of the Witwatersrand. My area of focus is on the take-up of materials developed as Open Educational Resources (OER) for Advanced Certificate in Education (ACE) programmes. I would like to investigate how these can be designed effectively for use in a wide range of programmes for teacher professional development. This particular research project will examine the materials developed as part of a South African Institute for Distance Education (SAIDE) OER pilot study. I would like to invite you to participate in this study.

As you have been involved in the team who collaboratively contributed to the development of the materials, you are already aware of the range and potential of the project. The research involves six institutions who are piloting the SAIDE materials. With your permission I would like to observe one of the classes in which you use the SAIDE materials.. I will sit in your room and observe what takes place. I will make notes of my observations. I will not interfere with the teaching of the class in any way.

I would also like to interview you, at a time and place that is convenient for you. The interview will last for approximately one hour. With your permission this interview will be tape recorded in order to ensure accuracy. All of your responses will be kept confidential, and no information that could identify you would be included in the research report. The interview material (tapes and transcripts) will not be seen or heard by any person in this organisation at any time, and will only be processed by myself. Participation is voluntary, you may refuse to answer any questions you would prefer not to, and you may choose to withdraw from the study at any point.

The final aspect of the research will entail completing the attached questionnaire. The questionnaire will take approximately 30 minutes to complete. Participation is voluntary, and no lecturer will be advantaged or disadvantaged in any way by choosing to complete or not complete the questionnaire. You may refuse to answer any questions you would prefer not to. Your responses will only be looked at in relation to all the other responses. This means that feedback that will be given on the basis of group responses and not individual perceptions. If you choose to participate in the study please complete the attached questionnaire as carefully and honestly as possible. Once you have answered the questions, please would you return it to me. The questionnaires do ask for identifying information, such as your name and the institution at which you are working but no one will have access to the completed questionnaires except myself and my supervisor, and I will ensure your confidentiality. If you do return your questionnaire, this will be considered consent to participate.

Attached to this letter are three forms where you can indicate your consent to participate in the interview and class room observation or not. Please fill in your details on the forms below and return them to me. I will contact you within two weeks in order to discuss your participation. I can be contacted by email at (ingrid.sapire@wits.ac.za) alternatively I can be contacted telephonically at 011 717 6070.

Your participation in this study would be greatly appreciated. This research will contribute to a larger body of knowledge on the development of materials as open educational resources, optimising their usefulness and quality. I hope that this will benefit the ACE programmes offered at your institution.

Kind Regards

Ingrid Sapire
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_____

A: Consent Form (Interviewing)

I _____ consent to being interviewed by the researcher for her study on Open Educational Resources. I understand that:

- Participation in this interview is voluntary.
- That I may refuse to answer any questions I would prefer not to.
- I may withdraw from the study at any time.
- The interview will last about 1 hour.
- No information that may identify me will be included in the research report, and my responses will remain confidential.

Signed _____

B: Consent Form (Recording)

I _____ consent to my interview with the researcher for her study on Open Educational Resources being tape-recorded. I understand that:

- The tapes and transcripts will not be seen or heard by any person in this organisation at any time, and will only be processed by the researcher.
- All tape recordings will be destroyed after the research has been completed.
- No identifying information will be used in the transcripts or the research report.

Signed _____

C: Consent Form (Observation)

I _____ consent to having one of my classes observed by the researcher for her study on Open Educational Resources being tape-recorded. I understand that:

- My name will not be revealed to anybody
- I will not be disadvantaged if I choose not to participate

Signed _____

Appendix J: Letter to institutions requesting permission to undertake the research

I will address this letter individually to the Dean of the Faculty of Education at each institution at which I would like to carry out the research. I will put the name of the particular institution in the places indicated in bold in the letter.

My name is Ingrid Sapire, and I am conducting research for the purposes of obtaining a Masters degree at the University of the Witwatersrand. My area of focus is on the take-up of materials developed as Open Educational Resources (OER) for Advanced Certificate in Education (ACE) programmes. I would like to investigate how these can be designed effectively for use in a wide range of programmes for teacher professional development. This particular research project will examine the materials developed as part of a South African Institute for Distance Education (SAIDE) OER pilot study. There are six sites at which the materials are being implemented, and **(your institution)** is one of those sites.

I would like to ask your permission to carry out the research at **(your institution)**. This will involve interviewing and observing classes given by the lecturers who are implementing the SAIDE OER materials in one of their programmes. All of the lecturers have been involved in the development process of the materials, and have discussed the possibility of site visits at the workshops held at the SAIDE offices over the past few months. I will be asking the lecturers to give me copies of their assessment tasks, relating to the SAIDE OER material. These artefacts will be used as further data in the research. I would also like to ask their students to fill in a questionnaire, in connection with the materials they are using (the SAIDE OERs). I am carrying out the research for my Masters as part of a bigger research programme instituted by SAIDE investigating the quality and take-up of the OER materials.

The research was discussed in a paper presented recently at the TEP Consortium Conference (28-29 May) in Benoni, which was attended by many members of the Deans' Forum.

The participation of your institution in this study would be greatly appreciated. This research will contribute to a larger body of knowledge on the development of materials as open educational resources, optimising their usefulness and quality. I hope that this will benefit the ACE programmes offered at your institution.

Yours sincerely

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Appendix K: List of data items collected

Data items are referred to using these titles, with page references given where quotations are made from the data.

Questionnaires completed by lecturers
Lecturer 1 Questionnaire 1 Site A
Lecturer 3 Questionnaire 1 Site B
Lecturer 5 Questionnaire 1 Site C
Lecturer 6 Questionnaire 1 Site D
Lecturer 7 Questionnaire 1 Site E
Lecturer 8 Questionnaire 1 Site E
Lecturer 9 Questionnaire 1 Site E
Lecturer 10 Questionnaire 1 Site F

Lecturer 1 Questionnaire 2-4 Site A
Lecturer 2 Questionnaire 2-4 Site A
Lecturer 3 Questionnaire 2-4 Site B
Lecturer 5 Questionnaire 2-4 Site C
Lecturer 6 Questionnaire 2-4 Site D
Lecturer 9 Questionnaire 2-4 Site E
Lecturer 10 Questionnaire 2-4 Site F

Interviews with lecturers transcribed
Lecturer 1 and 2 Interview Site A
Lecturer 3 Interview Site B
Lecturer 4 Interview Site B
Lecturer 5 Interview Site C
Lecturer 6 Interview Site D
Lecturer 7 Interview Site E
Lecturer 8 Interview Site E
Lecturer 10 Interview Site F

Observation notes
Lecturer 3 Observation notes Site B
Lecturer 4 Observation notes Site B
Lecturer 5 Observation notes Site C
Lecturer 6 Observation notes Site D
Lecturer 7 Observation notes Site E
Lecturer 8 Observation notes Site E
Lecturer 10 Observation notes Site F

Student questionnaires
Site A
Site B
Site C
Site D
Site E

Artefacts
Assessment tasks and customisations Site A
Assessment tasks Site B
Assessment tasks Site C
Assessment tasks and customisations Site D
Assessment tasks Site E
Assessment tasks Site F

Appendix L: Full course prospectus into which ACEMaths materials were placed per site

Table L.1: Table situating the use of ACEMaths materials at Site A within the full ACE FET Maths Literacy programme

Year of study	Semester	Module name
First	Semester 1	Numbers and Operations
First	Semester 1	Data Handling
First	Semester 2	Learning and Teaching
First	Semester 2	Functional Relationships
Second	Semester 1	Education Policy, Context and Professionalism
Second	Semester 1	Space and Shape
*Second	*Semester 2	*Teaching and learning Mathematics in the FET (w.r.t Mathematical Literacy)
*Second	*Semester 2	*Professional Practice in Mathematics Education

*Modules with an asterisk (*) are those into which the SAIDE ACEMaths materials were incorporated.

Table L.2: Table situating the use of ACEMaths materials at Site B within the full GET Maths ACE programme

Year of study	Module name
*First	*Curriculum Studies in Mathematics I
First	Mathematics Education
*First	*Literacy and Numeracy
Second	Literacy and Numeracy (continued)
Second	Teaching, Learning and Research
Second	Curriculum Studies in Mathematics I

*Modules with an asterisk (*) are those into which the SAIDE ACEMaths materials were incorporated.

Table L.3: Table situating the use of ACEMaths materials at Site C within the full B Ed (GET) programme

Year of study	Module name
First	EDUCATION I
First	PROFESSIONAL STUDIES I

First	SPECIFIC SUBJECT DIDACTICS: LEARNING AREAS I (Languages, Natural Sciences, Mathematics, Social Sciences, Economic and Management Sciences, Technology, Life Orientation, Arts and Culture)
First	INTRODUCTION TO BIOLOGY AND NATURAL SCIENCES
First	INTRODUCTION TO DRAMA, ART, DANCE AND MUSIC
First	INTRODUCTION TO ENTREPRENEURSHIP
First	INTRODUCTION TO GEOGRAPHY AND HISTORY
First	INTRODUCTION TO HUMAN MOVEMENT AND RELIGION
First	INTRODUCTION TO MATHEMATICS
First	INTRODUCTION TO TECHNOLOGY
First	COMPUTER LITERACY I
First	A choice of a 1st, 2nd or 3rd language introductory course
Second	EDUCATION II
Second	PROFESSIONAL STUDIES II
Second	SPECIFIC SUBJECT DIDACTICS: LEARNING AREAS II (Languages, Natural Sciences, Mathematics, Social Sciences, Economic and Management Sciences, Technology, Life Orientation, Arts and Culture)
Second	COMPUTER LITERACY II
Second	A choice of a 1st, 2nd or 3rd language course
Second	A choice of a mathematics or Mathematics Education course
Second	A choice of four elective content courses from a given list
Third	EDUCATION III
Third	PROFESSIONAL STUDIES III
Third	SPECIFIC SUBJECT DIDACTICS: LEARNING AREAS III (Languages, Natural Sciences, Mathematics, Social Sciences, Economic and Management Sciences, Technology, Life Orientation, Arts and Culture)
Third	A choice of a 2nd or 3rd language introductory course
*Third	*A choice of four elective content courses from a given list (including a 1st language course). Also including a choice between a Mathematics or *Mathematics Education course
Fourth	EDUCATION IV
Fourth	PROFESSIONAL STUDIES IV
*Fourth	*SUBJECT DIDACTICS (1st Major) including a compulsory *mathematics course where mathematics is a major subject
*Fourth	*SUBJECT DIDACTICS (2nd Major) including a compulsory *mathematics course where mathematics is a major subject
Fourth	A choice of two elective content courses from a given list

*Modules with an asterisk (*) are those into which the SAIDE ACEMaths materials were incorporated.

Table L.4: Table situating the use of ACEMaths materials at Site D within the full ACE LSEN programme

Year of study	Module name
First	Special Need and Child Development
First	An Introduction to Inclusive Education
First	Understanding Cognitive, Emotional and Motivational Differences Amongst Learners
First	Curriculum in Context
First	Curriculum Development
*Second	*Teaching and Learning Mathematics in Diverse Classrooms
Second	Understanding Language-based Barriers in Multilingual Multicultural Classrooms
Second	Enrichment of Cognitive, Emotional and Motivational Functioning in the Classroom
Second	Approaches to Learning and Teaching
Second	Classroom Assessment

*The module with an asterisk (*) is the one into which the SAIDE ACEMaths materials were incorporated.

Table L.5: Table situating the use of ACEMaths materials at the site within the full Mathematics ACE (GET/FET) programme

Year of study	Module name
First	Space and Shape **(GET and FET)
*First	*Learning and Teaching Mathematics **(GET and FET)
First	Data Handling and Probability **(GET and FET)
First	Curriculum in Context **(GET and FET)
First	Curriculum Development **(GET and FET)
Second	Number, Algebra and Pattern (GET only) Financial Mathematics, Functions and Calculus (FET only)
Second	Technology in the Mathematics Class **(GET and FET)
Second	Mathematical Reasoning **(GET and FET)
Second	Approaches to Learning and Teaching **(GET and FET)
Second	Classroom Assessment **(GET and FET)

*Modules with an asterisk (*) are those into which the SAIDE ACEMaths materials were incorporated.

**GET and FET represent separate courses, with different course material according to the mathematical content required.

Table L.6: Table situating the use of ACEMaths materials at the site within the full ACE SNE programme

Year of study	**Module name**
First	Learning and Development
First	Programme Development and Learning Problems
First	Remedial Assessment
First	Remedial Assistance (including mathematics)
Second	Learning Readiness
Second	Special Education Needs (Semester 1)
Second	Special Education Needs (Semester 2)
*Second	*Remedial Assistance (Mathematics)
Second	Remedial Practice
Second	Underachievement Semester 2

*The module with an asterisk (*) is the one into which the SAIDE ACEMaths materials were incorporated.