Exploring Higher Education Engagement in Computer Programming within a Blended Learning Environment: An Action Research Approach

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Declaration

I, Vikash Ramanand Jugoo, declare that the research reported in this thesis, except where otherwise indicated, is my original work, and has not been submitted for any degree or examination at any other university.

V.R. Jugoo	Date
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Ethical Clearance

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6 March 2013

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Protocol reference number: HSS/0082/013D
Project title: Student engagement in computer programming: A blended learning approach

Dear Mr Jugoo

Expedited approval

I wish to inform you that your application has been granted full approval.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

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Dedication

To the Supreme Lord for His guidance and blessings

&

To my family

Jeshika, Yudishthir and Shradha

for their love and support

Acknowledgments

I initially express my deep gratitude to the Supreme Lord for His guidance and blessings.

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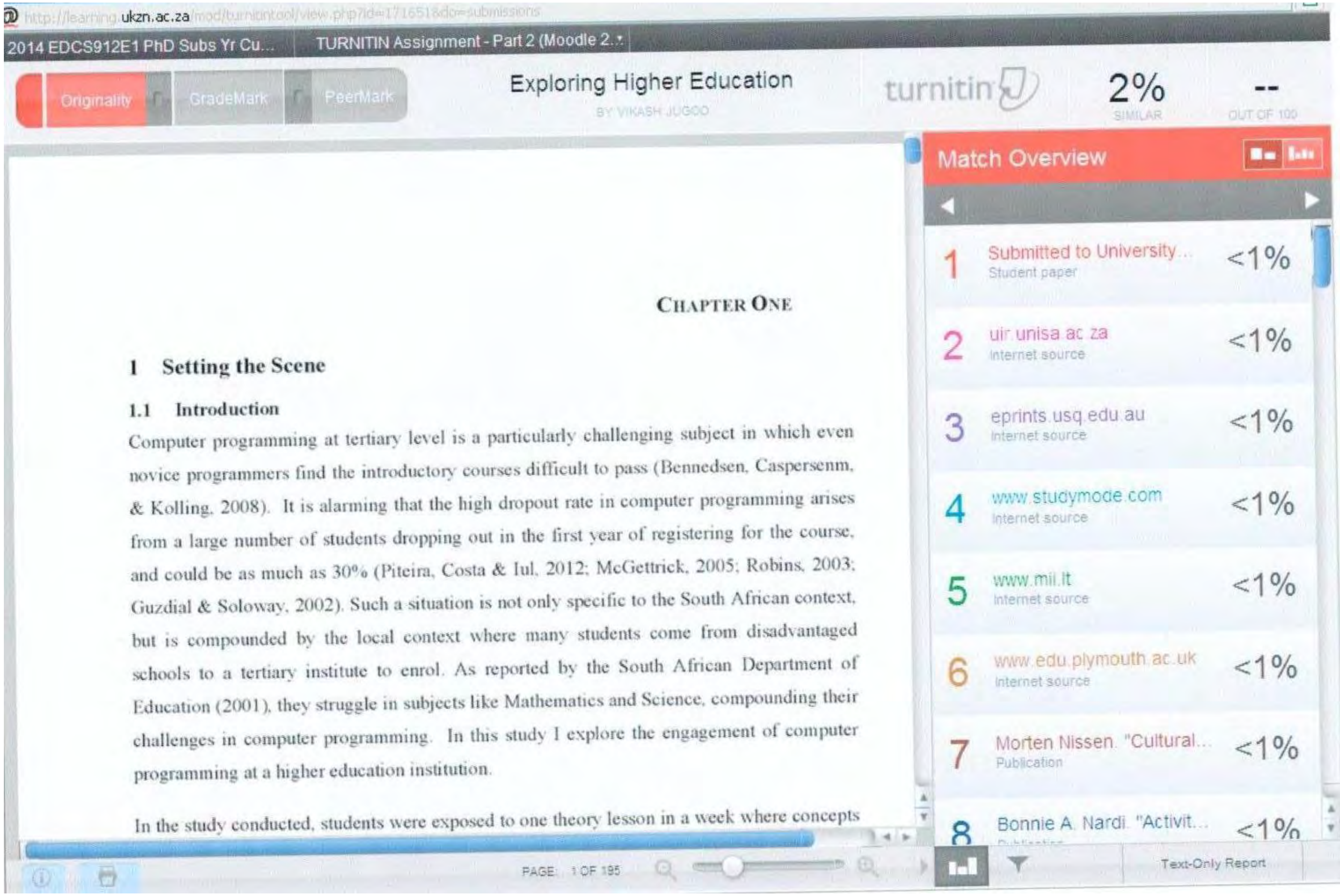
Turnitin Report



Abstract

Many novice programmers in higher education find computer programming particularly difficult due to its problem solving nature. High dropout rates have been observed both internationally and locally, but in South Africa, the circumstances of students coming from disadvantaged schools where they struggle in subjects like Mathematics and Science, especially compounds their challenges in computer programming when they enrol at a tertiary institute. In this study, I explore the engagement of computer programming at a higher education institution using an innovative approach of incorporating tools in the form of online learning and support structures to supplement the existing face-to-face and practical lessons thereby creating a blended learning environment (BLE).

This study, which is a qualitative one, used an interpretivist paradigm to explore the engagement of sixty, first year students in an introductory computer-programming course at a selected university in South Africa, using an action research approach within the context of a BLE. Action research refers to an evaluation of one's own practice with a view to improving one's effectiveness, in this case, analysing my own efficacy as a teacher, and the learning that occurred by my students (McNiff, 2013; Whitehead, 1989).

This study used two lenses: The first lens was my own as a lecturer/researcher who developed a variety of support structures in the form of notes, videos, animations, and blogging, to support student engagement in computer programming, and the second lens was the students' engagement with these tools. The study explored this dual engagement and asked two critical questions: 1) How does engagement of computer programming take place within a BL context using an action research approach, and, 2) Why does engagement of computer programming take place within a BL context using an action research approach, in the way it does? A dual form of engagement occurred creating a dynamic BLE. In the study, students were exposed to one theory classroom lesson, and three practical lessons. As the lecturer, I received feedback from the students which informed my attempts to improve the environment. Observations, a personal diary, electronic questionnaires, and focus group meetings were used to gather feedback on how students engaged in the BLE. The action research methodology was based on planning, acting, observing and reflecting. The analysis of the reflections was used in the re-planning phase of the next cycle and a total of three cycles were used. Although there were three main action research cycles, each tool was transformed resulting in smaller cycles emanating within the main action research cycle.

Activity Theory was used as a theoretical framework to describe and analyse the actions and engagement that transpired within the BLE. The results from this study highlight positive student engagement in learning through the use of examples and visual tools although the use of language was found to be a barrier under certain circumstance. Support and planning were also identified as important factors for both student and lecture engagement. Other aspects concerning feedback and reflection were established as important during the dual engagement employed resulting in the creation of a dynamic action research model of engagement.

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List of abbreviations

Acronym	Meaning
AR	Action Research
AT	Activity Theory
BL	Blended Learning
BLE	Blended Learning Environment
CHAT	Cultural Historical Activity Theory
Dr.Q	Diary, Report, Questionnaire
DS1	Development Software 1
GCE	Grey's College of Excellence
ICT	Information and Communication Technology
IT	Information Technology
ITN	Information Technology & Networks
LMS	Learning Management System
ND	National Diploma
SQL	Structured Query Language
TP1	Technical Programming 1
VB	Visual Basic

List of appendices

Coding

Method	Code	Located in
Student comments from electronic questionnaire	EQ	Appendix 2
My personal diary comments	PD	Appendix 3
Student focus group interview	SFGI	Appendix 4
Tutor focus group interview	TFGI	Appendix 5
Student comments from survey	SUR	Appendix 6
Student 1	Student 1	Chapter 5 and 6

Note: A student number, for example Student 1, is used multiple times in the narratives outlined, but does NOT refer to the same student in the sample used.

Examples of how the key is used

Example	Explanation
EQ01	The first comment in the electronic questionnaire in Appendix 2
PD02	The second personal diary entry in Appendix 3
SFGI03	The third student focus group interview comment in Appendix 4
SFGI04:5	The forth student focus group interview comment at line five in Appendix 4
TFGI06	The sixth tutor focus group interview comment in Appendix 5
TFGI07:8	The seventh tutor focus group interview comment at line eight in Appendix 5
SUR09	The ninth survey comment in Appendix 6

CHAPTER ONE

1 Setting the scene

1.1 Introduction

Computer programming at tertiary level is a particularly challenging subject in which novice programmers find the introductory courses difficult to pass (Bennedsen, Caspersenm, & Kolling, 2008). It is alarming that the high dropout rate in computer programming arises from a large number of students dropping out in the first year of registering for the course, and could be as much as 30% (Guzdial & Soloway, 2002; Robins, 2003; McGettrick, 2005; Piteira & Costa, 2012). Such a situation is aggravated by the local context in South Africa where many students come from disadvantaged schools. As reported by the South African Department of Education (2001), students struggle in subjects like Mathematics and Science, compounding their challenges in computer programming.

In the study conducted students were exposed to one theory lesson per week where concepts and techniques were taught in a large face-to-face environment. Thereafter, they were split into groups and attended three practical lessons on computer for the week, where they were required to solve tasks based on the theory lesson. As a means to assist students in their learning of this subject, various tools and support structures were developed resulting in the creation of a support environment. With the mixing of the theory, practical and support environments, a BLE was created.

In developing this support environment, as the lecturer, I developed tools and support structures for students to engage with. Thereafter, students engaged with these tools and provided feedback based on their experience in using them. Using the feedback received, I was able to refine these resources or create other resources to further assist students in their learning of computer programming. The interactions between students and lecturer created a dual form of engagement, which was explored in this study in an attempt to understand how it occurs and why it happens.

An action research methodology was used by making use of the principles of plan, act, observe and reflect. According to McNiff (2013) and Whitehead (1989), action research refers to an evaluation of one's own practice with a view to improving one's effectiveness, in this case analysing my own efficacy as a teacher, and evaluating the learning that occurred by my students. Based on the reflection, re-planning was possible which facilitated refinement of the resources through the use of the dual engagement. In this dissertation I consider the strategies implemented with a view to self-improvement as well as the effectiveness of such strategies on my students' learning. In this chapter, I discuss the rationale for engaging in this study, present the context, outline the key research questions, discuss the significance, and provide an overview of the dissertation.

1.2 Rationale for the study

The rationale for this study is driven by two imperatives: the first one is a *personal* imperative, and the second is *research* related.

My personal imperative arises from the fact that I have been a computer programming lecturer for many years at a University of Technology and have observed several difficulties concerning the first year students who register for the computer programming course on offer. In this regard three scenarios inform my personal imperative, viz., 1) the type of students wanting to study computer programming despite having achieved poor results in subjects that demand problem solving skills; 2) the poor pass rate in computer programming which resulted in decreased throughput rates, and 3) my personal commitment as a teacher of computer programming to improve the learning experience of the students. As a result, a research related project was created to explore these issues.

In terms of qualifying for university acceptance, I found that the majority of first year students enrol at the institution because they were not accepted by other neighbouring institutions. The Information Technology department statistics (see Appendix 9, DS, p. 247) indicate that those students who register for the Information Technology (IT) course, do so despite it not being their first choice of study. Students are sometimes forced into choosing courses based on the department where they receive acceptance.

In order for students to register for the IT diploma, the Department of Information and Communication Technology (ICT) has Mathematics as a prerequisite. However, most of the students that enrol for this diploma have passed Grade 12 with below average marks in Mathematics and Science. As a result, the department is required to lower its entrance requirements in mathematics to acquire the necessary intake of students.

The research imperatives that motivate this study are the developments, or lack thereof, in terms of IT student support, to improve student results. The poor results in Mathematics

(Howie, 2003) and the complex nature of computer programming (Stone & Clark, 2011), suggest that further support is required for students. Many institutions engage in other interventions in the form of tutoring software systems, multimedia tools, web tutorials and learning objects (Pillay, 2003; Hakulinen, 2011; Esper, Wood, Foster, Lerner, & William, 2014). These support structures help to engage students in the learning of computer programming and attempts to assist them to understand the concepts and techniques required to solve tasks in computer programming.

As a result of the practical nature of computer programming, traditional face-to-face teaching methods are not well-suited. As explained by Gomes and Mendes (2007), one of the challenges is to teach computer programming using static materials. Whiteboards, static presentations and printed materials are used mainly to explain dynamic concepts which students find difficult to understand. A popular approach is to use the traditional face-to-face teaching methods in conjunction with practical lessons and online support to create a *BLE*. According to Choy et al. (2007), blended teaching and learning is to combine face-to-face instruction with computer assisted instruction by mixing different learning environments.

The linkage between my personal and the research imperatives is that, as a computer programming lecturer working with students that have a poor mathematical background, I identified a need for further intervention by the department of ICT. This took the form of developing tools and support structures to enable students to better engage in learning the concepts and techniques required to be successful computer programmers.

In the next sub-section, I further describe information about the institution, the department, the subject and the students, to establish the context in which this study was conducted.

1.3 The context of the study

In order to maintain the confidentiality of the institution where this study was conducted, a pseudonym will be used. From this point onwards, the institution will be referred to as 'Greys College of Excellence' or (GCE). Descriptions of the community where the study was located, the institution and department, as well as a description of the subject being studied and the background of the students will provide an enhanced understanding of the context of this study and the factors that affected students. These are described in the following paragraphs.

During South Africa's apartheid era, residential areas were divided according to racial classification, and the municipal provision of money and resources was inequitably distributed, with African areas receiving the least. This affected the quality and quantity of public and governmental facilities available to the residents. Schools, clinics, hospitals, public transport, housing, municipal services and a host of other services were affected. Since 1994, with the advent of democracy, the SA government engaged in improvements in all former disadvantaged areas, and facilities like roads were developed (Reitzes, 2009). These former areas, however, have retained much of their demographic composition and are still reeling from the vestiges of underdevelopment from the apartheid days, particularly in education and schooling (Mavunga, 2014).

1.3.1 Institution

GCE is a higher education institution in South Africa situated in a previously disadvantaged suburb, racially classified under apartheid as a residential area for "Black" people. It attracts students from the local and surrounding Black communities. The institution is situated on the main road with easy access to transport in the form of buses and taxis. This study does not wish to essentialise race as a factor, but wishes to highlight the socio-economic background as an important factor impinging upon student participation and learning in the ICT programme at the institution.

GCE offers mainly undergraduate education in the faculties of Natural Sciences, Management Sciences and Engineering. Most of the qualifications are at the Diploma level with a few departments offering postgraduate qualifications. The department of Information and Communication Technology (ICT), where this study was conducted, is situated within the faculty of Natural Sciences. At the time of this study, student enrolment at this institution was approximately ten thousand.

During the course of this study, I identified many factors that possibly hindered the students' progress in learning. Firstly, many of these students lived at university residences. The main residences were located at the main campus, but with the high number of students requiring this form of accommodation, more student residences were acquired in the city and were situated at least twenty kilometres away from the institution. Buses were used to shuttle these students to and from campus on a daily basis with the first departure at 7am and the second at 7.30am. The buses were outsourced to external service operators who were found to be unreliable in keeping to schedule, causing students to be regularly late during the first semester of this study.

Secondly, in 2008, the former management attempted to improve the teaching and learning process by installing projectors and screens in all venues around the institution. All academic staff members were also provided with laptops to encourage the use of technology in the classroom environment. Unfortunately, the implementation of this project was not well planned. Whilst all staff members received a laptop, the screens in most venues were vandalised in the first semester of installation. As the result, the projectors were removed from the classrooms and distributed to each department. Within the department of ICT, fifteen staff members shared a total of five projectors.

A third factor revolved around students' dependence on study grants to fund their studies, without which many would not be able to engage in tertiary studies. This funding covered the cost of the tuition and residence fees and did not include textbooks. In 2010, the institution found that over 70% of the students did not purchase their prescribed textbooks. This was identified by the institution as a contributing factor that affected students' learning, and hence their abilities to pass tests and exams. As a result, the university management decided to assist students to obtain their textbooks from the university bookshop using their student accounts. The implementation of this system worked well from a teaching perspective since all students had the prescribed textbook on the first day of lectures, which I found enhanced the teaching and learning process. However, at the end of the year the university debt had increased because of non-payment of fees from students, including the outstanding textbook debt. Since 2013, when this study occurred, a decision was made to discontinue the purchasing of textbooks on student accounts, requiring students to fund the purchase of their own textbooks. As a result, approximately 70% of the students did not purchase textbooks.

On a positive note, GCE recognised the importance of using technology in the teaching and learning process and invested in the use of a learning management system (LMS) called *WebCT*[1] since 2008. This was in line with a report released by the Council for Higher Education (2007), that lecturers were using traditional teaching practices that had not changed significantly over the years to cater for an increase in diversity. In 2010 a

[1] WebCT is a learning management system which is now owned by the company Blackboard and is used for e-learning purposes.

changeover occurred from *WebCT* to *Blackboard,*[2] which was seen as an improvement in the use of technology. However, whilst the institution invested in using this technology, a shortcoming was the lack of a qualified staff member to promote and train staff in the use of this technology. Statistics (see Appendix 9, BB1, p. 245) provided by the administrator of this system outlined that approximately 20% of the academic staff utilised the LMS in 2012 because many academic members were not technology inclined. Another important reason for the non-usage of technology was due to its demanding nature in setting up the tools and the environment without having support or a reduction in teaching loads.

1.3.2 The department of ICT

The department of ICT is composed of a relatively young lecturing staff complement of fifteen academics, some of whom were new to the teaching and learning process. This department offers a National Diploma (ND) in Information Technology (IT) and provides IT services to all other departments with End User Computing. Staff members in the department of ICT utilised the LMS Blackboard to access notes, display solutions and to upload tests.

For students to gain entry into the department ICT and study the National Diploma in IT, they were required to write an aptitude test. The first year of the ND required all students to register for four subjects in their first year, of which computer programming was one subject. In the second year of study, students had the choice to specialise in computer programming or to branch away into the networking stream which did not contain any computer programming subjects. Generally, it was found that students who failed the computer programming at first year level automatically joined the networking stream. There were instances of a few students in the networking stream who carried the computer programming subject into their third year of study, having failed the subject previously.

1.3.3 Subject

The computer programming subject, *Technical Programming1 (TP1),* at first year level was the focus of this study. Another subject closely related to TP1, is *Development Software 1 (DS1)*. In DS1, students learn the problem solving concepts and techniques required in computer programming and are required to implement these techniques in the subject TP1. Unfortunately, students do not see the link between the two subjects and are unable to apply the knowledge learnt in DS1 to TP1. As a result, concepts taught in DS1 are repeated whilst teaching TP1.

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[2] Blackboard is a virtual learning environment

Statistics calculated in the department of ICT (see Appendix 9, PR1, p. 245) reflect that the pass rate of students taking the subject TP1 was below 50%. Supplementary interventions were required to assist these students to pass this subject. Whilst this is a practical subject, it was not possible for all the lessons to be hosted in the computer laboratory since it had implications for the laboratory usage and lecturer allocation. As the result, this subject was designed to have a theoretical and a practical component.

Approximately one hundred and fifty students are usually registered each year for the full time programme and another forty students for the evening programme. During the course of this study, approximately one hundred and twenty students attended the full time theory lesson, which was held weekly during the first lesson on a Monday morning at 8am. During this lesson students were taught computer programming concepts required to execute tasks in the practical lesson. In general, the lecturer was the active participant and the student passive during the theory lesson. However, I attempted to use probing questions to engage students to determine their understanding of the content, and to maintain a discussion in class. I used other techniques like, the use of examples on the white board to explain concepts, different coloured markers to write computer programme segments on the white board, and a video projector to demonstrate execution of a computer program.

During the practical lessons, students were divided into groups of approximately thirty students where they completed tasks assigned to them based on the concepts taught in the theory lesson. Each group had three lessons in the laboratory. There was no teaching that took place during this lesson, but two tutors were present to assist and guide students when they experienced difficulties in solving their tasks. During these lessons students were not allowed to discuss solutions in class with their friends and were only required to request assistance from the tutors. Over the years I had used different tools like notes and videos in an attempt to support students' learning of computer programming. However, no formal feedback was obtained from students to determine the effectiveness of the tools.

1.3.4 Students

During the selection process of the first year students for the IT Diploma, the department of ICT found the majority of students who enrolled, came from previously disadvantaged schools. Most of these students completed their secondary school education in the local townships in schools where there was a shortage of qualified mathematics and science teachers (Segar, 2012). Consequently, poor results were achieved in these subjects with the majority of students not attempting mathematics at higher grade level.

Interactions with teachers in schools from surrounding areas suggests that because of a lack of qualified teachers and poor infrastructure, the majority of schools surrounding GCE did not offer IT at secondary school level. The students that applied for this diploma have had limited, and in some cases, no prior experience in using a computer. From a departmental survey conducted, only 30% (see Appendix 9, AC, p. 247) of the students had access to a computer outside of the university environment.

Another inhibiting factor was that most students were afraid to ask questions in a large class environment. They preferred to create their own support structures and received help from their peers. The lack of questions and comments from students resulted in gaps in their knowledge as their needs and struggles were not identified, and they were unable to receive the necessary assistance to pass this subject.

In the above section, an attempt was made to describe the context in which this study is located for the purposes of clarifying the issues impinging upon student results, and the motivation for enabling a blended learning strategy.

1.4 Introducing the research questions

The scenario described in the previous section that occurred at this institution, resonates with the assertion by Stone and Clark (2011) that students at first year level struggle to pass computer programming courses at higher education. As a result, various attempts are made to assist students in programming. One of the ways is the use of a BLE. Blended learning is an approach used by combining different modes of delivery like theoretical and practical lessons with online support, in a meaningful way to enhance learning (Kaur, 2013). These environments are usually created and setup prior to the study and are utilised and evaluated within a specific context. In this environment, the engagement normally required by the lecturer is to develop tools and support structures, whilst students engage by utilising them and providing feedback. Based on the feedback obtained from the students, further engagement occurs by the lecturer. The outcome of this process leads to the creation of a support environment resulting in a BLE.

In my study, I was interested in creating tools and a support structure for ICT students to utilise, and to determine the impact of these on student engagement in computer programming. Whilst many studies (Hadjerrouit, 2008; Wang, Fong, Choy, & Wong, 2008; Dagada & Hungwe, 2012) have considered such engagements, it was either reported from a student or lecturer perspective. The intention in this study was to address both perspectives by creating a dynamic environment through the use of an action research process. To do this the following critical questions were asked:

1. How does engagement of computer programming take place within a blended learning (BL) context using an action research approach?
2. Why does engagement of computer programming take place within a BL context using an action research approach, in the way it does?

The BL context in the critical questions refers to three environments in this study, viz., 1) the face-to-face theory lesson, 2) the practical lesson, and 3) the support environment. In the face-to-face theory environment, the lecturer teaches concepts and techniques in computer programming in a large classroom environment. In the practical environment, the students work in a computer laboratory solving tasks by writing computer programs based on the worked covered in the theory lesson. The support environment gets created during the course of this study with tools being hosted on the LMS.

The notion of engagement in the critical question is approached from two perspectives i.e. from the lens of the lecturer and the lens of the student. Firstly, the lecturers' engagement in the BLE takes place through the face-to-face lessons in the classroom, the observation of students' writing computer programs in the laboratory and the creation of a support environment to assist students in the learning of computer programming. Secondly, the students' engagement in the BLE takes place through the face-to-face lessons in the classroom, the solving of tasks in the laboratory and the utilisation of the support environment to enhance their learning in computer programming.

1.5 The significance of the study

In previous years, the computer programming pass rate in the subject TP1 was approximately 45% (see Appendix9, PR1, p. 245). The data indicates that student engagement in computer programming can be improved to help students better understand the subject, and thereby improve their marks. Therefore, the aim of this study was to explore the engagement that occurred in computer programming through the use of an action research methodology. This process helped me as a lecturer to constantly reflect (McNiff, 2013) on my engagement, as well as that of the student and provided a viable process to improve student and lecturer interaction. Hence the use of an action research methodology plays a significant role in this thesis.

Action research and its use is explained in detail in Chapter 4, section 4.2.4.1.2, but a short description is provided highlighting the importance of this methodology for this study. This methodology allowed for planning, acting, observing and reflecting resulting in re-planning and the improvement of the learning process. This process aids in learning from shortcomings and implementing measures to improve the situation. A dynamic form of engagement occurred, with the lecturer constantly attempting to create, improve and refine the tools and support structures introduced in this study. After engaging with the tools and support structures, students provided constant feedback to me on their engagement. Using reflection and analysis of the students' feedback, I was able to better understand the students' experiences and further engage to enhance the environment to promote better engagement amongst the students in computer programming.

Several studies on the engagement in computer programming have focused on factors that affect novice programmers (Pillay & Jugoo, 2005b; Kinnunen, Mccartney, Murphy, & Thomas, 2007; McCartney, Eckerdal, Mostrom, Sanders, & Zander, 2007), while others have examined students' approaches to learning computer programming (Simon et al., 2006; Patil & Sawant, 2010). Others involved the development and evaluation of the use of specific support tools in computer programming (Dzvapatsva, Africa, Whyte, & Mitrovic, 2011; Linden & Lederman, 2011; Syers, 2011). While all these studies focus on student engagement, the engagement process is either reported from the perspective of the student or the lecturer. This study focuses on the dual engagement between the lecturer and the student.

In order to understand and describe the dual engagement that occurs, Activity Theory was chosen as a conceptual framework. This framework has been used in the field of education to describe and analyse the changes needed in a lecturer's practice (Buell, 2004). Furthermore, Activity Theory has also been used to understand the interaction that occurs between the student and the lecturer (Scanlon & Issroff, 2005). I, therefore needed, to understand the dual engagement that occurred within the BLE since the approach encompassed understanding the entire community involved. As a result, activity systems were created to depict the various forms of engagement that occurred. According to Willingham, Pollack, and Lewis (2002), those students that are meaningfully engaged within the activity system tend to perform better. The relationships in the activity system were analysed to understand the particular tensions that arose within the system, which allowed me as the lecturer, the opportunity to address those tensions and hence improve the environment. Furthermore, it helped me to theorise about these tensions with the intention of addressing these issues at a later stage.

1.6 Overview and structure of the thesis

This thesis is made up of seven chapters. This section will provide a summary of each chapter.

In Chapter One, I provided a summary of this study, explained the focus, rationale and described the context (composed of the institution, department, subject, and students). Thereafter the research questions were introduced and the significance of the study highlighted. This chapter concludes with an overview of the dissertation.

Chapter Two focuses on two main aspects of the literature relevant to this study, that is, computer programming and blended learning. Firstly, a description of what computer programming entails is given, then computer programming is viewed from the students' perspective by outlining student characteristics and barriers that affect computer programming. Thereafter, the lecturer's perspective is introduced by examining the approach in learning computer programming followed by the educational tools that are used in the learning process. Secondly, the BLE is presented, concepts are described and how such an environment is set up is explained. Thereafter the importance of the LMS is highlighted followed by issues of support related to working with computer programming in a BLE. Finally, the different types of engagement are discussed within a BLE.

Chapter Three presents the theoretical framework of Activity Theory. The link between engagement and Activity Theory is initially outlined, and how these principles apply to the context. Thereafter the Activity Theory framework is presented in detail by outlining its development from first to third generation. The literature dealing with Activity Theory is also interrogated in this chapter.

Chapter Four describes the research methodology and contains two parts. The first part presents the research paradigm with the methods and explains the data sources employed. Furthermore, the action research approach used is explained. The second part of this chapter provides a summary of the three action research cycles used. The first action research cycle outlines the creation and setup of the BLE. The second cycle utilises the feedback received from students in the first cycle, resulting in the creation of further support tools to promote and enhance engagement amongst students while learning computer programming. Finally, the third action research cycle revolves around the evaluation of the tools and support structures used in this study.

In Chapter Five, the first part of the findings related to the engagement that occurred in the theory and practical lessons is described. In doing so, Activity Theory is used as the framework to describe each activity system. Thereafter the engagement within these activity systems is explained highlighting the action research process, followed by the analysis of the activity system.

Chapter Six presents the second part of the findings which relate to the support environment. The presentation of this chapter follows the same structural pattern as the previous chapter, by firstly presenting the activity system of the tool or support structure, followed by the engagement and then the analysis. This process is repeated for each tool and support structure.

The concluding chapter summarises how the critical questions were answered. Furthermore, common themes are outlined resulting in the following key principles: engagement, feedback and reflection. Using these principles, a model is presented, based on the methodology used in this chapter, which highlights a dynamic action research engagement.

1.7 Conclusion

This chapter outlined the purpose for conducting this study and provided a background to the context of the study. The research questions were introduced and the structure of the thesis was outlined.

In the next section the relevant literature that supports the engagement of computer programming within a BLE is reviewed. The challenges that students experience in their learning of this subject are highlighted, and how a BLE can be used to support students is outlined.

CHAPTER TWO

2 Literature Review

2.1 Introduction

In this chapter, a review of the relevant literature concerning the main concepts is presented, namely, engagement in computer programming and engagement in a BLE. In the initial part of this chapter, the characteristics that lead to engagement are highlighted and the barriers in student engagement are outlined. The techniques used by lecturers to support student engagement, and the support tools they utilize in engaging students in computer programming are also described. Thereafter, the concept of blended learning is explained and the manner in which it is implemented in various environments is outlined. Further, the use of a learning management system within blended learning environments is highlighted.

2.2 Learning of computer programming

A brief history is outlined on the development of computer programming to position the study. This is followed by a definition of computer programming and the steps involved in writing a computer program.

A computer program is a series of steps that are executed to achieve a particular task. Since the invention of Charles Babbage's difference engine in 1822, instructions were used to perform specific tasks. In 1957 the first of a major computer programming language was introduced in the form of FORTRAN. Thereafter, in 1958 the LISP programming language was developed and used in the field of artificial intelligence. A transformation from FORTRAN to COBOL occurred in 1959, followed by the introduction of Pascal in 1968. This led to the development of C programming in 1972. In the late 1970's and early 1980's, a new computer programming methodology was used, called object orientated programming which led to the development of C++. JAVA was then introduced in the early 1990's and is currently widely used in the development of applications and in teaching of computer programming.

Farrel (2012, p. 2) states that computer programming is a "set of instructions that you write to tell a computer what to do". Bronson (2013, p16) defines computer programming as a self-contained set of instructions used to operate a computer to produce a specific result, and identifies four important steps for the learning of computer programming at first year level. Firstly, students are expected to analyse the problem. Secondly, they develop a solution which requires the programmer to logically put together the parts of the program in the form of an algorithm without writing any computer programming code (planning). Thirdly, students write the program which requires the programmer to translate the algorithm into programming code. Finally they test the program to determine if the output is correct.

Writing a computer program to satisfy the four steps described raises concerns about a first year student's ability to successfully complete each of these steps. Authors in this field agree that computer programming deals with a completely new way of thinking (Robins, 2003; Eckerdal, Thuné, & Berglund, 2005) which is associated with its problem solving nature (Pillay & Jugoo, 2005b), the components of which are planning, analysis, writing code and testing the required result. Apart from the problem solving skills involved, the programmer must be familiar with the way computer programming statements are written in a programming language. Failure to write the statements in the correct format results in errors and furthermore, if these statement are not organised into a logical sequence the desired output is not achieved, which explains why Eckerdal et al. (2005) describe computer programming as a new way of thinking.

The teaching and learning of computer programming is challenging at first year level. There is general consensus amongst authors in the field of computer programming that novice programmers struggle with the problem solving nature of this subject and they find this subject difficult to pass (Bennedsen et al., 2008; Stone & Clark, 2011). Bennedsen and Caspersen (2008) conclude that this has been a recurring problem over the past forty years. With the constant struggles that students experience in this subject, McGettrick (2005) argues that the teaching of computer programming is one of the seven grand challenges in the area of computing. As a result of these challenges many authors have emphasised the high dropout rate of 30% in these courses (Guzdial & Soloway, 2002; Robins, 2003; McGettrick, 2005; Piteira & Costa, 2012). Despite the many years of research in this field, there still exists a global problem in the teaching and learning of computer programming (Mead et al., 2006).

It is important to understand the students' experiences and engagement in computer programming in view of these challenges. Rogerson and Scott (2010) state that the focus of research has been more around the teaching of computer programming, with not much emphasis on students' experiences on learning to program. This highlights the need to understand the problem areas of programming from the perspective of the student. Boyle, Bradley, Chalk, Jones, Pickard (2003b, p. 165) argue that whilst the problems associated with computer programming are "multi-faceted", there is a need of support for the weaker students in order to assist them in succeeding in programming. In my experience as a computer programming lecturer, the issues confronting our IT students resonate with those described in the literature.

2.2.1 Student engagement in computer programming

In this section student engagement in computer programming is described by first outlining the factors that lead to success in computer programming, followed by the barriers that affect students in learning to program.

2.2.1.1 Student characteristics that lead to successful engagement in computer programming

A review of the literature indicates that student characteristics such as age, gender, previous experience, language, culture and problem solving ability have been studied to determine its influence on the progress of students' in computer programming. Many authors have undertaken the task to determine the effect of these student characteistics on novice programmers (Byrne & Lyons, 2001; Jenkins, 2002; Pillay & Jugoo, 2005b; Kinnunen et al., 2007). These studies reveal that the students' previous experience, which includes both academic and computer experience, has been a favourable characteristic for student success in computer programming. Students having previous experience with computers are able to engage better with the solving of tasks in computer programming.

The students' attitudes towards learning, and their levels of motivation are also characteristics that have been researched. Authors (Robins, Roundtree, & Roundtree, 2003; McCartney et al., 2007), have argued that these characteristics have a positive effect on the student's ability to program. Simon et al. (2006) asserted that students that are motivated and those who engage more with computer programming, perform better than students that surface learn by memorising concepts. Whilst motivation, attitude and engagement with computer programming leads to success, Kinnunen et al. (2007) challenges that these characteristics alone will not lead students to success if they are not able to think in analytical ways that lead to them solving the tasks.

Students can use different approaches whilst engaging in computer programming. Some students have a deep learning approach to computer programming which results in better performance (Simon et al., 2006) because of the nature of computer programming. Other authors (Jenkins, 2002) argue that, while surface learning through the use of memorising has its place in computer programming, it is the deep learning skills that give the students a better opportunity to succeed because of their ability to question and understand. Through the deep learning approach students are able to engage better in the solving of tasks.

In the above section, some of the pertinent characteristics that lead to success in computer programming have been described. The next section will focus on the barriers students encounter whilst engaging in this subject.

2.2.1.2 Student barriers in their engagement in computer programming

Students are faced with a variety of barriers while attempting to engage in computer programming, and as Gomes and Mendes (2007) suggest, problems experienced by novice programmers arises from their busy work schedules, difficulties in understanding abstract concepts and the problem solving nature of the subject. Other factors include the lack of comprehension, large class sizes and poor motivational levels. D'Souza, Hamilton and Harland (2008) suggests that when students have challenges with computer programming, it affects other factors like time management, study habits and confidence.

There are many factors that affect a students' engagement in computer programming. Prasad and Fielden (2003) state that most universities timetable first level computer programming courses to be lecture-centred with practical lessons. This results in computer programming concepts being taught in a theory lesson where lecturers use resources such as the whiteboard together with printed materials like the textbook or course notes. However, Gomes and Mendes (2007) argue that the teaching of dynamic concepts that are changing at each step in a computer program, through the use of static materials like the whiteboard and printed materials creates a challenge for students to understand the concepts. This results in poor understanding which affects the student's interest and motivation in computer programming (Sorva, 2013). Piteira and Costa (2012, p. 51) have "witnessed a decrease in interest and motivation (amongst) students' for learning" in computer programming which has resulted in poor pass rates. This is corroborated by Rogerson and Scott (2010) who state that students are affected by fear while learning to program. Furthermore, other factors like large class sizes, lack of individual attention and lack of immediate feedback can affect a student's learning of computer programming (Guzdial, Hohmann, Konneman, Walton & Soloway, 1998). Jenkins (2002) adds that a students' learning style also needs to be taken into consideration when teaching a student computer programming, since students learn in different ways which can influence whether they are successful or not in programming. Such factors may erode their confidence and motivation, resulting in confusion and low self-esteem which affects the results that they achieve in this subject.

Another important characteristic researched amongst students was their relationship between computer programming and their ability in Mathematics. There seems to be a general acceptance amongst some authors (Byrne & Lyons, 2001; McGettrick, 2005; Gomes & Mendes, 2007), that students who were successful in Mathematics were usually successful in computer programming. Byrne and Lyons (2001), Chumra (1998) and Pillay and Jugoo (2005b) found a strong positive correlation between students' performance in a programming course and their performance in other problem solving courses such as Mathematics or Science. It thus emerged that students who have difficulties with mathematics generally have difficulties with successful engagements in computer programming. Attempts are required to support these students to succeed in this subject.

The abstract nature of computer programming is another barrier for students when they engage in programming. Klopfer et al. (2004) concur that students experience difficulties as the result of this since they do not understand how the concepts work and cannot apply them in solving a task. As already stated, authors are in agreement that when learning computer programming, students are required to learn a new way of thinking (Eckerdal et al., 2005; Robins et al., 2003). Kinnunen et al. (2007, p. 64) argues that a computer program needs to be written in a very precise manner, resulting in an error if something as small as a semi-colon is missing, which can cause confusion to the student. This may cause a student to lose confidence and motivation. However, Schwartzman (2006) argues that confusion and uncertainty is important for learning to occur. He states that students are required to have a reflective approach to better understand their problems which results in them being accountable in solving their tasks.

Students also have difficulties with their ability to understand the task before attempting a solution. Pillay and Jugoo (2005a) argue that the lack of comprehension by students cause them to struggle in learning to program. This results from their inadequate planning skills that pose a challenge to them (Ratcliffe, 2002; Guzdial et al., 1998). Observations have been made by Perkins, Hancock, Hobbs, Martin and Simmons (1989) that students attempt to break down the problem in the middle of writing a program, instead of dealing with these issues in advance during the planning stage, which was corroborated by Pillay and Jugoo

(2005a). As a result students have difficulties in achieving the correct output when writing up a solution to a computer program.

The pass rate of students in computer programming is negatively affected because of the many challenges students experience while write a computer program. This is concurred with Mead et al. (2006) who asserts that the learning of computer programming is a challenging task experienced by students both nationally and internationally.

Having focused on the students' engagement in computer programming, the next section highlights the lecturers engagement.

2.2.2 Lecturers engagement in computer programming

In this section, the approaches used by lecturers in the learning of computer programming are outlined followed by a presentation on the different tools and support structures utilised by the lecturer in attempting to support learning of computer programming.

2.2.2.1 Approaches used in engaging with computer programming

Lecturers use a variety of techniques to support student engagement in computer programming. This can be achieved through the use of scaffolding which provides students with a basic structure that can be used to solve tasks (Caspersenm & Bennedsen, 2007; Muller, Ginat, & Haberman, 2007). In particular, cognitive scaffolding takes place when a more knowledgeable person i.e. lecturer or peer, helps the students to solve a problem (US Department of Education, 2007, p. 338). Through the use of scaffolds, students are able to learn the basic concepts and techniques and then apply them to more advanced tasks.

Another approach that can be used by the lecturer to engage students in computer programming is through the use of examples. Using this technique in the learning of computer programming can be used as a form of scaffolding to support students in the solving of computer programming tasks. Zhao (2013) concludes that support is necessary for students in the form of practicing concepts through the use of many examples. He states that "practice invariably leads to more practice, as the motivated student seeks to get better and better at programming" (p. 6). In a study conducted by Eckerdal et al. (2006), students indicated that learning to program through the use of practice is a better way to learning concepts.

Visual tools can also be used as an approach by the lecturer to assist students in engaging with computer programming. These tools could be in the form of teaching aids, software systems or models (Bassat, Ben-Ari, & Uronen, 2003). Authors agree that visual and interactive tools can be used to enhance understanding of abstract concepts which students have difficulties understanding (Naps et al., 2003; Salajan et al., 2009; Patil & Sawant, 2010). Kasurinen, Mika and Uolevi (2008) claim that students who actively use visual tools have improved their results in learning, Similar results have been found by other researchers (Rajala, Mikko-Jussi, Erkki, & Salakoski, 2007; Stephen, Franklin, Elizabeth, Juma, & Patrick, 2011). Jugoo (2012) used multimedia tools as a means to assist students learn the section on arrays[3] in computer programming. These students were exposed to animations while learning these concepts. Results indicate that students, who were previously failing, were able to improve their mark to a pass after engaging with the tools. This concurs with the assertion by Rudder, Bernard, and Mohammed (2007) that the use of visualisation techniques in teaching programming proved to be popular amongst students.

2.2.2.2 Engagement in computer programming using supporting tools

Many educational tools have been used to support and engage students in computer programming. Through the engagement of learning tools, students become more motivated which results in an improved academic achievement (Redecker, Ala-Mutka, & Punie, 2010). It is important to make use of technology in the support and engagement of students in the learning of computer programming. Williams (2003) claims that teachers must be prepared to use technology to enhance learning. Powers, Goldman, Louis, Carlisle and Mcnally (2006) state that this can result in active engagement and learning by the student, which is supported by Briggs (2005).

Reiser, Anderson and Farrell (1985) developed an intelligent programming tutor (IPT) to assist students with computer programming. However, Pillay (2003) states that not many ITPs are used to learning computer programming despite it being proven to be effective, since the developmental costs of such a programme is high (Suthers, 1996). Recently the use of gaming has been used to teach novice programmers Java concepts (Esper et al., 2014). Hakulinen (2011) believes that student motivation levels increase using this method, as they actively learn concepts in programming, which was corroborated by other authors (Serrano-cámara, Paredes-velasco, Alcover, & Velazquez-iturbide, 2014). Despite many studies

[3] An array is a structure used in computer programming and is used to store multiple values of the same type

reporting success in using these tools, Pears et al. (2007) suggest that they have not been successfully replicated in other contexts for two main reasons. Firstly, many of the tools have been developed in projects at a specific institution and required to solve a local problem. With the differences at other institutions, it becomes difficult to adapt the tools. Secondly, tools have been developed with research funds or as part of a doctoral study. In this case the tool is a prototype that lacks support.

A possible solution to these problems is the use of learning objects[4] to support and engage students in the learning of computer programming. Allen and Mugisa (2010) argue that larger content in computer programming can be broken down into smaller pieces of more meaningful content that achieves a single learning outcome. The smaller pieces of content become easier to replicate and utilise at different institutions which could possibly overcome the problems described previously by Pears et al. (2007).

Learning objects can be used to engage and support students in using of abstract concepts in computer programming (Boyle et al., 2003a). This is corroborated by Matthews (2014) who used learning objects in the learning of computer programming and found that students had a stronger understanding in computer programming. Moreover, Vincenti, Braman and Hilberg (2013) used a learning object to teach the ‘for loop’[5] in computer programming making use of interactive video and audio to engage with students in the learning process and allowed them to learn at their own pace. They found that the overall study was “positive” and students enjoyed learning using this approach. Costelloe, Sherry and Magee (2009) reported that students had fun using learning objects in the section on arrays in computer programming which led to better understanding. Similar tools were developed by Fossati et al. (2009) to teach a section on pointer based lists and had reported similar findings.

Boyle et al. (2003a) established learning objects, which covered a single learning goal like the while loop[6], to help in the teaching and learning of introductory programming. The use of visualisation was used in most of the learning objects to help students to visualise the abstract concepts. Students were able to progress at their own pace by displaying the animations many

[4] Learning objects are visualisation tools in the form of software that help a student to understand certain components in computer programming.
[5] The for loop is a computer programming structure used to repeat commands a fixed number of times.
[6] The while loop is a computer programming structure used to repeat commands an unknown number of times. This loop uses a conditions and it stops when the condition becomes false.

times, with a test given at the end. This method of learning was found to be an innovative way to teach computer programming.

Videos can be used to support and engage students in computer programming. Goeser, Flett, Kriske and Panter (2012) concluded that visual material help students to improve their understanding and performance. Syers (2011) believes that video demonstrations help the student to reinforce concepts being taught and found the use of video demonstrations to be helpful, which was corroborated by Gudio (2010).

Carlisle and Educator (2010) used videos in Java programming courses and reported them to be effective tools in the learning process and can reduce the time spent on lectures. Zahn, Pea, Hesse and Rosen (2010) have shown that problem solving tasks can be developed through the use of video by assisting in the cognitive and social development of students. However, Hsu, Hwang, Chang and Chang (2013) emphasise that videos need to introduced at the appropriate phases for them to be effective. Furthermore, Linden and Lederman (2011) argue that consideration must be given to the voice accent used in videos since this may lead to lack of understanding and motivation.

Simple animations to teach self-paced computer programming were developed by Linden and Lederman (2011) who made use of *PowerPoint* presentations for demonstration purposes during their face-to-face lessons. These animations contained program code and made use of colour coding during program execution. The intention of the colour coding was to help students better understand the programming code. Feedback obtained from the students suggested that students benefited from such an experience. As a step further, the researchers signed up ex-students to develop similar materials to assist with future teaching. Feedback from these students indicated that they valued the work experience and it helped them to reinforce concepts that they had previously learnt.

A blog can also be used to support and engage students in the learning of computer programming. Within an educational context, a blog is seen as a space where communication takes place between students, students and educators and between students and the internet community (O'Donnell, 2005; Farmer, Yue, & Brooks, 2008; Kerawalla, Minocha, Kirkup, & Conole, 2008). The blog has the ability to enhance students' engagement in education and allows for collaboration and the creation of knowledge (Lenhart & Fox, 2006). An observation was made Roblyer, McDaniel, Webb, Herman and Witty (2010) that shy students that may not ask questions in class would rather use social media, which was corroborated by Blood (2002) and Repman, Zinskei and Carlson (2005). Dzvapatsva et al. (2014) stated that with the engagement of social media in computer programming, the pass rates can be improved.

Collaboration can also be used to support and engage students in the learning of computer programming. McKinney and Denton (2006) concluded that the use of collaboration in an introductory course in computer programming led to higher academic performance, higher interest in the course and high retention rates. This concurred with Gonzalez (2006) who found that through the use of co-operative learning, pass rates increased by approximately 30%. However, Saavedra and Darleen-Opfer (2012) emphasised that communication and collaborative skills needed to be developed for students to interact with their peers and solve tasks and share outcomes.

Having explained the literature on computer programming, a blended learning approach using the methods described can be used to engage students in computer programming. The next section focuses on the BLE to enhance student engagement.

2.3 Blended learning

Various strategies can be used in presenting computer programming concepts to students. One such way is the use of a blended learning environment to supplement traditional teaching methods. Blended learning refers to the combination of face-to-face interactions with electronic learning tools (Welker & Berardino, 2006). Studies that have made use of a blended learning approach will be outlined.

The BLE can be used as a means to support students in their learning of computer programming. In order to achieve this, Akkoyunlu and Soylu (2008) suggest that the design of the environment take into consideration the needs of the student. Research conducted amongst three international institutions in Serbia, Macedonia and Croatia suggest that teaching methodologies have shifted from traditional lectures to a blended learning model that blends with practice, especially emphasizing a hands on approach (Ivanovic, Bogdanova, Milašinovic, Savic, & Bothe, 2013, p. 319). They also found that students felt a need to make use of technology as learning tools to enhance their learning process.

According to Huang and Zhang (2008) blending used in education must result in improving learning and provide for a deep learning approach and active participation of students.

Higher education institutions are required to find methods of delivery that are effective and flexible for students to gain access to better quality experiences (George-Walker & Keeffe, 2010). Picciano (2009) suggests that older lecturers are not comfortable using technology and may not make use it in their courses. He further states that lecturers need to be aware that the contemporary student is growing up with technology and lecturers are expected to use the technology in their courses to cater for these students.

2.3.1 Concepts of blended learning

Blended learning has been known by many different names such as hybrid learning, blended education and flipped classrooms, with an on-going debate on the precise meaning (Driscoll, 2002; Graham, Allen, & Ure, 2003; Osguthorpe & Graham, 2003; Laster, 2004; Oliver & Trigwell, 2005; Jones, 2006; Masie, 2006). The most common definition is the combining of face-to-face interactions with electronic learning tools (Welker & Berardino, 2006) or technology mediated instruction (Graham, 2006). Figure 2.1 illustrates the mixing of these two modes resulting in a blended learning environment.

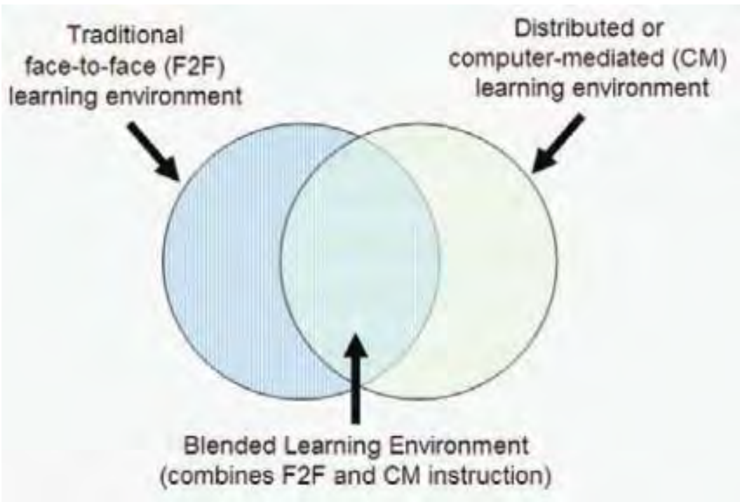

Figure 2.1: Blended learning environment

Blended learning deals with the meaningful combining of face-to-face and online technologies. Another definition outlined by Garrison and Vaughn (2008) describes blended learning as integrating the strengths of the face-to-face and the online learning with the intention of improving the learning experience and satisfying the educational purpose. This is supported by Laster, Picciano and Sorg (2005) and Banci and Soren (2008) who emphasise that the quality of education be improved with a valuable pedagogical purpose. Czerniewicz (2007) states that the debate has moved beyond technology and is now focused on the learning environment, a comment that is supported by Msile (2006). The use of a face-to-face environment creates interactions and discussions and is considered important for students (Kistow, 2011). A combination of this environment with online support may add more value to the learning process. Bonk and Graham (2006) state that the use of blended courses are becoming more popular with the new technologies that are available.

The use of a BLE offers many advantages to the teaching and learning process. Graham (2006) highlights three primary reasons for using blended learning, namely, to improve the effectiveness of learning, to increase access and convenience, and for greater cost effectiveness. Kistow (2011) utilised a BLE and reports that students found this environment to be convenient and flexible. He also states (p. 122) that in this environment engagement amongst students can occur in the form of "peer discussions and networking" which "motivates the less independent" student. On the other hand, Hara and Kling (2001) argue that the use of a total online environment can lead to isolation and stress because students may not understand instructions or content. With the combination of the face-to-face and online environments, students are able to obtain the best of both worlds.

2.3.2 Setting up a blended learning environment

In setting up a blended learning course a number of components are required. Students neither want a completely face-to-face environment, nor do they prefer a completely online course. Authors have concluded that students enjoy working with the blended experience (Akkoyunlu & Soylu, 2008; Banci & Soren, 2008). Orhan (2008) states that students prefer to meet and discuss issues and also to make use of technology. However, Utts, Sommer, Acredolo, Maher and Matthews (2003) found that students did not have positive attitudes towards blended learning courses in the study they conducted. Despite these conflicting views, Vignare (2007) argues that most students have found positive reactions.

For BLE to be effective, the manner in which it is setup and designed is of crucial importance. Gao and Iwane (2014) created a blended learning model consisting of the classroom, laboratory and online module which contained the following components: course objectives and the selection of textbooks, online tools, classrooms and laboratory rooms. The online module was used before the class and laboratory lessons in preparation for the lessons, and was also used after these lessons to reinforce concepts taught. At the end of the module an evaluation of the course took place for the purposes of improving the course.

Nel and Wilkinson (2008) provide a framework for meaningful blended learning practices in the undergraduate classroom within a South African context. They offer a framework on which collaborative online activities can take place in a BLE. A number of factors need to be taken into account when setting up the environment. Nel (2010), having used and implemented materials on a Learning Management System (LMS) for over ten years within a South African context, presented a four step process to setup the LMS. The first step is to create a plan to determine the activities required for the LMS. Thereafter, the design and setup of the tools is required, followed by students' utilisation of the tools on the LMS. Nel and Wilkinson (2008) state that students should be allowed to practice on this environment in a safe and less formal space. It is also important to ensure the active participation of students. The final step requires the evaluation and improvement of the course design, which she suggests can be done through reflections at mid-semester and at the end of the semester.

Ning and Wuzi (2011) highlighted the design of a course in computer programming using the language VB (Visual Basic). In their design they offered five areas of importance. The first area revolved around the role of teaching, that is, to be enthusiastic and take the initiative to promote learning which they suggest will optimize the learning by students. The second area concerns having online materials as a means to support and supplement the work carried out in class, due to the limited amount of time that lecturers have in the classroom. The third area involves dividing the computer programming course into two parts, namely, basic knowledge to help build the foundation of programming concepts, and advanced knowledge. The fourth step dealt with the teaching of concepts through the use of interesting examples which need to be comprehensive and include examples of the entire chapter. Case studies can help the student learn how to solve a task and through a comprehensive set of cases, students can practice and improve their ability to write computer programs. The final step requires support through the use of online classes and materials. Students have the opportunity to work independently or collaborate with others in times of difficulty. Teams are also created where students are required to work on projects.

2.3.2.1 Using a learning management system

A Learning Management System such as *Blackboard* or *Moodle* plays an important role in a BLE. Martin (2008) refers to a LMS as software that allows management of learning content and resources by students. Watts and Hammons (2002) state that it is important for higher education institutions to integrate technology with the classroom through the use of learning management systems. Precel, Eshet-Alkalai, and Alberton (2009) point out that the LMS is available to all academics but only used by a small percentage.

The teaching and learning environment can be improved by using a LMS. Studies conducted by Phahlane, Howe and Kekwaletswe (2011) indicate that students who used the LMS felt it had a positive effect on their learning. Lonn and Teasley (2008) name two categories of LMS users – those who use it for instructor communication (e.g. posting materials), and others who use it for interactive teaching and learning (e.g. students commenting on each other's work). However, Furner and Daigle (2004) argue that the use of the LMS must support the outcomes and goals of the course in order to achieve effective learning and enhance the effectiveness of the students experience.

2.3.2.2 Support

Support is required by the person setting up the BLE in the following ways. Firstly, technical support is required to ensure that technologies used are all stable. Secondly, support is required in the development of notes and materials for students to access. In a study conducted by Boyle et al. (2003b), a support team was used to setup the BLE containing expertise in the following areas: virtual learning environment, online teaching material and university technical support. Ginns and Ellis (2007) argue that the use of a blended environment requires similar support to that used for on campus laboratories. Dziuban, Moskal and Hartman (2005) suggest the use of an online help desk to assist students with challenges.

The BLE is well suited to support students in learning and engaging them in computer programming. In their study, Boyle et al. (2003b) provided support to students in the form of tutorials. However, Hadjerrouit (2008, p. 206) asserts that "online resources are highly important but not sufficient to help students progress beyond the novice stage to higher-order skills" in computer programming.

Students need to have access to the materials in order for it to benefit them. Mayadas (2001) notes that students access to the course is of utmost importance. Nel (2005) highlights that her study of students engagement in higher education was affected because they did not have access to the internet to access the online environment. Another importance constraint is for the institution to ensure that their network infrastructure can allow students to access the LMS from within and out of the institution.

2.4 Engagement and learning within a blended learning context

There are many studies that have successfully used a BLE in the teaching and learning of computer programming. A review of the literature of these studies will highlight the context, results and engagement between the lecturer and the students working within a blended learning environment. The effect of using such an environment will also be described.

A study was conducted by Hadjerrouit (2008) to explore the use of a blended learning model to teach a Java computer programming course. It presented the design, implementation of online resources and the evaluation of the implications for the student leaning of computer programming. Students were exposed to face-to-face lessons and an online environment. A number of outcomes resulted from this study, namely, 1) students showed a high level of satisfaction with the online resources; 2) students were of the opinion that they were able to construct their own knowledge of programming which proved to motivate them; 3) students believed that teacher student interaction in the form of face to face lessons was important, and 4) students were of the opinion that collaboration with other students played an important role in their learning but concede that the online resources cannot replace the human intervention like mentoring and tutoring when it comes to the teaching of higher order skills.

A study conducted by Wang et al. (2008) at the City University of Hong Kong developed a web based automated system that was used in their computer programming courses. Their previous course was taught in the traditional way of face-to-face lessons with smaller tutorials groups. A change was made to their current way of teaching to include an e-learning environment and a "clinic scheme" where students were able to consult with lecturers. This institution adopted the policy of using technology to provide a student-centred approach to education. The software allowed the lecturer to design exercises with varying levels of difficulties to cater for the different levels of students, and allowed them to monitor the progress and performance of each student. Through the use of the software, slow learners were detected and relevant exercises were administered to improve their learning of programming. Furthermore, talented students were also identified and utilised as peer assistance to encourage and help the slow learners. The lecturer first engaged by creating tasks using the e-Learning environment. Students engaged in solving the tasks by writing segments into software and received immediate feedback on the correctness of the segment. The following results were obtained from their study. Firstly, the BLE provided great flexibility to both the teachers and students. Secondly, it allowed students to learn at their own pace. Thirdly, using this form of teaching resulted in more students achieving grade ‘A’ passes. Finally, fewer students failed the course compared to the results when this course was taught in the traditional way. Comments solicited from students highlighted their enjoyment working in the BLE.

Galvez, Guzman and Conejo (2009) conducted a study in an object oriented computer programming course using a blended learning approach to teach students abstract data types in computer programming. Two e-learning technologies were used, that is, a web based assessment tool and an intelligent tutoring system with a problem solving environment. This environment offered students many tasks and provided feedback about their progress. The environment was personalised for each student and adapted to their needs enabling them to progress at their own pace. Hints were also provided to help the students in solving their tasks. The results from the study conducted show an “improved student performance” after using this environment.

Djenic, Krneta and Mitic (2011) conducted a study on BL in a basic programming course. A control group of students received lectures in the traditional way whilst experimental group received a BL course. They conclude that “the implementation and evaluation of the courses have shown advantages and improvements over the previous traditional courses covering identical material” (p. 251). Their traditional course was made up of instructor-led, face-to-face theory lessons, instructor-led exercises, practice in computer laboratories and lectures over the internet with learning from printed textbooks. In the BL model they had online and offline materials. The online materials were in the form of *PowerPoint* self-study notes, e-books, online exercises and discussion forums. There was constant redevelopment of the materials in order to improve them. The LMS *Moodle* was used to host the materials. An expert team was put together consisting of developers, designers, educators and reviewers to develop two online multimedia textbooks. There were interactive activities and exercises with a calendar of activities defined in advance. Testing also occurred to determine the progress of the student. This study highlighted the following results: firstly, the students that took the blended course achieved better results than those that attended the traditional course. Secondly, students in the blended course favourably reported about the user friendliness of the course, easy communication with the lecturer, active participation and graphic solutions. Thirdly, lecturers found the course very demanding in terms of monitoring students’ comments on the forums and to prepare and organise each of the many course segments.

They also had to re-adjust to a new lecturer and student roles, the environment in which the students worked in, and the evaluation of the students.

Within a South African context, Nel (2005) presented a series of publications with the overall aim to explore an effect of blended learning practice in a South African higher education context. In her first article she used an action research methodology to inquire into collaborative online learning of undergraduates. Students enjoyed the collaborative assignment and found the experience "interesting". They were able to meet new people and share ideas without face-to-face meetings. The negative aspects from this study revolved around the lack of participation by some of the student group members which resulted in added pressure on other group members. Students indicated that the pure online collaborative environment slowed them down, and believed that the face-to-face environment would have facilitated faster decision making. Finally, it was found that the lack of a computer and internet access hindered students' progress in this course.

Dagada and Hungwe (2012) also conducted a study using a blended learning approach to improve student performance in a web development course at a South African Higher Education Institution. They concluded that while lecturers are enthusiastic about using a BLE, there is a lack of understanding about the basic principles of blended learning. They further indicate an improvement in the performance of students resulting in an increase in the throughput rate.

2.5 Conclusion

In this chapter two main issues were discussed. The first issue described the characteristics of computer programming. The second issue highlighted the positive and negative aspects of student engagement within this subject. A positive correlation between students' ability in maths and computer programming was found because both of these subjects require problem solving skills. In computer programming, students have difficulties with abstract concepts and support in the form of videos, blog and collaboration can assist them. Similarly, learning objects were found to have contributed positively. The second issue explained the concept of a BLE. In this setting, students get the best of multiple environments, for example, combining face-to-face lesson, practical lessons and online support. Students were found to be motivated working in a BLE.

The next chapter outlines the theoretical framework used, explaining two main components, namely, the concept of engagement and the framework of Activity Theory with a linkage between these two concepts created. Finally, a detailed description of Activity Theory is provided.

CHAPTER THREE

3 Theoretical Framework

3.1 Introduction

This chapter initially provides a brief historical insight into the development of Activity Theory, focusing specifically on the contribution by Vygotsky's disseminations on human psychology, which gave Activity Theory its impetus. Vygotsky (1978) outlined that learning is a social practice that takes place with others before we can internalise the learning on our own. Students tend to be social and prefer to engage with others, particularly while learning in the classroom environment (Willms, Friesen, & Milton, 2009) and concentrate more, are less disruptive, mutually engaged and have lower dropout rates (Lee, Smith, & Croninger, 1995; Steinberg, Brown, & Dornbusch, 1996; Willingham et al., 2002). In order to capture the entire learning community during the engagement process, an activity system is required which can explore the various relationships and the social interactions that take place. With the constant engagement of activities between the student and lecturer, tools are created and enhanced within this activity system. Problems and challenges that surface within the activity system, like issues of absenteeism, necessitated a transformation of the system to enhance the engagements and improve the learning process.

The second aspect to be discussed in this chapter is the key principles of Activity Theory namely, activities as basic units of analysis, object-orientedness, internalisation and externalisation, history and development and artefacts and mediation, all of which demonstrate how the activities within an activity system are directed towards a goal and are mediated by tools or instruments. The importance of tools within an educational context in transforming the activity system and hence improving the learning of students is described. It is necessary for these key principles to be discussed first, as they are embedded concepts in the historical description that follows.

Thirdly, the chapter then traces the historical development of Activity Theory as initially proposed by Vygotsky (1978), further developed by Leontiev (1981) , and finally expanded by Engeström (2001).

The notion of contradiction is thereafter introduced since it play a very important role in transforming an activity system. Engeström (2001) argues that contradictions take place within different points in an activity system resulting is disturbances and tensions and describes them on different levels. Bellamy (1996) concurs that through the use of tools, contradictions or tensions arise within an activity system causing it to transform the activity to improve the effectiveness of the system.

The penultimate section explores how Activity Theory was used in other research related studies. For clarity, Activity Theory is described with its own language and terminology. Finally, an explanation is given on how Activity Theory is used in this study. In particular, a motivation is provided for its use in the field of education as outlined by Crawford and Hasan (2006) and Murphy and Mannzanares (2007). A critique of Activity Theory is offered which is argued in terms of the definition of action within an activity system and the difficulty of the language used in Activity Theory. A deliberate attempt is made to address both of these issues in this study by providing an explanation of the terms used and by outlining the definition of activity as applied in this study. As a result I, argue in favour of Issroff and Scanlon (2002) that Activity Theory provides an effective framework for better understanding the students' experience.

Activity theory used in this study is based on interactions between the lecture and the student resulting in engagement. An explanation is firstly provided with regards to students' engagement followed by its relevance to Activity Theory.

3.2 Engagement in Activity theory

Students' engagement can be related to performance and may influence their results. Willingham et al. (2002) argue that student performance, is generally better by those that are engaged whilst those that do not engage adequately tend to be disruptive during lessons, miss lessons and have poor concentration which results in them dropping out (Lee et al., 1995; Steinberg et al., 1996). Students are more productive at university when they engage in purposeful tasks of studying, peer collaboration and applying what they have learn (Pace, 1990). Strydom, Kuh and Mentz (2010, p. 276) conclude that "student engagements can be a potentially powerful tool for improving student success"

In order for students to engage in purposeful tasks in computer programming and achieve success, purposeful engagement is also required by the lecturer. This can be achieved by using many various approaches such as learning through practice (Eckerdal et al., 2006), making use of visual and interactive means (Patil & Sawant, 2010) and learning by example

(Zhao, 2013), to name a few. Furthermore, support tools in the form of learning objects can be developed to assist students (Matthews, 2014) while videos can be used to engage students in the learning of computer programming (Guido, 2010). The use of a BLE is another approach to successfully engage students in the learning (Choy et al., 2007; Hadjerrouit, 2007).

With the lecturer introducing various resources into the learning environment and students engaging with them and then providing feedback, the lecturer could refine and improve the resources or develop and introduce further resources. This two way interaction leads to a dual form of engagement between the lecturer and the student.

There are also many factors that can hinder the process of engagement. Within a South African context the issue of language barriers is an important consideration since many of the students are at educational institutions where the medium of instruction is their second language. This could be problematic since many of these students entering university may not have developed adequate skills in reading, listening and speaking in English (Ayliff & Wang, 2006; Cross & Carpentier, 2009; Mqwashu, 2009). This factor can pose as a barrier during the engagement process.

In order to capture the entire learning community during the engagement process, an activity system is required which can explore the various relationships and the social interactions that take place. With the constant engagement of activities by students and lecturers, tools are created and enhanced within this activity system. Problems and challenges arise, resulting in the transformation of the system to enhance the learning process.

Activity theory is a framework that allows the creation of an activity system which includes the engagement between the subject (individual/s), instrument (tools) and community (all members that affect the activity system). It is governed by rules (practices and norms required in the system) and contains a division of labour (role of each member) while attempting to achieve its objective (what the system is trying to achieve).

Within a South African context, Activity Theory provides useful insights in this developing and transforming society. For example, the use of technology plays an important role in education requiring students to access online materials through the use of an internet connection. However, many students were not able to afford this facility and in some instances areas were not well developed with infrastructure for students to access the internet, resulting in a contradictions or tension. Activity Theory provides a suitable framework to expose these contradictions or tensions. Hence, it has much to offer when applied to the learning experience of students within a South African context. Furthermore, within the context of this study, Activity Theory served as a useful framework for the dual engagement process that occurred. Interactions between the various relationships are described, explored and analysed resulting in tensions and contradictions. In attempting to overcome the tensions, the system transforms and moves closer to its objective. A detailed explanation of Activity Theory is provided in the sections that follow.

3.3 Activity Theory explained

3.3.1 Background of Activity Theory

Activity Theory dates back to the 18th and 19th century and was originally published in Russian and translated into English some decades later. The underpinning of Activity Theory was introduced by the Russian psychologists Vygotsky, Leontiev and Luria in the 1920s and early 1930s (Kuutti, 1996; Engeström, 2001; Fitzsimons, 2005; Uden, 2007).

These researchers, whose ideas were radical at that time, went beyond the prevalent conceptions of psychology during their time and investigated the concept of thought and consciousness. Vygotsky is credited with building a new theory of human psychology (Engeström, 1993). Whilst his colleagues were interested in laboratory based experiments with rats, Vygotsky's theory of human psychology dealt with mediation and changes in behaviour. He suggested that a stimulus-response activity was usually mediated by an instrument or tool. This research led to the birth of Activity Theory which provides a "unified account of Vygotsky's proposals on the nature and development of human behaviour" (Lantolf, 2006, p. 8). The ideas of Vygotsky were further developed by researchers like Leontiev and Engeström. The core argument to Leontiev's (1978) idea, compared to Vygotsky (1978), revolved around a community of collective actions instead of individual activity. Engeström (2001) further argued that under certain circumstances of diverse culture, participants may require the interaction of multiple activity systems, since the use of one activity system may not be sufficient to capture all the effects of the diverse group.

To understand the application of Activity Theory, certain key principles need to be initially clarified. After the key principles have been explained, a historical description of the development of Activity Theory is given. It is essential that the key principles are explained first as these concepts are alluded to in the description of the historical development of Activity Theory.

3.3.2 Key principles of Activity Theory

Kuutti (1996) outlined the following basic principles of Activity Theory: *activities as a basic unit of analysis, object-orientedness, internalisation and externalisation, history and development* and *artefacts* and *mediation*. All of these principles are integrated into Activity Theory and cannot be seen in isolation. This section begins with a discussion on each of these principles and provides examples within the context of this study.

3.3.2.1 Activities as a basic unit of analysis

Human action is seen as the unit of analysis by many psychological theories. However, these actions are fruitless if it is not situated within a context since it is not possible to understand it. In Activity Theory the "minimal meaningful context for individual actions must be included in the basic unit of analysis" (Kuutti, 1996, p. 23). Each individual engagement in the form of action is referred to as an activity, which is not static and rigid and will change during the process. Each of the individual actions leads to a collective process. Some examples of activities as a basic unit of analysis that is relevant to this study relate to the lecturer engagement in creating supplementary notes and the student engagement in using these notes.

3.3.2.2 Object-orientedness

An activity involves engagement by an individual/s who focuses on achieving a specific goal or object (Morf & Weber, 2000; Kuutti, 1996) implying that an activity is object orientated. This should not be confused with the concept of object orientated computer programming which deals with attributes and the encapsulation of methods. Object oriented in this context refers to the participants within the activity system moving towards their desired goal. An object within an activity system could be something physical, like building a house, software that encrypts a password or something conceptual like a theory (Kuutti, 1996; Jonassen & Rohrer-Murphy, 1999).

Leontiev (1978) highlighted the notion of an object oriented collective activity as illustrated in Figure 3.1 below. The bottom of the hierarchical structure contains a condition made up of a number of operations. Above the conditions are the goal directed actions whilst the object-oriented collective activity is situated at the top of the structure and represents a social and cultural motive.

Wells (2011) explains the following: an action is associated with an individual and an activity is seen as collective. In the same way motivation is understood to be individual and a motive is seen as socially and culturally located within a community, a point that is also supported by Daniels (2001a). This thinking moved away from separating the individual and social constructs and focused on collective activity.

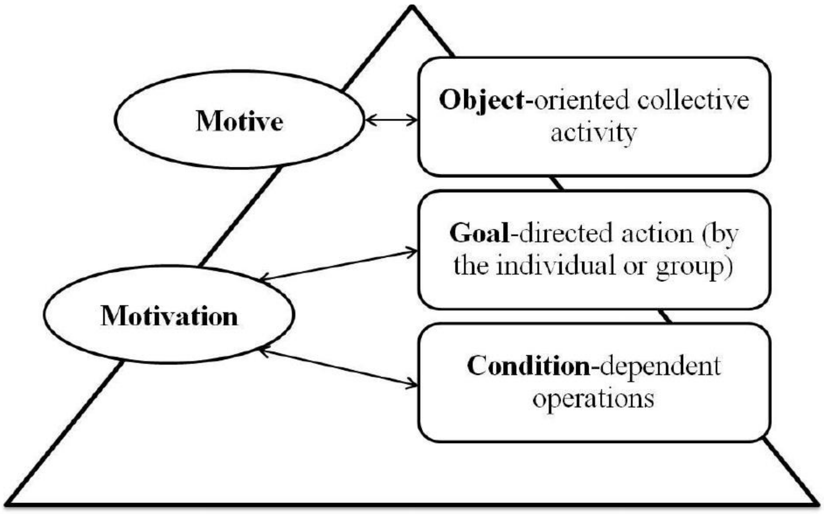

Figure 3.1: Leontiev's object-oriented collective activity incorporating individual actions

An example of a motive within the context of this study is related to student engagement in learning using the use of supplementary notes. This is a collective activity requiring the following process: the lecturer develops and uploads the notes to the LMS, an administrator controls the working order of the LMS, the department of ITN maintains and controls the network and finally the students download and read the notes. Hence a collective set of activities are involved to achieve this motive.

3.3.2.3 Internalisation and externalisation

Activities have a dual nature since they have an internal and external side associated with it (Kuutti, 1996). In Activity Theory there is no separation between the internal and external representations of activities. They cannot be understood by analysing them separately since they transform each other. For example, a child who is learning how to add two small numbers will make use of their fingers (external representation) to get the answer. As time progresses, this activity becomes internalised and the child is no longer dependent on the external artefact. Kuutti (1996) state that the internal activities can be in the form of mental simulations, imaginings or considering alternative plans.

Within the context of this study, students are required to internalise the content provided in the supplementary notes. Thereafter, they are required to utilise the knowledge acquired to solve tasks in the form of writing an external computer program.

3.3.2.4 History and development

Human activity is historically constituted and constantly develops over a period of time. As a result of its fluidness, an activity develops its own history. As each activity develops over time, parts of the older activities are embedded in the developmental process, making it important to understand and analyse the current activity in relation to its historical development (Kuutti, 1996).

Within the context of this study students utilised supplementary notes if they missed a theory lesson. However, the initial set of notes was found to be too theoretical and students were unable to understand the concepts explained. Thereafter, these notes were enhanced to include examples to further explain the theoretical concepts. The development of the supplementary notes helped to improve student understanding and enhanced the student engagement.

3.3.2.5 Artefacts and mediation

Human activity is mediated by instruments (Kuutti, 1996) in the form of tools that can be anything from a sign or language to machines and computers (Hashim & Jones , 2007). The mediation of tools is considered the most fundamental principle of Activity Theory and it distinguishes human activity from animal activity (Vygotsky, 1978). The mediation of the tool takes place by the individual in order to achieve the desired objective which results in the transformation of the object. However the tools can also be restrictive in terms of what they can achieve because of its limitations, hence resulting in its development and improvement.

An activity is mediated by different types of tools that could be internal (a thought or an idea) or external (a computer). Bertelsen (2000) describes three kinds of tools that can mediate a human activity: primary tools (artefacts, instruments, machines, computers) which are physical and produce change to the material object, secondary tools (language, signs, models, ideas) are psychological and influence the change in behaviour and tertiary tools (cultural system, scientific fiction, context, virtual realities). Within the context of this study an example of a primary tool was the development of supplementary notes using the *Microsoft PowerPoint* software.

3.3.3 The development of Activity Theory

Activity Theory is a framework that investigates human activity which is mediated using tools within a specific social context following a set of rules. However, the conception of this framework started with a simple stimulus-response activity. The following sections will discuss the progression and development of Activity Theory starting from the first generation presented by Vygotsky. It outlined the notion of a simple stimulus-response activity as being a complex process since the interaction is mediated by some instrument or tool. This idea was further enhanced by Leontiev who moved away from an individual action and introduced the concept of collective action. This process was illustrated by Engeström who then introduced the notion of multiple activity systems interacting with each other resulting in the third generation of Activity Theory. This section further discusses these concepts.

3.3.3.1 First generation of Activity Theory

As outlined previously, Vygotsky studied the higher order mental functions of human consciousness dealing with the communication and interrelationships between people and the real world. An activity was seen as a stimulus-response which is mediated by instruments and tools (Verenikina & Gould, 1998). Vygotsky (1978) proposed a triangular representation, as depicted in Figure 3.2, which highlights that a simple stimulus-response process is a complex process and is mediated by something else.

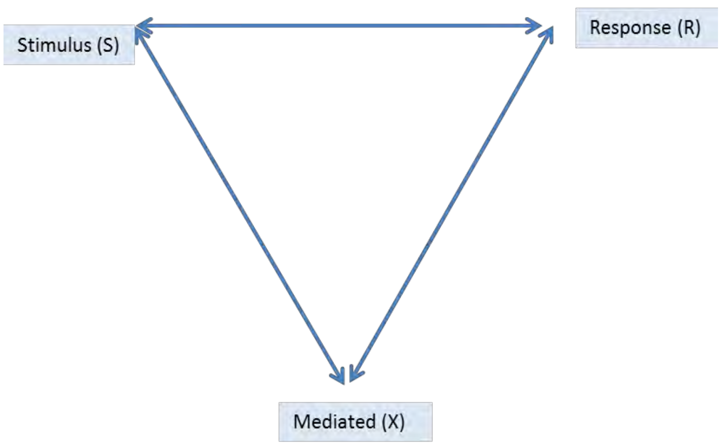

Figure 3.2: Vygotsky's model of a mediated act Adapted from Engeström (2001, p. 134)

Within the context of a learning environment, Vygotsky (1978) cites the example, where he states that the learning process of a student should not be understood as a simple response (R) to what is being taught (S). It is a process that is mediated by a second order stimulus (X) which directs the academic activity through the use of tools. These tools can be seen as mediating the teaching and learning process and in turn affect the students understanding of what is being taught.

This illustration was then adapted to a human activity that contains three characteristics: it is directed towards an object, it is mediated by instruments and it takes place within a culture. This model was reformulated to illustrate an activity of human action that contained a subject and an object which was mediated with an instrument or tool to achieve an outcome. (Uden, 2007) as illustrated in Figure 3.3. This model was seen as the first generation of Activity Theory which focused on the analysis of individuals actions (Daniels, 2001a).

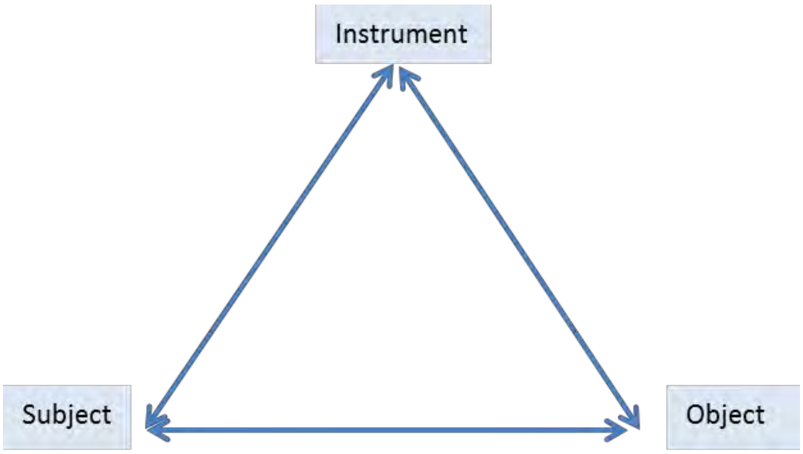

Figure 3.3: Vygotsky's model reformulated - Mediated relationship at the individual level Adapted from Kuutti (1996, p. 28)

In this illustration, the subject refers to an individual while the object referred to the goal being achieved. Mediating instruments are the tools that aids the subject in achieving the goal (Daniels, 2001b). These instruments or tools can be either technical (e.g. computer) or psychological (language or signs). The subject and the object are not seen in isolation, but instead are mediated by an instrument which is culturally constituted. An example within the context of this study, using Vygotsky's model, refers to the student as the subject who wants to learn computer programming (object), and makes use of the supplementary notes (tools) to facilitate this process.

3.3.3.2 Second generation Activity Theory

Leontiev was a student and colleague of Vygotsky working within the same group and was tasked with the development of human beings from one-celled organisms (Bertelsen &

Bodker, 2003). After the death of Vygotsky, Leontiev continued the work on human consciousness using the activity approach taking Activity Theory to a higher level. He added another layer below Vygotsky's triangle, illustrated in Figure 3.3, and moved away from individual action, focusing on collective activity as the unit of analysis. He explained the concept of collective activity using the example of the "primeval collective hunt" (Leontjev, 1981, pp. 210-213) as follows:

Consider a search party of a primeval tribe in search for food and animal skin (clothing). Each person in the hunting party has a specific role to play i.e. the bush beaters role was to scare the animals towards the hunters who were waiting to attack and kill.

ACTIVITY: Bush beaters hunt activity
ACTION: Bush beaters – beating of the bushes with hands or sticks
GOAL: To scare the animals towards the hunters
CONDITIONS: Dense bush
OPERATIONS: With dense bush, the bush beater can use his hands or sticks to beat the bush to distract the animals towards the hunters. These operations may change and are controlled by the type of conditions. A different set of operation could take place under different conditions.

The example above illustrates the hierarchical structure of an activity which is made up of a number of actions, which in turn consist of a set of operations. Leontiev (1978) identified operations as the methods used by individuals to achieve their goals. He identified three levels of activity as depicted in Figure 3.4.

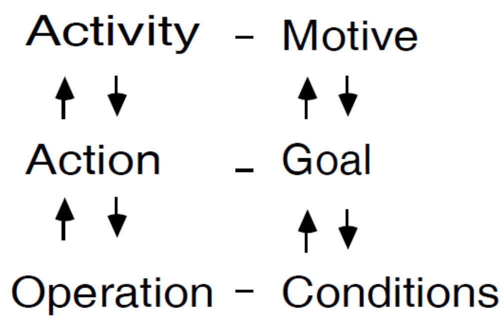

Figure 3.4: The hierarchical structure of an activity Adapted from Daniels (2008, p. 119)

Activity is on the top of the hierarchy and does not exist without a long term purpose having strong motives while actions are directed towards specific short term goals. An activity is achieved through a number of actions and operations which contributes to its purpose. The action carried out is a conscious act consisting of intentional and operational characteristics. The intentional characteristic refers to what must be done while the operational characteristic refers to how it can be done. Leontiev (1981) states that the operation is carried out subconsciously in a routine way to complete the action.

Figure 3.4 illustrates the reciprocal nature of activity, action and operation which implies that an activity may become an action and an action may become an operation (Kuutti, 1996). These activities are not rigid and are dynamically changed as conditions change (Uden, 2007; Kuutti, 1996).

A simple example depicting the concept of activity, actions and operations is outlined by Kuutti (1996) using the activity of building a house:

ACTIVITY (Motive): Building a house
ACTIONS (Goals): Fixing the roofing, transporting the bricks by truck
OPERATIONS (Conditions): Hammering, changing gears when driving

Within the context of this study, the following example can used to depict the concept of activity, actions and operations:

ACTIVITY (Motive): Development of supplementary notes to assist students that missed the theory lesson.
ACTION LEVEL (Goal): Create the notes using Microsoft PowerPoint.
OPERATIONS (Conditions): Type the content on each slide. Add examples to the notes.

As previously stated, the activity illustrated by Vygotsky is focused on the individual; however Leontiev introduced the collective idea of an activity. The notion of human activity as given by Leontiev can be described using the upper part of Vygotsky's triangle and a lower triangle which introduces the subject-object-community which has rules and division of labour as the forms of mediation. The expansion of Vygotsky's representation included the social or collective elements of an activity system which included the community, rules and division of labour. This interpretation was visually illustrated by Engeström (1987) as outlined in Figure 3.5.

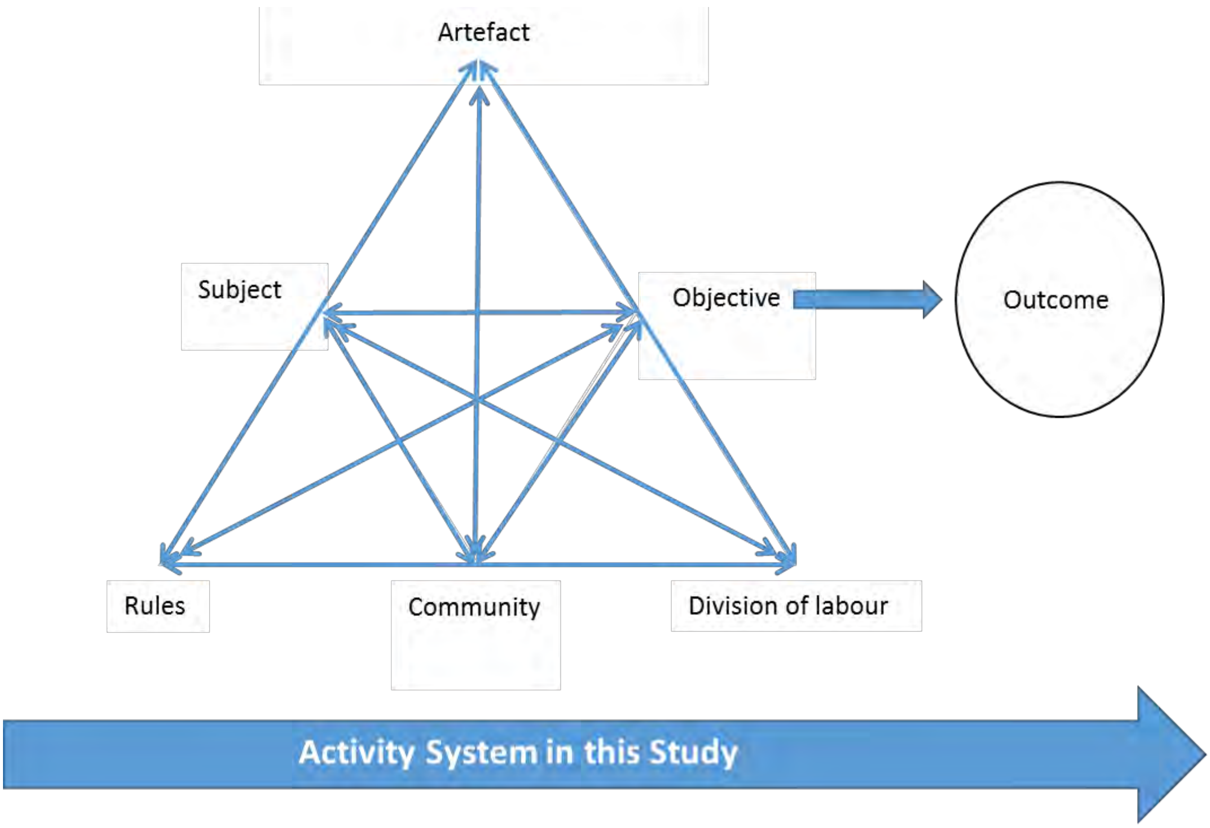

Figure 3.5: Conceptual model of the human activity system, the second generation activity system. Adapted from Engeström (1987, p. 78)

Each of the aspects of this activity system is described. The subject could be an individual or a group of individuals with different skills. The objective is the goal that the activity system is moving towards and refers to the "raw material" or "problem space" at which the activity is directed (Engeström, 1993, p. 67). The artefact or the tool in the activity system mediates the subject towards the object. The community of the system are all those that have a stake and are affected by the system and share the same objects. Rules refer to the norms and conventions that constrain the community of the system. This could refer to established and accepted practices. The rules can be both explicit and implicit and can include written and unwritten rules. The division of labour in the activity system refers to the responsibilities of all those in the community of the system. This can take place horizontally which refers to how the tasks are divided between members of the community. It can also exist vertically, which will bring about the division of power and status. The outcome of the activity system is achieved when the system is transformed to achieve the result.

With the introduction of Figure 3.5, the upper part of the triangle remains the same as Vygotsky's representation whereby the tools mediate the subject towards the object. Two new relationships are formed in the lower part of the triangle. The first is the relationship between the *subject-community* which is mediated by the *rules*. This suggests that a defined set of rules need to be in place for the subject and the community to exist. The second relationship is between the *community-object* and is mediated by the *division of labour* which implies that the power of the individuals within the activity system will determine how the object is transformed. Between each of the relationships described, there are double arrows which highlight the mutual relationships that exist in the system.

Contradictions arise between the various relationships in an activity system which leads to the transformation of the system in achieving its objective. Cole and Engeström (1993, p. 8) state that "equilibrium is an exception, and tensions, disturbances, and local innovations are the rule and the engine of change". Tensions and disturbances will take place in an activity system with the introduction of new ideas and technologies which causes resistance in achieving the goal. Engeström, Miettinen and Punamaki (1999) state that adopting the new change leads to aggravated secondary tensions where an old element clashes with a new one creating disturbances and conflicts because of the attempts to change the activity. These contradictions are explained in detail in section 3.3.4.

3.3.3.3 Third generation activity system

The second generation activity system was found to contain a limitation when applied internationally amongst a diverse multicultural set of participants (Cole, 1999). Problems were identified in these systems regarding diversity and dialogue between different cultures and traditions. As a result, the interaction of multiple activity systems was introduced. Engeström (2001) argues that focusing on one activity system does not capture the effects that may arise from outside of this system and hence introduced multiple activity systems as illustrated in Figure 3.6.

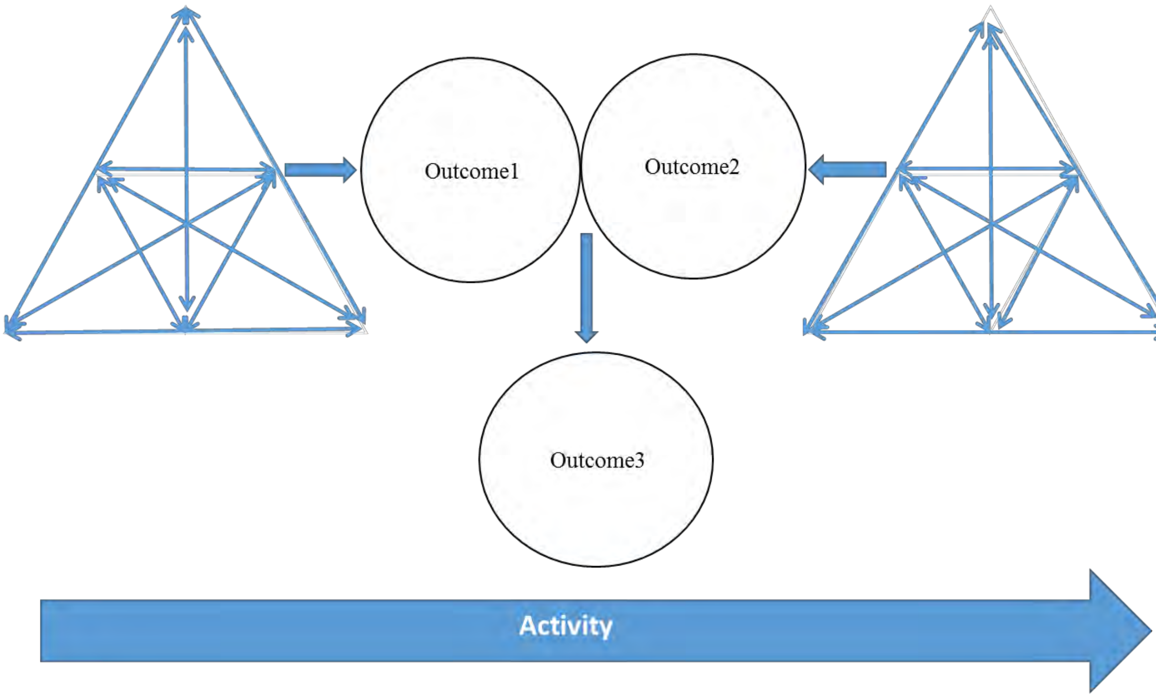

Figure 3.6: Two interacting activity systems as a model for the third generation activity system. Adapted from Engeström (2001, p. 136)

The aim of this system is to develop conceptual tools to comprehend multiple perspectives and networks of interrelated systems (Engeström, 2001). The five principles that summarise this Activity Theory are given:

Firstly, the unit of analysis is related to a network of activity systems and should be viewed in the context of other interacting activity systems that surround it. The analysis of an activity system starts with the central activity system under investigation and is surrounded by other interrelated activities that are supporting the central activity and contains its own activity system (Hassan, 2003) as illustrated in Figure 3.7. This diagram also contains numbers that depict contradictions within the activity system and will be further explained in the next section.

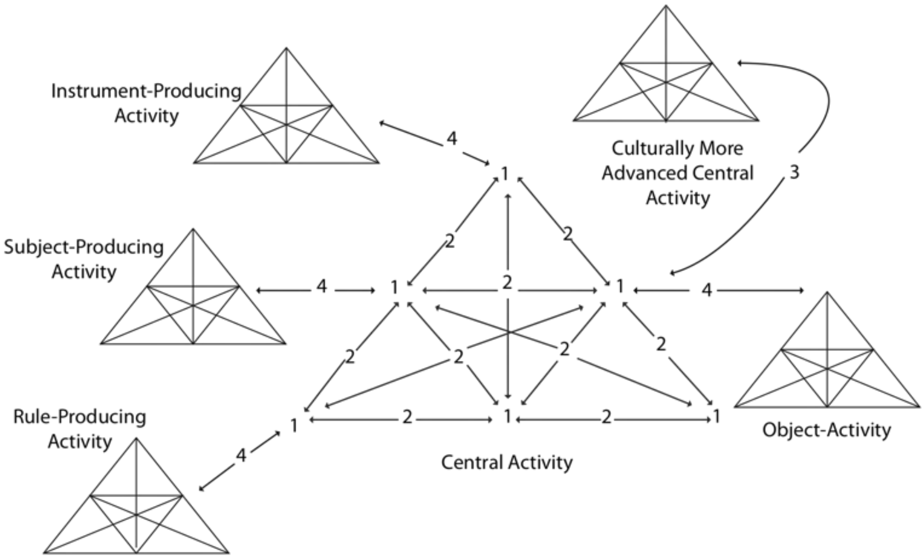

Figure 3.7: Central activity and interconnected activities. Adapted from Engeström (1999)

Secondly, activity systems are multi-voiced and have a community with multiple interests, opinions and traditions which result from the division of labour amongst the participants. It also focuses on the diversity of the instrument, rules and the division of labour in the activity system. Thirdly, the problems of the activity system are understood over a period of time which investigates its history and changes that occurred. Fourthly, the role of contradictions in activity systems refer to the potential cause of desirable changes that take place as a result of surprise, ambiguity and potential change. Finally, expansiveness of the activity system refers to the changes that take place as the result of the contradiction and hence developing the activity system to a higher level.

3.3.4 Contradictions in Activity Theory

Activity systems are characterised by the contradictions that occur within the system (Engeström, 1993; Engeström, 1987) which are seen as tensions taking place amongst the components of the activity system. As previously described, these tensions arise from disturbances and innovations and ultimately cause the system to change and develop. Contradictions can be in the form of conflicts, historical tensions, clashes and breakdown, gaps, dilemmas and virtual disturbances that provide opportunities for innovation and changes to the activity (Engeström, 2001). Innovations result as a shift or turning point in the object (Engeström & Mazzocco, 1995). It is important to resolve these contradictions by analysing the system and hence improving the overall nature of the activity system.

Sometimes contradictions do not lead to the transformation of an object because they are not easily identifiable (Engeström, 1993).

Engeström (2001) identified four levels of contradictions that can take place in an activity system, namely, primary, secondary, tertiary and quaternary. These can be explained using the illustration in Figure 3.7 above. Primary contradictions (represented by the number 1) take place at each "corner" of the activity system: subject, object, instruments, community, rules and division of labour (p. 102). Secondary contradictions (represented by the number 2) take place "between the corners" of the activity system: subject and instruments, subject and object, rules and community etc. Tertiary contradictions (represented by the number 3) take place with the introduction of a "culturally more advanced" form of activity (p. 103). Quaternary contradictions (represented by the number 4) occur between the main activity system and "neighbour activities" that link to the main system (p. 103). As a result of the contradictions, solutions are found within the activity system hence making "invisible breakthroughs" (p. 105).

Within the context of this study the following contradiction occurred in the form of a tension.

> *TENSION: The lecturer developed supplementary notes to assist students that missed the theory lesson in an attempt to catch up with work missed. However, students could not understand the theoretical concepts in the notes, since it lacked examples and explanations, resulting in them not using these notes.*

Each time a tension of this nature arose in this study, as the lecturer I transformed the activity system in order to move closer to the desired objective.

3.3.5 Activity Theory in other research contexts

Activity Theory has been used in many studies (Lindell, 1991; Heiskanen & Niva, 1996; Beyer & Holtzblatt, 1998; Vicario & Troilo, 1998; Miettinen & Hasu, 2002; Wilson, 2006) ranging from education (Engeström, 1987), communities of practice (Engeström, 1993), information systems (Bodker, 1996), library sciences (Spasser, 2002) and information sciences (Wilson, 2006). Within the context of education, Activity Theory has the ability to bring about a change in the lecturer's practice (Buell, 2004). It has also been used to investigate and understand student resistance to learning new tools (Blin, 2004).

A study on the evaluation of learning technologies within the higher education classrooms was conducted by Scanlon and Issroff (2005). They used Activity Theory to understand the student and teacher interactions, available resources, expectations and perceptions. Activity Theory was also applied to study the design and implementation of learning through the use of technology (Issroff & Scanlon, 2002; Barab, Schatz, & Scheckler, 2004; Blin, 2004; Brine & Franken, 2006). Lim and Hang (2003) found that in order to effectively study the integration of technology in schools requires one to go beyond the activities of the classroom, which was well suited to using Activity Theory.

Similarly, Crawford and Hasan (2006) used Activity Theory in their research because it provided a well-developed framework for analysing the complex and dynamic settings which involve the human engagement between the subject and the tools. They outline that it provides a useful paradigm by shaping the design and effectiveness of using technologies. Murphy and Mannzanares (2007) used Activity Theory to analyse e-teachers in distance learning at high school level. This study outlined how the introduction of new tools can bring about positive change in teacher's practice. Activity Theory is increasingly being used to analyse conditions of human activity using technology (Mlitwa, 2007).

Within a local context Activity Theory has also been used as a framework to study within the context of higher education. Naidoo (2012) used Activity Theory to explore master teacher's use of visuals as tools in Mathematics classrooms. Each master teacher was analysed within an activity system where contradictions were found in terms of language, parental involvement and poor resourcing.

Orland-Barak and Becher (2011) integrated action research and Activity Theory in their study dealing with teacher education. They conclude that the "participatory character of action research encourages and challenges the researcher to expose gaps, dualities, and inconsistencies" between what is adopted and what is eventually realised. During the process the researcher "zooms in" to explore the data and find the contradictions or tensions that emerge from the activity system. Thereafter, the lens of Activity Theory was used to "zoom out to magnify" the contradictions within the system (p. 127).

3.3.6 Critique of Activity Theory

Garrison (2001) raised a concern about the meaning of the word action within the Activity Theory process. He outlined that action refers to self-action, inter-action or a trans-action and questioned the form of action that Activity Theory referred to. Rajkumar (2005) also expressed concern about the language use of Activity Theory suggesting that it was confusing and difficult to understand. Yamagata-Lynch (2010) in her presentation referred to an anonymous editor who suggested that Activity Theory was difficult to follow and questioned its worthiness when used in empirical studies. Toomela's (2000) critique of Activity Theory focused on observable activities and suggested that it did not take into consideration cognitive processes of the individual.

In response to the criticism by Garrison (2001), the word *action* within the context of this study is that which is conducted by the individual. In most cases it referred to the student or the lecturer. Based on the comments made by Rajkumar, a list of terms is provided in the next section to clarify the action research terminology. In response to the comments made by the anonymous editor, Yamagata-lynch (2010) stated that

> *Theoretical framework and the language of AT and activity systems analysis provides researchers with a perspective for organizing and communicating data about human interactions that other methodologies do not necessarily address*

This framework has been used by others within the educational context and I am in agreement with the comments made by Yamagata-lynch and believe that this framework is suitable for the context of this study. Finally, in response to Toomela who was critical about cognitive processes, I state that within the context of this study my aim was to observe students within the BLE and to obtain feedback about their experience using tools and support structures. Despite all of these criticisms, I believed that Activity Theory was a suitable framework to utilise within the context of this study because each support structure is seen as a basic unit of activity and is evaluated thereof. The use of Activity Theory also enabled specific tensions to become visible which helped to understand and analyse the behaviour of the activity system transforming it towards its objective.

3.4 Activity Theory in this study

To facilitate the reader's understanding of the manner in which AT was used in this study, an explanation of terms used is initially given.

3.4.1 Explanation of terms used in this study

a. Activity in this study takes place on two levels. The first is the students' engagement (SE) in the blended learning environment and the second is the lecturer's engagement

(LE) in improving the blended learning environment after receiving feedback from the students.

b. The central activity in this system is engagement of computer programming in the blended learning environment.

c. The subject in the SE activity system is the student, whilst the lecturer is the subject in the LE activity system.

d. The object in the SE activity system refers to the meaningful engagement of students in the blended learning environment, whilst the object in LE activity system deals with the improvement and support provided in the enhancement of the blended learning environment.

e. The outcome in the SE activity system is for the effective engagement in the learning of computer programming by the students. In the LE activity system, the outcome is in providing effective support in the learning of computer programming.

f. The tools in the SE activity system refer to the following: supplementary notes, extra theory lesson, small group discussion, blog, mentors, videos and animations. In the LE activity system the tools refer to electronic questionnaire, *PowerPoint*, *Google* blogger and *YouTube* which were used in developing the resources.

g. The community that exists between both of the activity systems (SE and LE) are the students, lecturer, department of ICT, institution and the department of Information Technology and Networks (ITN).

h. Each activity system has its own set of rules.

i. During the development of the tools, each activity system developed tensions. These tensions were addressed by making changes to improve the activity system towards its goal. As a result of the improvements, innovations arose. An example of a tension in the SE activity system related to students missing or being late for the compulsory theory lesson. An innovation in the LE activity system was the introduction of a second theory lesson.

3.4.2 The approach used

In this study, the lecturer provided support to assist students while they engaged in computer programming tasks in a BLE. As a result, a dual process was identified: the lecturer creating support tools and structures and the students engaging with them. A representation of the dual engagement is illustrated in Figure 3.8 which lends itself to a third generation activity system.

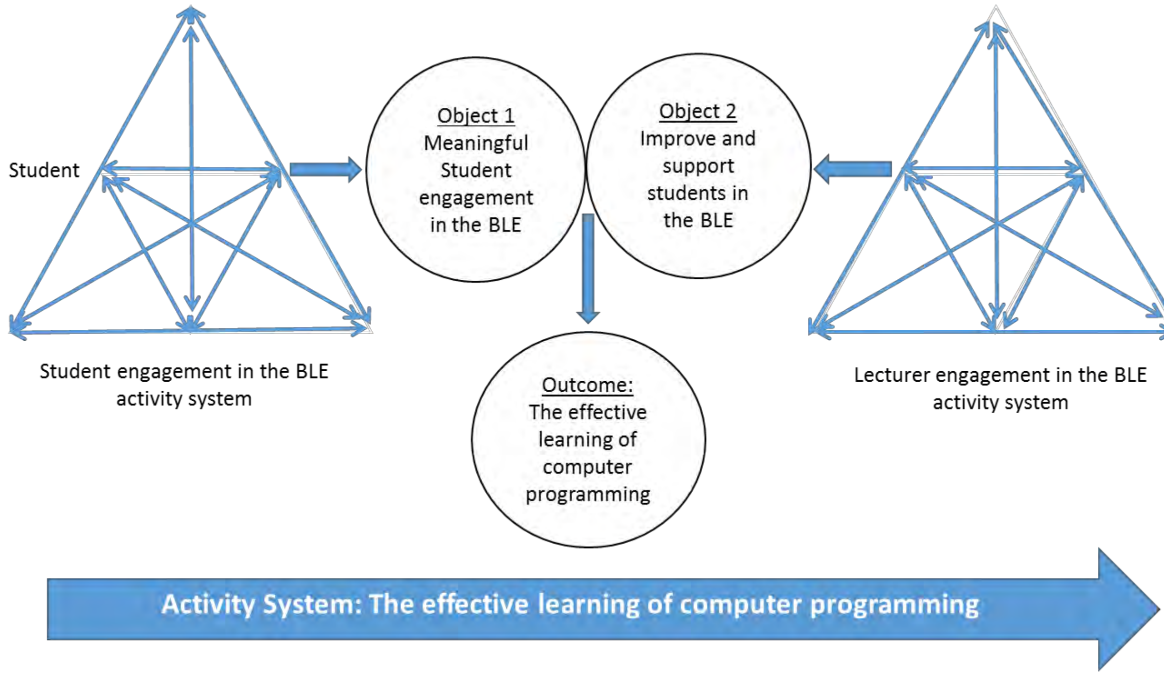

Figure 3.8: Activity system used in this study – third generation

However, within the context of this study, individual activities are evaluated and explained using a second generation activity system as illustrated in Figure 3.9.

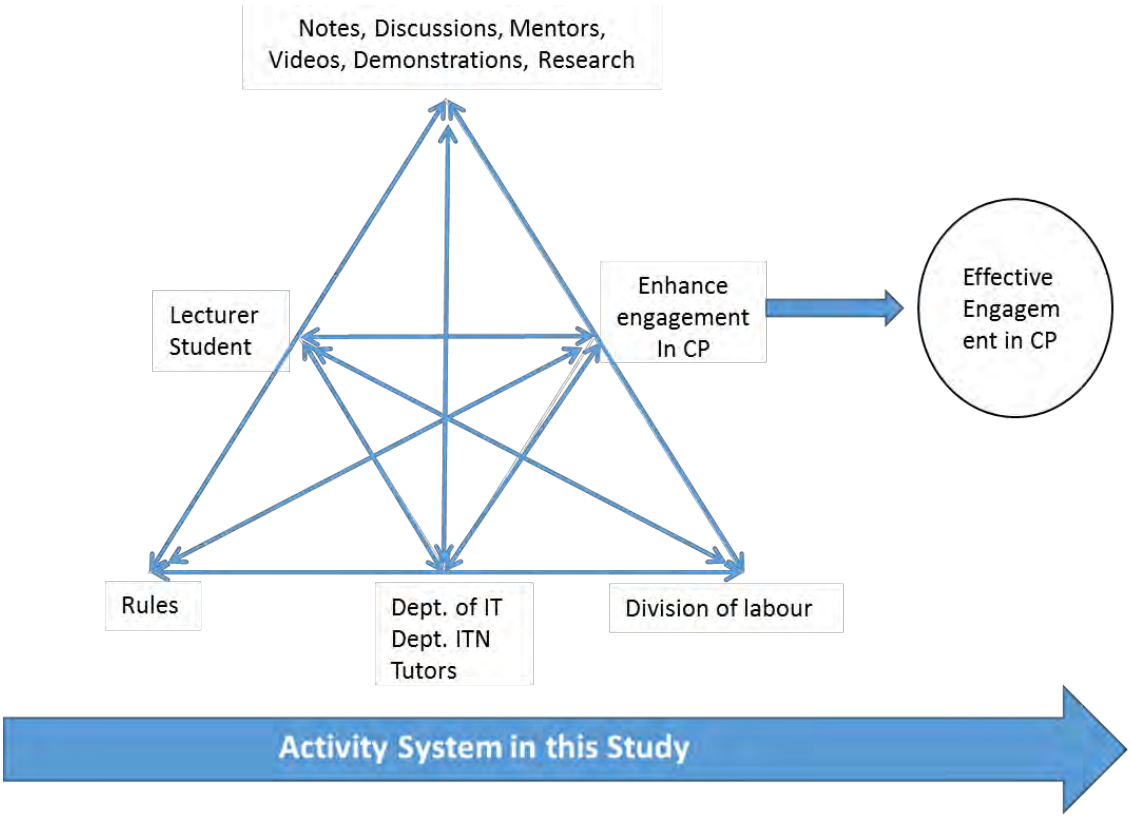

Figure 3.9: Activity system used in this study – second generation

This approach was used to isolate the various scenarios within the context of this study and to evaluate the relationships that exist within the activity system. In this way, tensions were observed and a transformation occurred to improve the activity system.

3.4.3 Linking of Activity Theory with Action Research

In the field of educational practice, researchers are constantly trying to find solutions to existing educational problems and ways to influence practice. Chambers (2003, p. 398) describes applied educational research as "what happens when cultural systems overlap as a result of some sort of deliberate, recent or anticipated intervention". This study is based on an attempt to find solutions to the problems students were having in computer programming through the means of intervention. As a result, the use of action research as a methodology was found to be useful and will be described in great detail in the next chapter. However, it was important to understand the implication of using action research with Activity Theory.

Much academic debate has transpired in terms of using action research with Activity Theory, and especially at the International Society for Cultural and Activity Research which served as a forum to interrogate contentions about "the relationship between action research and cultural historical Activity Theory" (Somekh & Nissen, 2011, p. 1). Engeström's view on action research was that it is “not a (coherent) method” and “certainly not a viable substitute for a methodology genuinely built on CHAT”. This was an opinion that was opposed by others who suggested that Vygotsky (whose roots lie in Activity Theory) and Kurt Lewin (founder of action research) were friends and they influenced each other’s work. “It is general knowledge that they had corresponded on many occasions, read each other’s work and were influenced by each other’s ideas” (Somekh & Nissen, 2011, p. 4). Although this point does not provide concrete evidence in terms of a relationship between CHAT and AR, the intention behind these comments is to illustrate a connection between the two.

In this study, I apply a similar approach used by Orland-Barak and Becher (2011) by integrating action research and activity theory. The action research process contained cycles of planning, acting, observing and reflecting. Within each cycle of this study, further cycles ensued. However, before a new cycle started, analysis was carried out during the reflection process of the previous cycle which was used in the planning phase of the new cycle. During this process of reflection, Activity Theory was used as a means to analyse the activity system by examining the relationships within the system and detecting tensions that arose. This form of analysis helped me as the researcher to theorise around these tensions and to find possible solutions.

3.5 Conclusion

This chapter explored Activity Theory as a conceptual framework within this study. Based on the rules and division of labour, Activity Theory provided a useful framework to describe, explore and analyse the engagement and tensions that occurred within the activity system with a view to transforming it to achieve its desired goal. It specifically allowed discussion and analysis of my engagement as a lecturer in developing support structures for students. Furthermore, it assisted in understanding the students’ engagement in the learning of computer programming, within a BLE.

Having established the theoretical framework, the next chapter describes the methods used in this study. The action research methodology employed is described in detail, and the chapter further summarises how the lecturer engaged by setting up a support environment and developed tools for students to engage with in order to enhance their learning in computer programming.

CHAPTER FOUR

4 Research Design and Methodology

4.1 Introduction

The previous chapter provided an argument for the use of Activity Theory as a theoretical framework. This chapter outlines two main aspects. The first highlights the research design by situating the study within the interpretative paradigm as outlined by Cohen, Manion and Morrison (2011) and justifies the use of a qualitative approach. Thereafter the validity and trustworthiness of the study is established as given by Golafshani (2003) and Patton (2002). This is followed by a description of the ethics maintained in this study. A context is then provided highlighting the challenges that students experienced and the need for support. Finally, the methods utilised in keeping with a qualitative study as outlined by Cresswell (2014) is given which highlights how these methods respond to the critical questions. Since action research methodology plays a vital role in this study, ideas from Lewin (1946) and McNiff (2013) are explained and outlined. An argument is made for the use of action research within this paradigm. Other research methods of observation, focus group meetings, personal diaries, electronic questionnaire and surveys are described in detail. Quantitative statistics are also used sporadically to illustrate certain aspects of the study.

The second aspect of this chapter outlines how the action research methodology is applied in this study. It explains the setup of the action research environment which comprised of two parts. Firstly, the creation and implementation of customised software called Dr.Q is explained in detail and highlights the action research process that was undertaken during the setup process. The pilot study conducted is also described. A detailed explanation of the tools designed for the lecture and student are explained. The second part was the setup of the LMS, *Moodle*. Engagement with the LMS is explained and technical challenges highlighted. Thereafter, a summary is provided to graphically depict all the steps that occurred in each action research cycle, to holistically understand this process. Thereafter, a step by step description is provided outlining these steps.

4.2 Research design

4.2.1 Interpretative paradigm

A paradigm is a framework that is used to view and interpret a situation. According to Cohen et al. (2011, p. 5), who cite Kuhn, explain:

A paradigm is a way of looking at or researching phenomena, a world view, a view of what counts as accepted or correct scientific knowledge or way of working, an 'acceptable model or pattern (Kuhn, 1962:23), a shared belief system or set of principles, the identity of a research community, a way of pursuing knowledge, consensus on what problems are to be investigated and how to investigate them, typical solutions to problems, and an understanding that is more acceptable than its rivals.

It influences the way knowledge is studied and interpreted and sets down the intent, motivation and expectation of the research. Willis (2007, p. 8) describes a paradigm in a more simplistic way as being "a comprehensive belief system, world view, or framework that guides research and practice in a field".

The interpretive paradigm "is characterized by a concern for the individual" (Cohen et al., 2011, p. 17) and deals with deep insights into the complexities of the individuals' world as they experience and perceive it (Schwandt, 1994). It focuses on "subjective understanding or interpretation (Verstehen) of human action" (Babbie, Mouton, Vorster, & Prozesky, 2010, p. 30). The researcher's interpretation plays an important role in this type of study, bringing "subjectivity to the fore, backed with quality arguments rather than statistical exactness" (Garcia & Quek, 1997, p. 459). The advantage of using such a paradigm allows the researcher to find meaningful observations of a situation whilst the weakness revolves around it being more complex to analyse and interpret objectively since it results in many solutions and interpretations. The interpretive paradigm focuses on a specific context in which people live or work in order to understand the "historical and cultural setting of the participants" (Creswell, 2014, p. 8). The researchers background "shape their interpretation" (p. 8).

A qualitative research approach is used in this study. According to Creswell (2014, p. 4):

Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem

According to Nieuwenhuis (2007), a qualitative approach is a naturalistic way to understand the real world within a specific context. Based on these definitions, the interpretative paradigm is well situated using the qualitative approach.

Within the context of this study, the specific context is based on the first year computer programming class at a higher education institution. Based on my years of experience in this field as a researcher, I interpret and give meaning to the data obtained from the students whilst they engage with tools and support structures in their learning.

Several researchers like Creswell (2013), Hatch (2002) and Marshall and Rossman (2011) have outlined the following core characteristics associated with qualitative research which I have explained within the context of this study and outlined in Table 1.

Table 1: Qualitative characteristics used in this study

Characteristic	**How it is used in this study**
Natural setting	Data was collected at the institution where the study occurred. I taught the subject without changing the teaching and learning environment that students were used to. The only difference was that as the lecturer, I observed the engagements that occurred amongst students within the BLE. The additional activity that occurred required students to provide feedback by the end of each lesson, which is not an unusual process in education. Every attempt was made to maintain the classroom environment as naturally as possible.
Researcher is the key instrument	As the lecturer employed an action research methodology, I am both the lecturer/developer of programmes and researcher, which places me at the centre of the study.
Need to use multiple sources of data	Many different data sources were used in this study, which included: student feedback, observation, focus group meetings, surveys and a personal diary.
Should have meaning to the participants	Students use tools and support structures to enhance their learning in computer programming.

Should be a reflexive approach	As the lecturer and researcher, I constantly reflected on the feedback obtained from students. The data collected was analysed and further action taken, which resulted in changes to the BLE environment in an attempt to improve the learning by students.

The characteristics of qualitative research fit well within the interpretative paradigm. One such design that can be employed within qualitative research is the use of an *action research* methodology "which serves the purpose of engaging people in activities that explore and seek to understand practice and its impact" (McAteer, 2013, p. 11). The action research methodology requires a process of reflection and analysis followed by further action in an attempt to make improvements. Cohen et al. (2011, p. 359) state that "reflexivity is central to action research, because the researchers are also the participants and the practitioners in the action research".

Within the context of this study, I worked within the interpretative paradigm using a qualitative approach to understand student engagement in learning computer programming within a BLE. This paradigm allowed me to make meaningful observations and reflections of student engagement in the BLE. Using an action research methodology, I was able to make enhancements to the BLE with the introduction of support structures to assist students in their learning. Since the study is a qualitative one, which occurs in the real world settings of lecturer/student engagement and learning, the issues of the study's reliability and validity became relevant, issues which I describe in the following section.

4.2.2 Validity and trustworthiness

In quantitative studies, the world is regarded as made up of observable, quantifiable facts and results of experiments are regarded as reliable or replicable by any other researcher using the same methodology (Golafshani, 2003), which generates the concepts of generalization or universalism. Validity refers to whether measurements are accurate and that the instrument used to measure the phenomenon is actually measuring what it says it intends to measure. According to Golafshani (2003), the concepts reliability and validity have their origins in a positivist tradition, and these concepts as defined by the positivist or even quantitative studies, do not have the same meaning in qualitative studies. This is because qualitative research uses naturalistic approaches eliciting findings from real world contexts and seeks understanding of phenomena in their local context rather than universal generalizations.

According to Patton (2002, p.14) in qualitative research the "researcher is the instrument", in other words, the researcher is very much part of the context s/he is researching. The idea of reliability in qualitative research is about deriving an understanding of the phenomenon and the term *trustworthiness* is substituted for validity in qualitative studies, which refers to establishing confidence in the data that is elicited in the study. To improve trustworthiness, Patton accepts the use of triangulation of methods, that is, the use and combination of several methods of research as well as several types of data. In my study I have employed the use of several methods to gather data, as well as several types of data were admitted for analysis. These data gathering methods included an electronic questionnaire, focus group meeting with students from two groups, focus group meetings with tutors and observation of students in the theory and practical lessons. Data was verified using multiple data sources. Thus the use of multiple methods such as observation, interviews, and recordings (electronic and otherwise) leads a more trustworthy construction of my own, and the students' realities.

4.2.3 Ethics

4.2.3.1 Getting permission

The study was conducted for a first year subject at a University of Technology. Permission to carry out the study was first requested from the institution where the study was conducted (see Appendix 1, p. 207). Once this process was approved, written permission was requested from the students in the first year programming class to be participants of this study (see Appendix 1, p. 208). All of these students were informed about the nature of the study from the outset and were made aware that participation was optional and they had the right to withdraw at any stage without being penalised in any way. A consent letter was given to all participants outlining their protection within the study. Amongst all those students identified in the study, only one student chose not to participate.

4.2.3.2 Observations

A group of ten students in each practical group was chosen to be observed during the practical lessons. These students were informed verbally about the nature of my presence during the study in which I would write about my observations while moving from one student to another. Students were aware of exercising their right to decline being observed at any time during the study.

4.2.4 Methods

In keeping with the assertion by Cresswell's (2014, p.189) that data generation sets up the margins of the study, establishes the procedures for recording information and "collecting information through unstructured or semi structured observations and interviews, documents, and visual materials", I adopted a qualitative design based on the interpretative paradigm.

Data was obtained from a population of sixty first year student, thirty from group B and thirty from group D. The four tutors were also used during the focus group meetings to gather information. Table 2 outlines all the data sources used in this study and outline how it is linked to the critical questions.

Table 2: Methods used in the study

Critical Question	Participant	Tools / Method	Inquiry
How does engagement in computer programming take place within a BL context using an action research approach?	Researcher, lecturer, student	Action Research Cycle 1: January - March Cycle 2: April - August Cycle 3: September	Qualitative
	Student	Electronic Questionnaire was used by two groups of thirty students to provide feedback at end of each lesson.	Qualitative
	Researcher, lecturer, students	Observations & reflections were conducted by the lecturer who observed ten students each in two groups during the practical lesson	Qualitative Quantitative
	Learning Management	*Blackboard* statistics was obtained to determine the	Quantitative

	System	students usage of the various tools Blog statistics	
CQ2: Why does engagement in computer programming take place the way it does within a BL context using an action research approach?	Student	Focus group meetings Group B – two meetings Group D – two meetings Tutors – two meetings	Qualitative
	Researcher, lecturer	Personal diary Captured notes during the theory and practical lesson Captured notes on reflections	Qualitative
	Student	Surveys were used to determine the students experience with the various tools and support structures in the BLE	Qualitative

The use of action research was central to this study and occurred within three cycles. In the first two cycles, students provided feedback on the BLE at the end of each practical lesson. To simplify this process, a customised electronic questionnaire was developed. Data was also collected through observations and by keeping a personal diary. A key component of the action research process was my self-reflection as researcher/lecturer on many situations in order to improve it. Statistics were also obtained from the LMS, *Blackboard* about student usage of these tools. Finally, during the last action research cycle, surveys were conducted to establish student views on the tools and support structures used in the BLE.

The sections to follow discuss each of the method used in this study. It starts with a description of action research and outlines how it was used in this study. Thereafter a description is given on the other methods used which included observations, focus group meetings, personal diaries, electronic questionnaires, quantitative statistics and surveys.

4.2.4.1 Action Research

4.2.4.1.1 What is Action Research?

According to McNiff (2013, p. 23) "action research is a name given to a particular way of looking at your practice to check whether it is as you feel it should be". Action research is a practitioner form of research that requires professional intervention to improve the practice in line with the value system of the researcher. Action can be taken without performing any research and research can be performed without any action. However, action research combines both the process of action and conducting research. Whitehead (1989) provided a simple question: "how do I improve my practice?" with the aim of making improvements in the teaching and learning process. Action research is a process of enquiry by the teacher into the effectiveness of his/her owns teaching, and the learning taking place by the students. McNiff and Whitehead (2009, p. 11) describe a three step process of conducting action research. The first step requires identifying the problem in the learning process. Secondly, it involves doing research to analyse the problem and to find ways of improving the situation. It is also important to determine whether improvement in the learning process occurred. Finally, it is about telling the story and sharing the findings. This is the process that was followed in this study.

Action research was first well documented by Kurt Lewin in the 1940s. He introduced the theory and practice of action research which included the "iterative spiral" of planning, acting, observing and reflecting, which could be used by groups in their own research to solve problems (McNiff, 1988). This work provided the foundation of researching real life situations with the researcher being the active participant (Greenwood & Levin, 1998). Many researchers have elaborated on Lewin's form of action research with each promoting a different cyclical approach of action and reflection (Elliott, 1981; Kemmis & McTaggart, 1982; Ebbutt, 1985; McKernan, 1991). Furthermore, action research has been used in a number of philosophical paradigms such as positivism (Clark, 1972), interpretivistic (Elden & Chisholm, 1993) and critical theory (Carr & Kemmis, 1986).

While there are difference in approaches when conducting action research, there are also some common elements which satisfies the requirements in any definition (Walter-Adams, 2006). According to Walter-Adam (2006) action research is about teachers striving to understand and to improve their practice. It involves the gathering of evidence about practice with teachers trying to see the effects of planned changed in their practice. Action research is a process that strives to be systematic and rigorous. Carr and Kemmis (1986) describe action research as being about the improvement of practice, the improvement of the understanding of practice and the improvement of the situation in which the practice takes place.

A key component to encourage the change of practice hinges on the process of reflection. This reflective process leads to re-planning and further action to transform the BLE through a reflexive approach. Lisle (2010) defines reflection as thinking analytically, critically and evaluatively, while reflexing is planning future actions after receiving a response. Reflexivity is well suited as an approach to be used in an educational environment where learning takes place. Winter (1987) states that a competent teacher will search all possibilities to find a the reason for the lack of understanding, resulting in a reflexive practice. The researcher is able to learn from the reflexive practice and implement changes in order to improve the learning environment. Steier (1991) outlines that when the researcher is part of the research inquiry, then a reflexive form of methodology occurs and Brookfield (2000) states that in doing so the researcher raises his/her consciousness. A reflexive process takes place within the action research methodology which deals with planning, acting, observing, reflecting and revised planning which requires the integration between the theory and the practice (Winter, 1987).

Some critics argue that action research cannot be used as a research method (Hakim, 2000; Williams & May, 1996) since it lends itself to specific fields. Charles and Ward (2007, p. 3) indicate that the history of action research "paint a complex picture" with its roots being found in different "geographical contexts and in different professional research communities". In this study, I do not see any of these criticisms as a stumbling block for the following reasons. Firstly, action research has been extensively used in education with well-published studies supporting its use (Baumfield, Hall, & Wall, 2013; McAteer, 2013). Secondly, to buttress my motive for using action research, I draw strongly on the explanation given by Walter-Adams (2006) that, action research concerns a teacher's efforts to understand and to improve his own practice, by gathering of evidence about his practice, and making changes to improve and receiving feedback to evaluate the effects of planned changed in their practice.

4.2.4.1.2 Action Research in this study

Stenhouse (1983) extended this idea that "action research is systematic enquiry undertaken to improve a social situation, and then made public". He points out that curriculum research and development is the responsibility of the teacher, and "it is not enough that teachers work should be studied, they need to study it themselves" (Stenhouse, 1975, p. 143). However, the notion of improvement can be problematic since one person's idea of improvement may be seen negatively by another person since it depends on the researcher's values and beliefs in a situation. Educational research through action research may not result in a universal truth. It is about the researcher within a particular context attempting to improve a situation based on his value system.

Within the context of this study, as the researcher, I had made use of an action research methodology in an attempt to improve my engagement as a lecturer and to further improve the students' engagement in learning computer programming through the use of a BLE. Within an interpretative paradigm, a qualitative approach was used to understand how and why students engaged in computer programming. Through this understanding, it was easier to plan and take further actions in an attempt to improve the engagement and hence enhance the learning. The action research process was well suited for this study since it allowed me as the lecturer and researcher to constantly reflect and evaluate the student engagement in the BLE resulting in further actions in attempting to improve the BLE.

Lewin's (1946) model of planning, acting, observing and reflecting and then re-planning was used in this study. This action research process, which outlines two cycles, is illustrated in Figure 4.1 and depicts the progress of time.

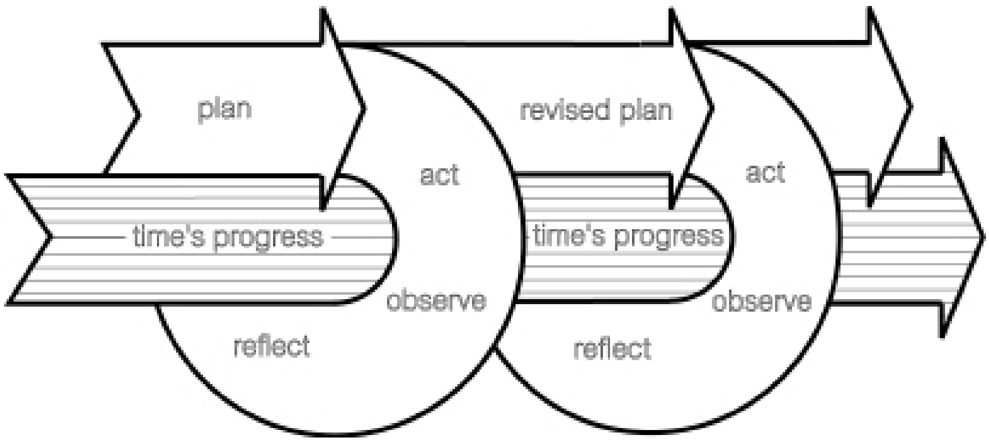

Figure 4.1: An adaptation of Lewin's cyclic model

Each of the action research steps that occur in one cycle are explained in Table 3.

Table 3: Action Research process used in this study

Action Research Step	**How it is used in this study**
Planning	I identified challenges experienced by students in computer programming. This phase involved my engagement as a lecturer, through the use of reflection and analysis, to plan a strategy to find ways to address the challenges. In most cases the plan included introducing tools and support structures to assist student.
Acting	Once a plan was established and a tool or support structure was identified, the action of the plan was translated into my actual development of the appropriate tools or support structures to address the challenge.
Observing	After the tool or support structure was developed, students engaged with them. Their engagement occurred within the formal lessons as well as outside these lessons. Feedback was provided by the students on their use of the tool or support structures at the end of each practical lesson by completing an electronic questionnaire.
Reflecting	Having gathered the data, a process of reflection occurred to evaluate the students' experience. These reflections were analysed in an attempt to further improve and enhance the student engagement. Based on the analysis, a re-planning phase occurred, leading to other action research cycles.

Using an action research methodology in this study had many advantages. Firstly, action research is a natural way of acting, learning and performing research at the same time. Secondly, in the action research process, the researcher is not an outsider but is knowledgeable in the field of study and an active participant in the research process. Thirdly, the action research process can develop a critically reflective practice (Hubball & Burt, 2003). Fourthly, there is considerable flexibility and awareness in the action research process (Dick, 2002). Finally, the action research methodology supported the dual engagement process that occurred.

There were three main action research cycles, however, in a particular cycle, further smaller action research cycles unfolded resulting in cycles within cycles. McNiff (1988, p. 45) drawing from the work of Whitehead, indicates that this process can be "messy" having spirals within spirals. Each tool and support structure developed underwent an action research process with multiple cycles. A timeline similar to Figure 4.2 was used to illustrate the smaller cycles for each tool and support structure.

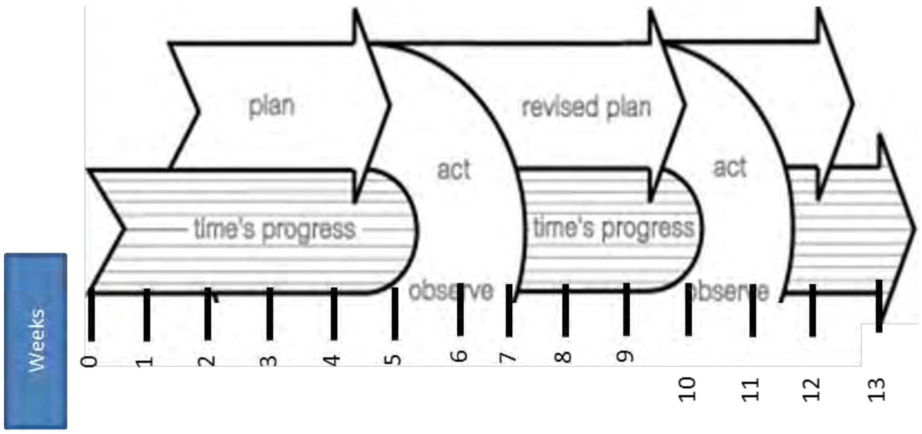

Figure 4.2: Action research cycle depicting time

Comments are also added to this figure to outline the action and reflection steps that occurred during this process making it easier to understand how the tool or support structure transformed over a specified period of time. However, it becomes difficult to illustrate these activities for all the resources, making use of this diagram. As a result, a graph is presented later in the chapter to visualise a holistically picture of all activities in one action research cycle.

4.2.4.2 Observations

Creswell (2014, p. 190) states that "a qualitative observation is when the researcher takes field notes on the behaviour and activities of individuals at the research site". Within the context of this study student engagement was observed during the practical lessons.

The students in the computer programming subject were split into four groups (A, B, C, D) for their practical lessons with each group having three lessons per week. Groups A and B, and C and D were timetabled concurrently. There were forty students in groups A and C using laboratory 1, and thirty students in groups B and D using laboratory 2. Laboratory 1 contained seven rows of computers with the first row having four computers whilst all other rows had six. Laboratory 2 contained thirty students which contained five rows of six computers.

In this study, I chose to observe twenty students in total, with ten students each in laboratory 2 from groups B and D. The students were chosen with careful consideration being given to their physical location in the laboratory so as to easily facilitate movement during the observation process. In group B, students in the last two rows were chosen for observation with a total of five males and five females. A different configuration was chosen for group D as a means of introducing variety. The first two students in each row, apart from the two students in the last row furthest away from the board, were observed which comprised of six males and four females. There were two reasons for omitting the two students, firstly, the observation process was restricted to ten students for each group and secondly, students observed in group B included the students in this position. The configuration chosen added more variety in terms of the position where students were located in the laboratory.

I used an observation schedule (OS1) to assist me with the student observation in the laboratory. It was designed keeping in mind my critical questions of how and why student engagement occurred within the BLE. This schedule contained twenty four questions in total revolving around students' punctuality, the type of support they received during the lesson, the tools they engaged with to solve their tasks and the mistakes or innovative means used in solving tasks. Ten questions were straight forward yes / no type, three questions required an answer based on the alternatives given and eleven questions were open ended requiring explanations and comments.

The observation process started on 5th February 2013 and stopped on 17th June 2013. This schedule was completed each time groups B and D had a practical lesson. Students were observed for at least sixty minutes of the ninety minute lesson since some of my time was also utilised with the second class during the concurrent lessons that occurred. The observation of students ended once no new data was being generated.

The observation schedule was made up of two pages for each group. The first page had a list of five names and the second had the other five names. Appendix 7 (OS, p. 243) outlines a snapshot of the observation schedule with two students. At the beginning of each lesson, the students under observation, who sat at the same location for each lesson, were quickly identified and the first part of the observation schedule relating to attendance and punctuality was filled out. Thereafter, comments were made for each student during the course of the lesson based on the activities that occurred. I was able to stand at one position and view the screens of all ten students without my presence being overbearing whilst they worked. However, from that position I was unable to view the finer details that students worked on. This required me to walk around in intervals of approximately fifteen minutes to view these students' activities, which frequently changed based on the tasks they solved. During the observation process, personal diary entries were also made based on issues that were observed but not listed on the observation schedule. These entries were made in another book which was used as a diary.

After each practical lesson, the details on the observation schedule were captured into the customised software. Weekly reports were obtained in an attempt to guide me with the type of intervention that was necessary. These reports were analysed to determine how students engaged in the BLE, which was in response to the first critical question.

4.2.4.3 Focus group interviews

Interviews according to Creswell (2014) can take on different forms with one being a focus group interview that contains about six to eight interviewees. He states (p. 190) that the "interviews involve unstructured and generally open ended questions that are few in number and intended to elicit views and opinions from the participants". Within the context of this study, "views and opinions" of the students were solicited regarding how and why they engaged with the various support tools within the BLE.

A total of four focus group meetings occurred with the students. At the end of the first action research cycle, approximately eight volunteering students, four males and four females, were selected and interviewed from group B. A similar sequence of events occurred with group D. Thereafter the same procedure was repeated at the end of the second action research cycle.

The focus group interviews were semi-structured and conducted using a few predefined set of questions. A sample of the questions from the first focus group meeting is outlined in Appendix 4 (FGM1, p. 221). The questions focused around how students engaged within the BLE and established the advantages, disadvantages and challenges they experienced in utilising the tools and support structures. Thereafter, reasons were established in terms of why students' engaged with the tools and support structures in the way that they did. Whilst a set of predefined questions were created before the interview, further questions were asked based on the responses that were received. The answers obtained from focus group meetings were also used to validate the responses obtained from the electronic questionnaire and responded to both critical questions. Details of the focus group interviews are outlined in Table 1.

Table 4: Details of Focus Group Interviews

	Date	**Time**	**Approximate Duration**
Interview 1			
Students in group B	21st March 2013	9.15am	1 hour
Students in group D	21nd March 2013	11.00am	1 hour
Tutors	22nd March 2013	11.00am	1 hour
Interview 2			
Students in group B	18th June 2013	9.15am	1 ½ hours
Students in group D	18th June 2013	11.00am	1 ½ hours
Tutors	19th June 2013	11.00am	1 hour

A second set of focus group interviews occurred with the four tutors, who were present during the students' practical lessons. They were interviewed to obtain their perspective of the students engaging with the support materials in the BLE. Their comments were further able to provide a holistic picture of the students' engagement in the BLE. Furthermore, two of the tutors spent more time with groups A and C in the computer laboratory compared to myself and were in a position to corroborate or refute some of the observations that I made with the sample population in groups B and D.

Interviews of the students and the tutors were transcribed. The software *Nvivo* was used to create categories for each of the tools and support structures that were used in this study. Other categories were also created dealing with problem solving, computer programming, use of examples and support. A general category was created for all the smaller items that were not catered for. Thereafter, the interviews were imported into the *Nvivo* software and the appropriate aspects of the interview were pasted into the relevant categories.

The data obtained from the interviews were used to validate the feedback obtained from the electronic questionnaire. More importantly, the data from the first cycle of the action research process was utilised to inform the planning of the second cycle.

4.2.4.4 Personal diaries

According to McNiff (2013, p. 108) "diaries are valuable sources of data because they show developments in the action and in thinking and theorising. You can document how your own perceptions change over time and how you used new learning to help make sense of a situation". During the action research process in this study, I expected there to be many moments that needed documenting in terms of what I did and how the learning occurred. An electronic diary was kept to automate this process for easier analysis.

Customised software called Dr.Q (described in detail in section 4.3.1.1) was developed and used in this study. One aspect of the software allowed me as the researcher and lecturer, to keep a personal diary by making daily comments of interesting and unusual observations and engagements with students whilst learning computer programming. Each entry made was linked to a specific category. For example, if the entry dealt with students' engagement with videos, then the category videos was selected for that specific entry. As a result of using categories, related comments were grouped together and reports were generated making it easier to analyse the data. Whilst there was a set of predefined categories that were commonly used, the software allowed the user to create new categories.

Diary entries were made based on observations made during the practical and theory lessons. Other entries were made during the many reflective moments that I had. Additionally, entries were also made when moments of inspiration occurred. As a result it was of utmost importance to have my diary with me at all times. Once the entry was manually entered, it was then captured into the Dr.Q software. This duplication took place since the entries were not always made in the laboratory where the software was installed.

An example of a diary entry that was made on April 24th at 9.25am was as follows:

CATEGORY	**COMMENT**
Diary entry	*Students had problems solving question 2 dealing with the use of methods. They did not know how to apply the use of the parameters.*
Supplementary Notes	*None of the students used the supplementary notes during this lesson*
YouTube	*One student made use of YouTube in an attempt to better understand the concept needed to solve the task*
Problem solving	*Students struggling with the problem solving concepts*

Making use of my computer programming knowledge, I wrote a structured query language (SQL) command to query the database that stored all the diary entries and found a total of one thousand two hundred and forty three diary entries in the database for the duration of this study. Keeping a manual diary would have been a difficult means to analyse the numerous amount of entries that were made in this action research process. The use of categories in the software simplified the analysis process in extracting data that related to specific topics. From these topics, I was able to understand how students engaged in the learning of computer programming and why students engaged the way they did.

4.2.4.5 Electronic questionnaires

McNiff (2013, p. 108) states that "questionnaires can be helpful but notoriously difficult to construct". She alludes to live online forums "becoming increasingly used to share information and engage with discussion" which can provide "rich sources of data". Within the context of this study, a similar data source described by McNiff was used in the form of an automated electronic questionnaire, which enabled students to provide detailed accounts of their engagement in the BLE.

The electronic questionnaire was completed by students at the end of each practical lesson to provide feedback on their lesson and to indicate the type of engagement that occurred while solving tasks or while interacting with the various tools and support structures provided. Furthermore, this process was repeated for the theory lesson to determine the type of engagement that transpired in that environment. As a result, students were required to provide constant feedback on their engagement in the BLE.

The use of a paper based environment to receive the feedback was not an option because of the large volumes of data that was expected. As a result, an electronic questionnaire was developed and installed in laboratory 2 for students in groups B and D to complete at the end of each lesson.

4.2.4.6 Quantitative statistics

For the largest part, the nature of this study revolved around gathering of qualitative data. However, some quantitative data was collected through the use of software applications used in this study. Firstly the LMS *Blackboard* contained a feature to monitor the students' usage of the tools hosted on this system. Secondly, the blog had a dashboard that also provided similar statistics in terms of the usage. Finally, I was able to write queries and obtain statistics from the customised software, Dr.Q. Each of these data sources will be described.

4.2.4.7 Using **Blackboard**

The LMS *Blackboard* was used to host the vast majority of the supporting tools. The statistics feature for each tool was activated on the 4th March 2013 till the end of the study and tracked the student number, date and time when a tool was accessed. Whilst all students utilised *Blackboard*, the usage reports (see Appendix 9, BB4, p. 246) of the tools were only generated for the sample groups B and D on a weekly bases.

The information obtained from *Blackboard* could not be used in isolation since some students could have downloaded the tools and used them offline. As a result, the data obtained was utilised in conjunction with the feedback from the electronic questionnaire and the focus group meetings. This point can be illustrated using the following example within the context of this study. I found that 80% of the students downloaded the supplementary notes the first time that it was hosted. Whilst this may have seemed to be a positive outcome, feedback obtained suggested that this tool was ineffective. As a result, these statistics were used as a guideline to determine students' usage.

4.2.4.8 Using the blog

The blog was another tool that was used in this study for students to access information. It was developed using *Google* Blogger on the 15th April 2013 and the link to access the blog was setup on the LMS in order to track the students' usage and to generate the relevant reports for groups B and D.

The blog contained a dashboard (see Appendix 9, BD, p. 246) which allowed me as the researcher to login and view a variety of statistics, with the page view statistics being of most importance. However, I found that this statistic was misleading, for example if the number of views on a page was fifty, it did not mean that fifty different students accessed the page, since it was possible for one student to have accessed a page multiple times. As a result, statistics obtained from the blog were verified by using information from other data sources.

4.2.4.9 Using the customised software

The customised software Dr.Q contained an electronic questionnaire for students to provide feedback and reporting tools to assist with the analysis of data. The third component of this software was the electronic diary that enabled me as the lecturer and researcher to groups entries based on categories. The development of the software started on 7th January 2013, however, the design and planning had started in November of the previous year.

The reporting tools were used to obtain statistics from the closed ended questions of the electronic questionnaires which was used to draw conclusions on the students' experiences of the BLE. Reports were designed to extract information between a start and end date. In most cases the reports were generated each week on a Friday afternoon for reflection and evaluation of the data.

4.2.4.10 Surveys

In the third action research cycle, a survey was used (see Appendix 6, S1, p. 239) to evaluate the students experience with the tools and support structures used in this study. The survey was developed on 5th August 2013 using the online tool called *Contact 123*. Students in groups B and D were required to complete the survey.

In developing the survey, drag and drop components such as textboxes, combo boxes and radio buttons were used to allow students to easily complete it. Students were required to evaluate each of the tools and support structures that were used during the course of this study.

The questions were mainly open-ended requiring students to state their experience with the various resources used in the learning of computer programming in the BLE. The main idea behind the questions was to answer the second research question, that is, *why* students engaged in the learning of computer programming the way they did.

Students completed the survey for all resources over a three day period 19th, 20th and 21st August, since nine tools and support structures were evaluated in total. Table 5 below outlines how the survey was administered. Once the surveys were completed, the data was exported to an Excel spreadsheet. I was able to sort the spreadsheet in order of the tool name to analyse the responses based on each tool.

Table 5: Survey schedule

Day	**Tool evaluated**
19 August 2013	Theory Lesson, online tests, supplementary notes
20 August 2013	Group discussions, Blog, mentors,
21 August 2013	Videos, animations, *Google*

4.3 Research methodology

The previous section described the methods that were used in this study. In this section I will focus on the action research methodology employed. There were three main action research cycles that were utilised and will be described. The first cycle dealt with the setup of the customised software and the configuration of the LMS and introduced supplementary tools and online tests for students to engage with. The second action research cycle dealt with the creation of tools and support structures in an attempt to enhance the learning experience of the student. These supporting structures were in the form of group discussions, a blog, mentor assistance, videos, animations and the use of *Google* as a research tool. The third action research cycle focused on the evaluation of the tools and support structures. During this cycle, students reflected on the type of support received and provided feedback on each one.

Each of these tools were developed using an action research cycle of its own resulting in smaller cycles taking place within the main cycle. In most cases the tools were developed concurrently, however, it is explained independent of each other in the next chapter. As a result a summary of each of the three main cycles is first illustrated in order to understand a global picture of what transpired in this study. Figure 4.3 depicts the activities that transpired during the three main action research cycles.

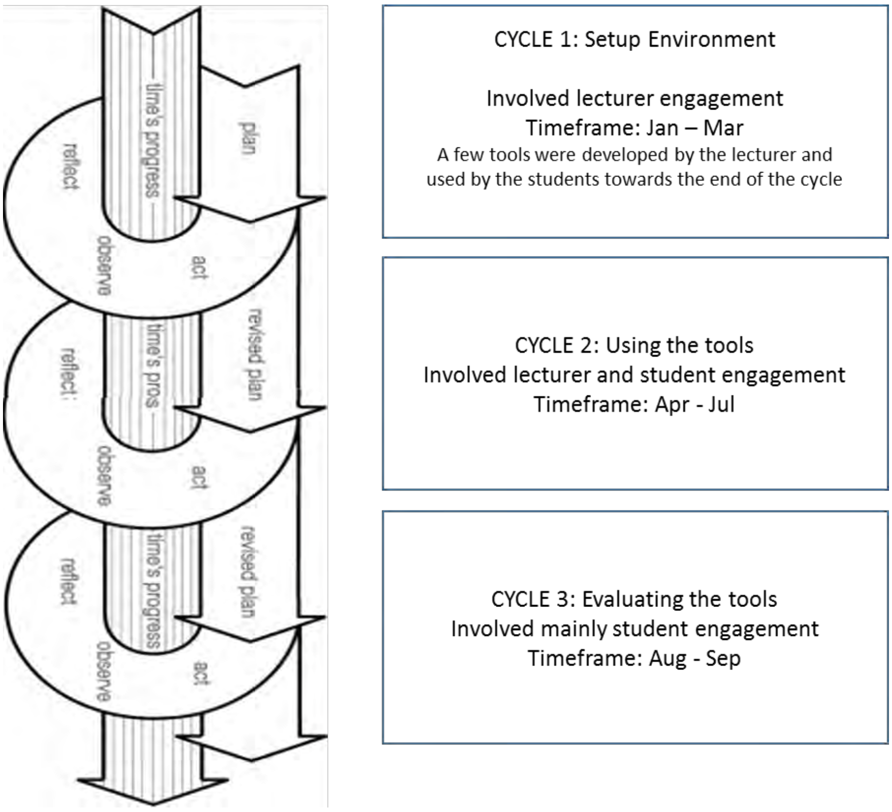

Figure 4.3: Main Action Research cycles used in this study

4.3.1 Setting up the environment

As indicated previously, the first cycle revolved around the setup of the environment in this study and a detailed description of this process is outlined.

4.3.1.1 Customised software DR.Q

Week 1: Planning and designing the software Dr.Q started.

The lifecycle of the electronic questionnaire depicting all the action and reflective moments that occurred during the transformation process of this software is illustrated in Figure 4.4.

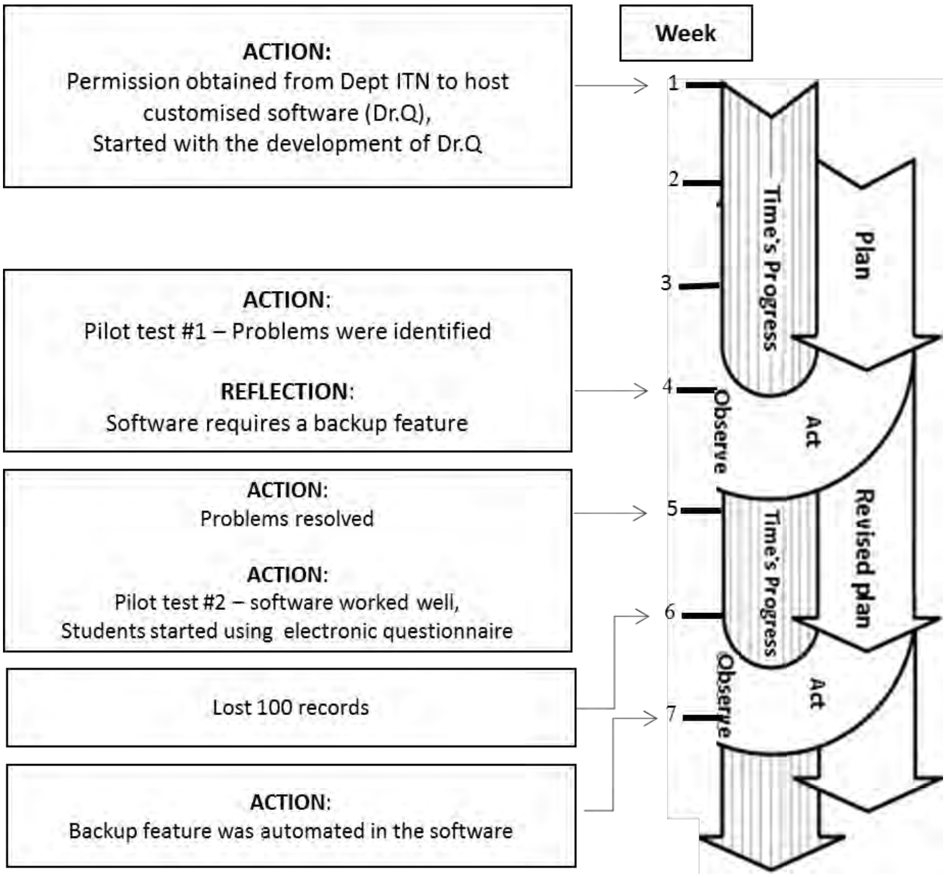

Figure 4.4: Development cycle of the customised software (Dr.Q) in cycle 1

The action research nature of this study required constant feedback from the students after each lesson. As a result of the large amounts of data, I decided to develop customised software to perform this task. Incorporated into this software were two features, namely, a personal diary and reporting tools, designed to assist me as the lecturer and researcher to analyse the data. All of these features were packaged into one customised software package which I abbreviated and called Dr.Q, for (D)iary, (R)eports and (Q)uestionnaire. The development of this customised software package will be described.

4.3.1.1.1 Development of the software

Week 1: Started with the development of the software

Prior to developing the software, permission was obtained from the department of Information Technology and Networks (ITN) to install the customised software on each computer in the laboratory where the study took place. Permission was also obtained to centrally host the database on one of the servers on the local area network. Once permission was granted, the inputs, processes and outputs of the software design were clearly identified and analysed. I chose to write the software for a *Microsoft* Windows environment using the programming language C# in Visual Studio and connected to a SQL server database. The software was initially developed on a single user machine which connected to the local database. Rigorous testing of the software by the computer programmer occurred before it was packaged and installed on each computer in the laboratory. The database was centrally installed and configured on a server to which the application connected to. The connection string in the application, which linked to the database on the local machine, was changed to read from the centrally situated database.

Once the development of the customised software was completed, a testing process was required in a live environment to ensure its correctness. This was achieved through the use of a pilot study.

4.3.1.1.2 The pilot study

Week 4: Pilot test #1, Week 5: Pilot test #2

Bazeley (2013, p. 55) suggests that one should "put all your proposed research procedures, including strategies for analysis, through a 'dry run' with the kind of settings or people who will eventually become your research focus". A pilot study took place on the 30 January 2013 to identify problems with comprehension and interpretation of questions and to determine if the software wrote the data correctly to the database and produce valid reports. Ten students were randomly chosen from the first year class together with the four subject tutors to complete the questionnaire. During this process, two students and three tutors raised concerns about two questions, which they felt were ambiguous. One spelling error was also detected by the tutor. On completion of the questionnaire, the first person submitted their responses successfully. All others that attempted to submit thereafter, failed with the software producing the error: "Too many connections open". I immediately realised the cause of this software related problem of not closing the database after the data was written to the database, and addressed this issue together with all the other corrections that were identified. Thereafter a second pilot test occurred on the 4th February 2013 with another group of ten randomly selected students and the four subject tutors. This time there were no problems with the interpretation of the questions and the technical error writing to the database was rectified.

After testing all aspects of the customised software and being confident that it was stable, I was able to start utilising it.

4.3.1.1.3 Lecturer's tools

Week 5: Started using the diary and reporting features of the software

Once logged into the Dr.Q system, as the lecturer and researcher I was able to make entries into my personal diary. Each entry made was dependent on a category to facilitate the grouping of information. Some of the common categories used were: programming, notes, videos and a blog. An example of a diary entry was outlined in section 4.2.4.4.

I also had access to a variety of reporting tools which enabled me to obtain statistics based on the student responses. Two reports were most frequently used in this study, namely, the student comments report and the student summary report. The first report displayed the students' comments for the open-ended questions in the electronic questionnaire while the second report summarised the responses of the closed-ended questions. Both the reports required the user to input the start date, end date and the report type (i.e. theory or practical lesson). As a result, I was able to view daily or weekly reports. An example of each report is illustrated in Appendix 10 (CSR1, CSR2, CSR3 & CSR4, p. 248-251). Reports were also available based on the diary entries I had made and contained filters similar to the students' reports. A snapshot of a category report is outline in Appendix 10 (CSR5, p. 252).

4.3.1.1.4 Student's tools

Week 5: Students were able to provide feedback on the Dr.Q software on the blended learning environment

The Dr.Q software contained two student questionnaires pertaining to their theory and practical lessons, to facilitate student feedback on the BLE. Both questionnaires contained the following types of questions: yes/no, Likert rating and open ended. The five point Likert rating scale was used as follows 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree. A concerted effort was made to ensure that the completion of the questionnaire was not time consuming, since this process occurred during the class time.

The theory lesson questionnaire contained six yes/no question, four Likert ratings and two open ended questions while the practical lesson questionnaire contained eight yes/no questions, two Likert ratings and two open ended questions, which required students to make comments based on reflections of their lesson and the tools used. A snapshot of the electronic questionnaire is depicted in Appendix 2 (p. 211).

The practical lesson questionnaire was easier to facilitate than the theory lesson questionnaire since students were in the laboratory and completed it at the end of the lesson. The difficulty arose in the completion of the theory lesson questionnaire, since it took place in a classroom environment with no computers. Students were given two alternatives to provide feedback on their lesson which occurred on a Monday morning. Firstly, students could fill out a paper based questionnaire at the end of the theory lesson and capture the details the next day during their practical lesson. The second alternative revolved around students completing the electronic questionnaire at the beginning of the practical lesson which took place on Tuesday morning. The sample group unanimously opted to complete the electronic questionnaire the next morning and were confident of remembering all events that occurred the previous day. A snapshot of the theory and practical lesson questionnaire is given in Appendix 2 (TLEQ, PLEQ, p. 211-212).

4.3.1.1.5 Students engagement with DR.Q

Week 5: Students were able to provide feedback using the electronic questionnaire

Students found the electronic questionnaire easy to use. The tutors ensured that all thirty students completed the practical questionnaire at the end of all three practical lessons. This took place for both groups B and D. In particular, the tutors also ensured that the theory lesson questionnaire was completed by these two groups on a Tuesday morning before their practical lesson commenced. In one week, a maximum of thirty students in group B would have completed the practical lesson questionnaire three times and the theory lesson questionnaire once, resulting in a maximum of one hundred and twenty entries being created in the database. This was also the case for group D hence resulting in a maximum total of two hundred and forty entries being generated in one week.

With such a large number of entries accumulating at a rapid rate each week, the backup of the database was important. As an IT lecturer, I constantly request students to save and backup their work in the laboratory. As a result, one of the tutors questioned me on the issue of backup during the pilot test, and he was surprised to find out that the software lacked an automatic backup feature. My response was that I realised the importance of making backups, however, because of time constraints a manual backup was planned at the end of each week. Nonetheless, approximately one hundred records were lost after the first week, before any backup of the database was made. After this incident, I prioritised the inclusion of an automated backup feature in the software, which occurred at the end of each working day.

In this section the lecturer's and students' engagements with the customised software were described in detail. An explanation will now be given about the engagement that occurred with the Learning Management System.

4.3.1.2 Learning management system

Week 1: setup and configuration of Moodle to provide online support environment to students

A LMS is an effective tool used to host materials in an online environment. This was identified by the institution where the study was carried out resulting in them subscribing for the services of *WebCT* for many years and then migrating to the services of *Blackboard*. Large sums of money were paid for this proprietor based service however, comments elicited from the administrator of the LMS indicated that approximately 25% of the staff, who were technologically driven, utilised this tool.

4.3.1.2.1 Lecturer engagement: using **Moodle**

Week 5 – started using Moodle

In this study I originally chose to use *Moodle* as the Learning Management system to host online materials since I was aware of it being used locally, nationally and internationally by educational institutions. The advantage of such a system revolved around it being open source software that was free of charge. On the other hand, the disadvantage was no having any face to face or telephonic support. I was satisfied in using *Moodle* despite its drawback, since I believed it had benefits to offer the institution in terms of savings. Furthermore, I believed that the online support available through the use of *Google* searches was sufficient for me to resolve any problems that would arise.

The lifecycle of *Moodle* depicting all the action and reflective moments that were undertaken during the transformation process is illustrated in Figure 4.5.

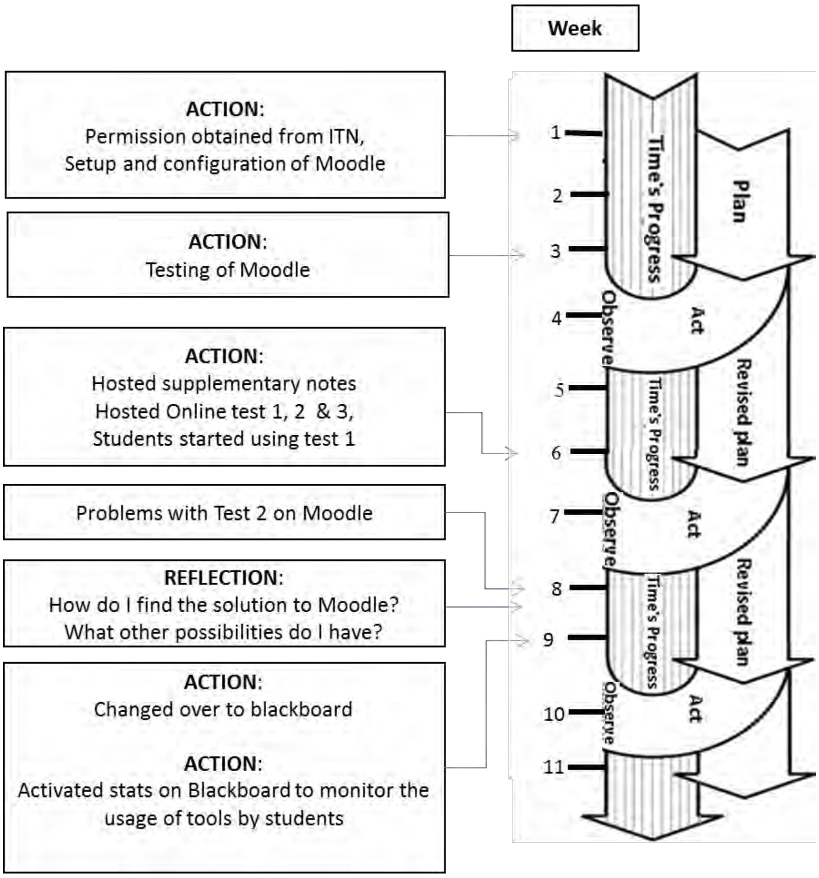

Figure 4.5: Using *Moodle* to host online tests

Having made the decision to use *Moodle*, permission was obtained from the department of ITN to install and host the software. They agreed to host the software but not provide support since they lacked the expertise within the department. Having agreed to these terms, an ITN technician installed and configured *Moodle*. I was the designated administrator of the system which enabled me to upload and setup the course materials. Improvements were made to the interface by defining colours and themes, creating suitable headings and adding institution logos to improve the appearance and quality of the environment, in an attempt to improve the students' appeal in using the software.

Once the *Moodle* environment was setup, the next step required the hosting of materials by the lecturer and for students to be registered in order to access the materials.

4.3.1.2.2 Hosting notes on the learning management system

Week 5: Started hosting supplementary notes

The lecturer engaged with *Moodle* by developing supplementary notes using *Microsoft PowerPoint* and uploaded them to *Moodle*. Thereafter, all registered students in the course

Technical Programming 1 were able to login and access the hosted materials. On commencement of the course, students logged into *Moodle* and engaged with the notes by either downloading them or viewing them online.

With *Moodle* working effectively, it was time to host other materials. At this stage I wanted students to conduct online theory tests in the form of multiple choice questions. The publisher, Cengage, of the prescribed textbook, Java Programming – 6th edition by Joyce Farrel, provided a test bank of questions for instructors to utilise. A series of three theoretical tests were created on chapter two of the textbook to get students to learn the theoretical concepts. Criteria for each test was setup on *Moodle* which enabled the next test to only become active once the student achieved above 80% in the previous test. The reason for having a high pass mark was to ensure that students grasped all the theoretical concepts. While this process would have required surface learning, I believe that it was essential to achieve in order for students to apply their deep learning skills in solving their tasks as outlined by Jenkins (2002).

4.3.1.2.3 Student engagement with **Moodle**

Once the environment had been setup and the materials were hosted, students were required to login to the LMS in order to access the materials. They engaged with *Moodle* by accessing the theory tests on the LMS on a computer connected to the institution network. After completing and passing the first test, students were unable to start the second test. *Moodle* produced the fault: "Error while writing to the database". With the lack of face-to-face or telephonic support, I had to find a solution to this technical problem. After four days had passed by and not being any closer to solving this problem, I felt pressurised since this problem prevented me from developing other materials. Having used the LMS *Blackboard* extensively previously, I replicated the online tests on *Blackboard* and found that it worked. I immediately made a decision to move over all content from *Moodle* to *Blackboard*.

The changeover was quick and seamless as a result of having previously gained a wealth of experience with the *Blackboard* environment. After making this change, students adapted easily to the new environment which was used till the end of the study. The statistics feature was activated to allow me to monitor the students' usage of the tools. In hindsight, I believe that this change over to *Blackboard* proved to be the correct decision since I was extremely familiar with it. I had limited experience with *Moodle* and with the lack of support with this environment, it would have demanded more of my time. It was important to channel my time effectively within the BLE and not struggle with technical difficulties, since the action research methodology employed in this study proved to be time consuming.

4.3.1.2.4 Analysis

In this support activity system, three tensions were identified with the *Moodle* LMS and are analysed based on my engagement as the lecturer. The first two tensions involved my engagement within the activity system whilst the third dealt with the students' engagement with the online tests. Each of these issues relate to the second critical question dealing with why engagement in computer programming occurs in way it does.

Firstly, a tension took place at the point of the rules whereby students were unable to take the second test despite satisfying the requirement of the first test. The *Moodle* environment produced an error, for which I had to find the solution. Within this activity system, I adopted the role of a lecturer, researcher and technician creating a busy work schedule which was time consuming. A decision was required in terms of the way forward in using the online tests. The easiest solution was to remove the criteria of achieving 80% for each test since this created the technical difficulty. In doing so all tests would be available for students to access on *Moodle* with no sequential order in taking them. The second idea was to simulate the online testing, with the 80% criteria, on the proprietary based LMS *Blackboard*, which was setup and configured by the university and if successful, to change over to this LMS.

As described previously, the *Blackboard* solution was adopted since I believed that the 80% pass criteria had better learning possibilities and could also help the students to develop a persevering attitude towards each test. This would also ensure greater student engagement with the learning materials. Furthermore, it was still early in the study and students had time to adapt and settle into the new LMS. This environment was also setup and configured by experts in the field resulting in fewer problems, and if the need arose there was the option to obtain face-to-face support. It's also worth noting that these students were exposed to *Blackboard* in their other subjects and were already familiar with this environment.

Upon reflection on the use of *Moodle* as a LMS, I realised that I had introduced an unnecessary element of risk into this study since I had no past experience or training to deal with troubleshooting of technical challenges. The following diary entry (PD1) was made on the 1 March 2013:

> *It was great learning how to work with Moodle but it's taking up too much of my time which can be better utilised elsewhere in this study. It's time to migrate to Blackboard*

My technical knowledge of using software connecting to a database was limited, which introduced an unnecessary element of risk in attempting to use *Moodle* as a LMS, considering that *Blackboard* was already a tried and tested LMS used at the institution. However, this is in keeping with my attitude of trying out different ideas and technologies in an attempt to learn new products to enhance my knowledge. The by-product of using *Moodle* was an attempt to assist the institution in saving money by using free software as opposed to paying large sums of money in licencing fees by using proprietary based software like *Blackboard*.

Secondly a tension occurred between *Moodle* (instrument) and the department of ITN (community). *Moodle* is open source software and there was no formal support as offered by vendors of propriety software such as *Blackboard*. The technicians from the department of ITN who installed and configured the software were not trained with this software usage and were not able to assist with the problems experienced. As a result of their inexperience with *Moodle*, it is possible that the setup of *Moodle* was not installed properly resulting in the error that transpired. Upon further reflection as a software developer, I should have realised the maintenance and technical challenges that can arise when working with software that connects to a database off a network, and should have identified other institutions that successfully used *Moodle* and established relationships with administrators of those institutions as a means of acquiring support and becoming better prepared to handle these difficulties. In an intensive study of this nature, additional support structures were necessary to deal with challenges of this nature. Boyel et al. (2003) in their study, acquired a technical team to handle challenges similar to those experienced in this study.

The setting up and configuration of the customised software and learning management system was described in detail. The next chapter presents the findings of support structures and tools utilised. To prepare the reader for this chapter and to understand the how the sequence of events unfolded during the action research process, a summary of events is presented, outlining all the events that occurred during each of the three cycles.

4.3.2 *Action Research process summarized*

4.3.2.1 *A summary of cycle 1*

A holistic presentation of Cycle 1 is illustrated in Figure 4.6 outlining all the activities that transpired. It also highlights the timeline and the sections that were covered during this period.

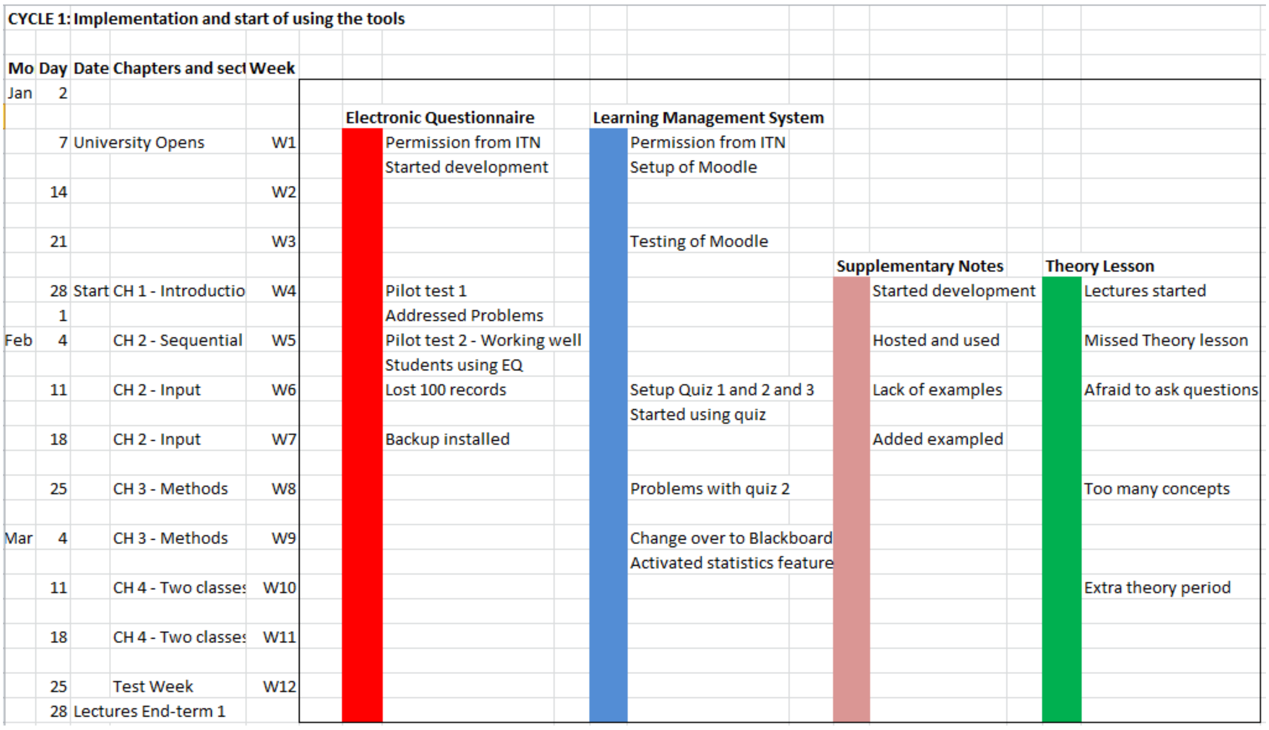

Figure 4.6: A summary of activities in cycle 1

A week by week description of the activities illustrated in Figure 4.6 is outlined in Table 6 highlighting how the events transpired in cycle 1. The action, observation, feedback and reflection phases of the action research process are highlighted. Note that the first week started when the institution opened in the new academic year of 2013.

Table 6: Summary of events that occurred in cycle 1

	Permission was obtained to conduct the study in 2012
Week 1 *7 Jan 2013*	University opened for the new academic year. ACTION: Permission was obtained from the department of ITN to install the customised software in the relevant laboratories, to host the database and to configure and setup *Moodle*.

	ACTION: The development of the customised software Dr.Q started. ACTION: The setup and configuration of *Moodle* started.
Week 2 *14 Jan 2013*	ACTION: Development of the DR.Q software started. ACTION: Monitored the installation and configuration of *Moodle*.
Week 3 *21 Jan 2013*	ACTION: Started testing *Moodle*. REFLECTION: *Some students may miss the theory lesson or may need supplementary notes to be productive in the practical lesson.* ACTION: Started creating supplementary notes for students.
Week 4 *28 Jan 2013*	ACTION: The first theory lesson took place. ACTION: The first pilot test of the electronic questionnaire software occurred with ten students and four tutors. FEEDBACK: Spelling errors were found on the questionnaire. An error was detected when the data was being written to the database. ACTION: All the problems with the electronic questionnaire software were addressed
Week 5 *4 Feb 2013*	ACTION: A second pilot test occurred with the electronic questionnaire software with ten other students and the four tutors. FEEDBACK: The electronic questionnaire received positive feedback. However, one of the tutors questioned how the data was being backed up. Students started using the electronic questionnaire and provided feedback on the BLE. Students started using *Moodle*. ACTION: Supplementary notes were hosted on *Moodle*.

	OBSERVATION: It was found that some students missed the theory lesson. These students constantly distracted the tutors during the practical lessons and as a result, other students were not able to receive assistance from the tutors.
Week 6 *11 Feb 2013*	OBSERVATION: 100 records were lost in the electronic questionnaire database. REFLECTION: *An automatic backup feature was required to prevent loss of information.* ACTION: Online tests 1, 2 and 3 were setup on *Moodle* with a pass mark of 80%. Students started using the first quiz. FEEDBACK: Students commented that the supplementary notes lacked examples. REFLECTION: *What examples can be added to the supplementary notes? How do I present the examples for effective understanding?* OBSERVATION: Students were not responsive and were afraid to ask questions in class. As a result there were gaps in their understanding. REFLECTION: *How can I promote students to ask questions in class? How can students get answers outside of the classroom in order to improve their understanding?* *Consider a blog where students can post questions anonymously? Consider using some of the enthusiastic second year students who are good computer programmers to assist the first year students?*
Week 7 *18 Feb 2013*	ACTION: An automatic backup feature was installed in the electronic questionnaire software. ACTION: Examples were included to the supplementary notes in the form of Java programs and included many explanations in the form of comments. FEEDBACK: Some students indicated their preference for visual material.

Week 8 *25 Feb 2013*	FEEDBACK: Students experienced problems accessing the second theory quiz on *Moodle*. REFLECTION: *How can the problem with Moodle be resolved? Where can I obtain support regarding this problem with Moodle? What other options were available to host the tests and other online material?* FEEDBACK: Student indicated that too many concepts were taught in the theory lesson. REFLECTION: *Will I be able to teach at a slower pace and complete the syllabus? Should I remove a practical lesson in place of a theory lesson? Would it be possible to introduce an extra theory lesson without removing any practical lessons?*
Week 9 *4 Mar 2013*	REFLECTION: *I cannot solve the issue with Moodle and don't have any assistance to address the problem.* ACTION: A changeover was made from *Moodle* to *Blackboard*. Students started using the online-tests on *Blackboard*. ACTION: The statistics feature was enabled on *Blackboard* to monitor the student's usage of the supplementary notes and online tests.
Week 10 *11 Mar 2013*	ACTION: A second theory lesson was introduced in order to reduce the number of concepts taught in one theory lesson.

4.3.2.2 Reflections from cycle 1 and plan for cycle 2

Reflection #1: How can I assist students that are afraid to ask questions in the theory lesson? The plan was to develop a blog.

Reflection #2: What visual tools can be used to improve the student engagement in the learning of computer programming? The plan was to develop videos and animations.

Reflection #3: How can students engage actively in solving their tasks through the use of research? The plan was to engage students in having to carry out research through the use of *Google* in solving their tasks.

Reflection #4: How can students receive assistance immediately in the laboratory? How can students receive assistance in smaller groups from outside of the classroom? A plan was to allow students to interact with each other during the practical lesson, in the form of small group discussions. Student mentors were identified as a means of helping students in small groups outside of the classroom.

The above planning occurred at the end of the first cycle. Whilst these reflections are presented in a particular sequence, it was not implemented in the same sequence. A summary of the sequence of events that occurred is outlined.

4.3.2.3 Summary of cycle 2

A holistic presentation of the events that transpired in cycle 2 together with a timeline illustrating how all the activities unfolded during this cycle is depicted in Figure 4.7. It highlights the concurrent activities that transpired.

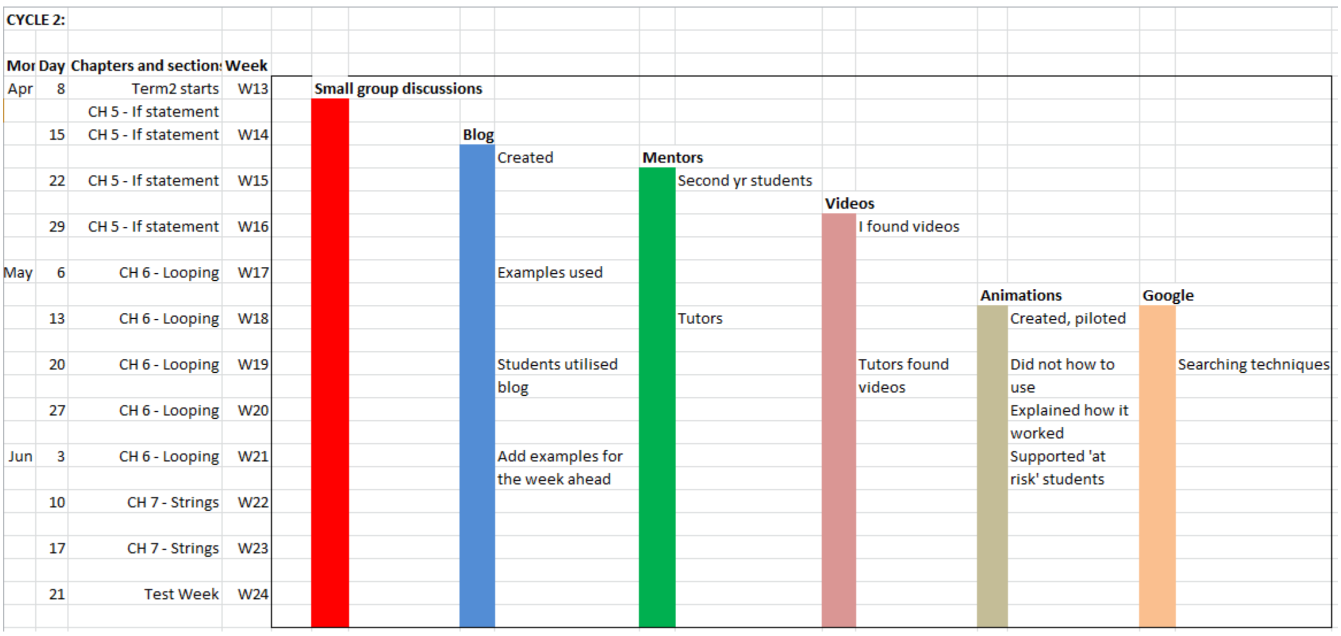

Figure 4.7: A summary of activities in cycle 2

A week-by-week description of the activities illustrated in Figure 4.7 is given in

Table 7 and provides a weekly breakdown of how the events occurred in cycle 2.

Table 7: Summary of events that occurred in cycle 2

Week 13 *8 Apr 2013*	REFLECTION: *From cycle 1, tutors indicated that they were constantly distracted by students that missed the theory lesson and they could not support other students that required assistance.* ACTION: Small group discussions amongst students were allowed during the practical lesson.
Week 14 *15 Apr 2013*	REFLECTION: *From cycle 1, how can I assist students that are afraid to ask questions in the theory lesson?* ACTION: A blog was created to assist students who were afraid to ask questions in class, to post questions instead.
Week 15 *22 Apr 2013*	REFLECTION: *How can I assist students outside of the classroom?* ACTION: Second year students were identified as mentors to assist students in small groups outside of the formal class.
Week 16 *29 Apr 2013*	OBSERVATION: Only two students posted questions on the blog. FEEDBACK: Students could not see the link between the theory lesson and the blog. REFLECTION: *How can I promote the use of the blog? What would interest students in being active participants on the blog?* REFLECTION: From c*ycle 1, students indicated that they preferred the use of visual material. What visual material can I introduce?* ACTION: I found videos on *YouTube* as a means to help students visually grasp concepts.

Week 17 *6 May 2013*	ACTION: Notes that were related to the work carried out in the theory lesson were added to the blog. ACTION: Examples were added in an attempt to attract students to the blog.
Week 18 *13 May 2013*	FEEDBACK: Students commented that the mentor programme was ineffective. REFLECTION: *The mentor programme has great potential but failed. With the lack of student mentors, how can I improve this programme?* ACTION: A more formal mentor structure was created making use of the tutors to assist students outside of the formal class. FEEDBACK: Students did not find the videos useful since they could not understand the accent of the narrator. ACTION: Another visual tool, used previously with success, was introduced in the form of *PowerPoint* animations, to assist students visualise abstract computer programming concepts. REFLECTION: *Students don't seem to be proactive in their learning. Let me provide written instructions on the use of the animations to determine if students are able to successfully use them.* ACTION: A pilot study was conducted by five students to determine if the instructions of the animations were clear. Minor changes were made based on the feedback received and the animations were uploaded to the LMS. REFLECTION: *Cycle 1 showed that students were becoming too dependent on receiving knowledge and were not prepared to create knowledge.* ACTION: *Google* was used to determine if students could find solutions independently during the practical lesson. REFLECTION: *With the introduction of Google, another opportunity is created to determine how proactive students are in finding solutions.*

Week 19 *20 May 2013*	OBSERVATION: Students started posting questions on the blog. FEEDBACK: Positive feedback about the blog was received from students. ACTION: Tutors were used to select videos from *YouTube*. FEEDBACK: Students did not know what the *PowerPoint* animations were trying to achieve. REFLECTION: *I need to explain the use of the PowerPoint animations to students.* OBSERVATION: *Google* searches by students produced irrelevant results. ACTION: Students were taught how to search for information using appropriate keywords on *Google*.
Week 20 *27 May 2013*	ACTION: The animations were explained to the students.
Week 21 *3 Jun 2013*	ACTION: The blog was modified to include work for a week before the lesson took place. FEEDBACK: Students found the videos very useful. FEEDBACK: Students found the animations very useful. OBSERVATION: Students were able to find the required information using *Google*. However, they were unable to apply the information correctly in solving their tasks. ACTION: Students 'at risk' of not qualifying to write the final examination were identified. Support in the form of extra lessons occurred making use of the animations.
Week 22 *10 Jun 2013*	OBSERVATION: Very few students read the notes on the blog prior to the theory lesson

	ACTION: Support for 'at risk' students continued
Week 23 *17 Jun 2013*	ACTION: Support for 'at risk' students continued
Week 24 *24 Jun 2013*	OBSERVATION: Students that were 'at risk' were able to pass their final test.

4.3.2.4 Reflections of cycle 2

Many tools were used in Cycle 2 to address concerns from Cycle 1. Firstly, small group discussions were introduced to assist students that experienced difficulties to obtain immediate assistance. Secondly, a blog was developed to assist students that were afraid to ask questions in class. They were able to post questions anonymously at any time with no pressure. Thirdly, mentors were used to provide assistance to students outside of the formal lessons. Fourthly, videos and animations were introduced as visual material to enhance engagement in learning computer programming. Finally, *Google* was used as a means to make students proactive in their learning. In this way students became active learners and were accountable in solving their tasks.

Each of the tools and support structures underwent a transformative process whilst students engaged with them in an attempt to make improvements to enhance the learning of computer programming. The question that now remained: How effective was the students' engagement with the tools and support structures? Cycle 3 of the action research process revolved around the evaluation of each of the tools and support structures in the blended learning environment.

4.3.2.5 Summary of cycle 3

During the first two cycles, support structures were put into place to assist students with computer programming in the BLE. The third cycle required students to use their experiences from the previous two cycles to evaluate the tools and support structures. Surveys were developed using the web based application called *Contact 123* in order to get an overall impression of why students engaged with the support structures in the way they did.

Contact 123 is an online web based application, similar to *Google Forms*, that allows the user to create surveys, event registrations, quizzes and polls. A user is able to register for free with restricted access to all of the features or subscribe by making a payment and having full access to the application. For this study, *Contact 123* was chosen over *Google Forms* since it was used by other staff members in the department and the support, if required, was easily available. Once logged into the application, I was able to create and design a survey using drag and drop tools. This form was then saved and published online, and a link was uploaded to *Blackboard* for students to access the survey. Once all the students completed the survey, I was able to download the results to a *Microsoft Excel* spreadsheet which was then ready for analysis. The survey is provided in Appendix 6 (S1, p. 239).

4.4 Data analysis

The use of Activity Theory as a framework in education is given by Crawford and Hasan (2006) and Murphy and Mannzanares (2007), provided a rationale for its use in my study. Activity Theory was used to analyse the relationships that existed within the activity system and to detect varying degrees of contradictions or tensions that occurred therein (as discussed in section 3.3.4). These contradictions or tensions were critically analysed using deductive and inductive reasoning.

Within the context of this study, one such tool used was a blog. The analysis of this activity system is depicted as a unit of activity and tensions are found within the system. Reflection of the tensions are analysed based on the feedback from students which resulted in improvements to the activity. Descriptions of these activity systems are outlined in the next two chapters, with evidence provided to support the findings.

In the next chapter, Activity Theory is used to setup and analyse the activity system using the key principles described in section 3.3.2. To alert the reader about how the analysis will proceed, a brief explanation using an example of the blog is presented here. Figure 4.8 illustrates the activity system for the blog.

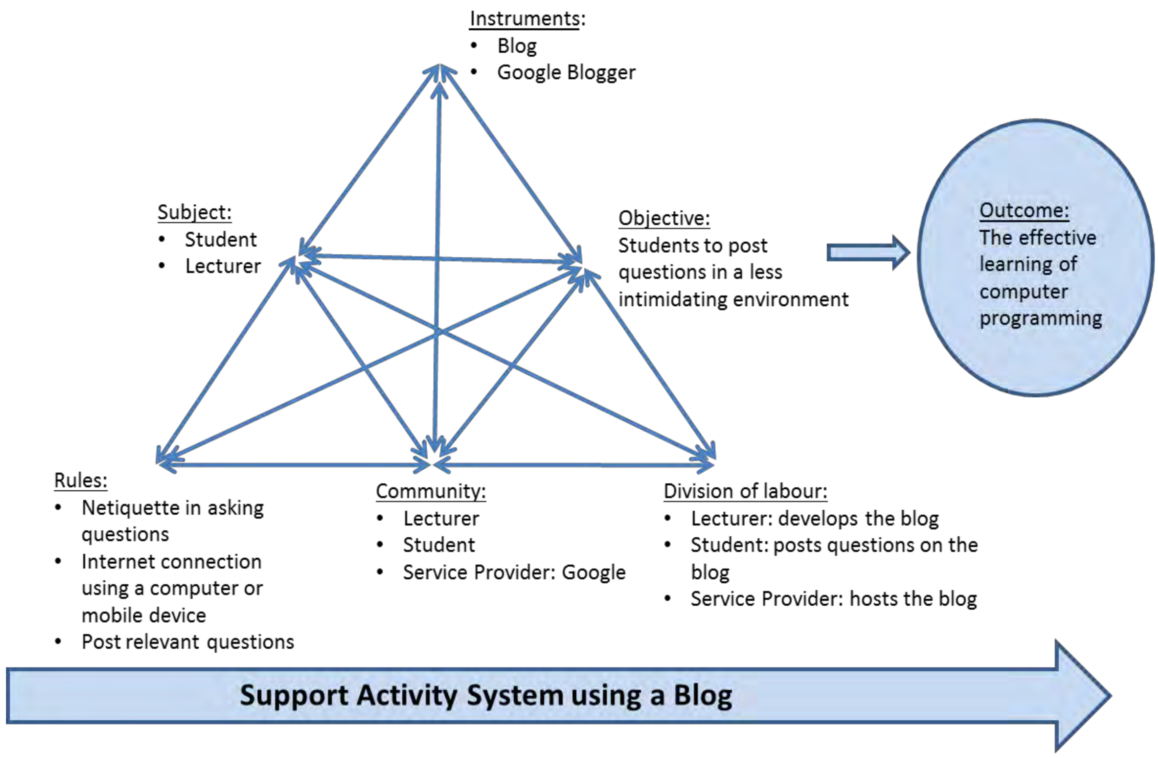

Figure 4.8: Support activity system using a blog

This figure helps to interpret the relationships and the activities of the blog holistically, exposing the various components within the activity system whilst attempting to achieve its goal. Each of the relationships between the components was analysed causing varying degrees of conflicts to surface. These conflicts or tensions were analysed and theorising around them occurred. In some instances, innovations were found which helped to enhance the activity system.

It is important to note that two levels of analysis occurred during this study. Firstly, during the action research process of each tool, a reflective phase occurred based on the feedback that students had made using the electronic questionnaire. As a result, analysis occurred during this phase in an attempt to transform and improve the activity system in the BLE. This analysis revolved around how students engaged with the various tools in the BLE and hence responded to the first critical question. A second level of deeper analysis occurred making use of Activity Theory as an analytical tool to determine why students engaged with the tools in the BLE the way they did. This is presented in the next chapter and responds to the second critical question.

4.5 Conclusion

This chapter described the methods utilised in this study and provided an explanation of action research. Thereafter, the setting up of the environment was outlined and the development of the customised software Dr.Q was explained, followed by the setup and challenges with the LMS.

The Dr.Q customised software proved to be successful in terms of gathering large sums of data and generating useful reports which facilitated easier analysis of the information. My background in software development contributed to the success of using this tool in the data gathering process. The LMS served the purpose of hosting tools for students to access. However, the first LMS, *Moodle,* resulted in technical challenges and because of the lack of support in this study, a changeover occurred to using *Blackboard*. A summary of the action research process conducted was provided to visualise each cycle in totality since some of the events occurred concurrently. Having outlined the data that was gathered, the next chapter presents an analysis using Activity Theory as a framework.

CHAPTER FIVE

5 Findings – Part 1: Theory and practical activity systems

5.1 Introduction

The previous chapter dealt with the methods utilised in this study and provided an explanation of the action research method. A summary was also provided of the action research cycles that were employed in this study.

This chapter will present the first of a two part finding process and focuses on the theory and practical environments. In presenting each environment, the activity system is first illustrated using a second generation activity theory diagram. Thereafter the engagement within this system is outlined making use of an action research diagram. Finally, analysis on the activity system occurs and reflective moments are presented.

The first activity system presented was based on the theory lesson. Within this system a number of challenges were experienced with the lecturer resources, student attendance, students' passive approach in class, issues surrounding the textbook which culminated in students complaining that too many concepts being taught in this lesson. Each of these issues are analysed and reflected upon. The second activity system was the practical environment in which tutors who were expected to assist students during the lesson were distracted by those students that missed the theory lesson. Reflection was required to find ways to address this and many other issues that arose.

This chapter concludes with a summary of the key issues (challenges) identified in these two environments. These issues formed a spring board for the development of tools and support structures in an attempt to address and overcome the challenges which are outlined in the next chapter.

5.2 The theory lesson

Week 4 – Start of the theory lesson

5.2.1 Setting

In the theory lesson activity system, one hundred and fifty full-time students were registered for the computer programming course. I found from attendance registers that approximately one hundred and twenty students consistently attended and about twenty students were usually absent. Ten students had informed me about a conflict in their schedules and were given permission to attend the part-time lesson.

Since computer programming is a practical subject, it was possible to eliminate the theory lesson completely and have all lessons in the laboratory. However, from my experience as a lecturer in this subject, I found teaching computer programming concepts and techniques in a computer laboratory environment created a few problems. Firstly, more periods needed to be allocated since students were in smaller groups in the laboratories which utilised more resources (human and venue). Secondly, the computer became a distraction to the student while learning theoretical concepts, as many were surfing the internet or playing games. Despite getting students to switch off their monitors during the lesson, I found that teaching theoretical concepts in a laboratory was not ideal.

As a result of these challenges the timetable was structured to have one theory lesson at the beginning of the week where important concepts were taught. This was followed by the implementation of the concepts in three practical lessons. The theory lesson took place on a Monday morning at 8am and during this lesson many concrete examples were used to demonstrate concepts and techniques.

5.2.2 Presenting the theory activity system

Figure 5.1 illustrates the theory lesson activity system. This activity system is related to students learning concepts and techniques in computer programming. The lecturer (subject) was responsible for teaching concepts in computer programming to the students (subjects). In this activity system, the lecturer was the active participant in transmitting knowledge to approximately one hundred and fifty students making use of a variety of tools (instruments) which included examples on white board and the use of the computer and projector. Using examples as a teaching strategy featured to a great extent in this activity system to enhance the learning process. The institution and the department (community) provided a supporting and administrative role to the lecturer. Each party in the community had a role to play (division of labour) with the institution being responsible for providing well-resourced venues and the department provided the necessary support for lecturers to teach their subjects. Students were expected to learn the concepts and techniques (objective) necessary for solving tasks. In this activity system I found that some students missed the theory lesson making it difficult for them to solve tasks during the practical lesson. Together with not missing this lesson, it was important for students to be punctual and to ask questions (rules) in order to grasp the concepts taught in class.

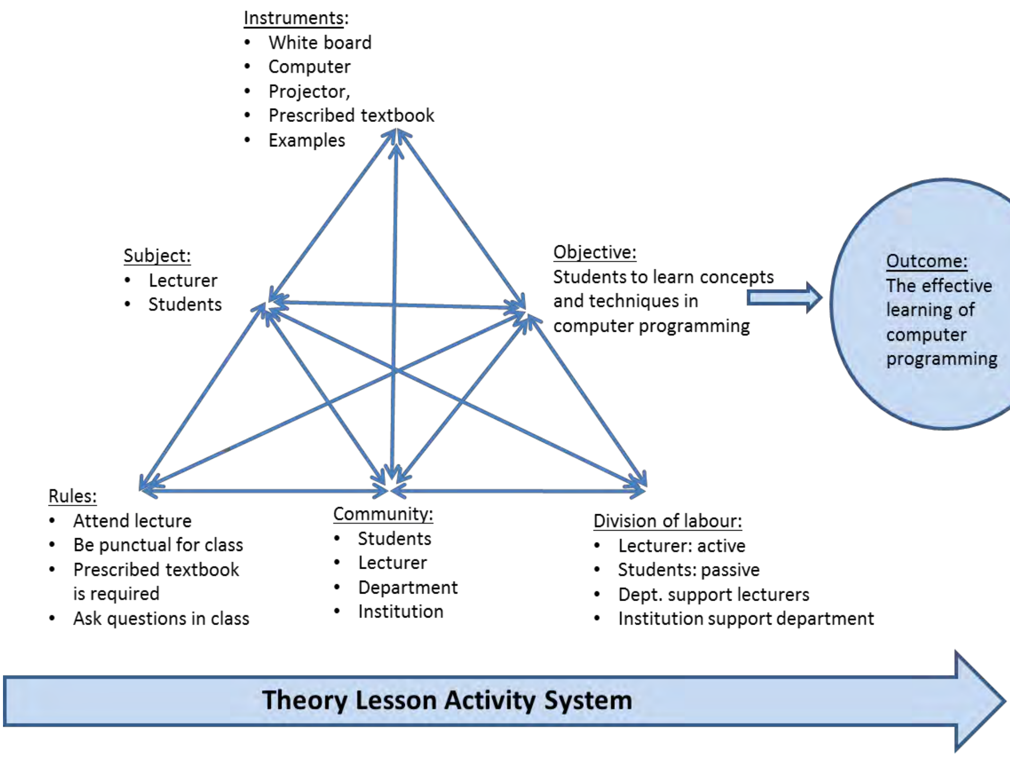

Figure 5.1: Theory lesson activity system

5.2.3 Engagement

The lifecycle of the theory lesson depicting all the action and reflective moments that were undertaken during the transformation process is illustrated in Figure 5.2.

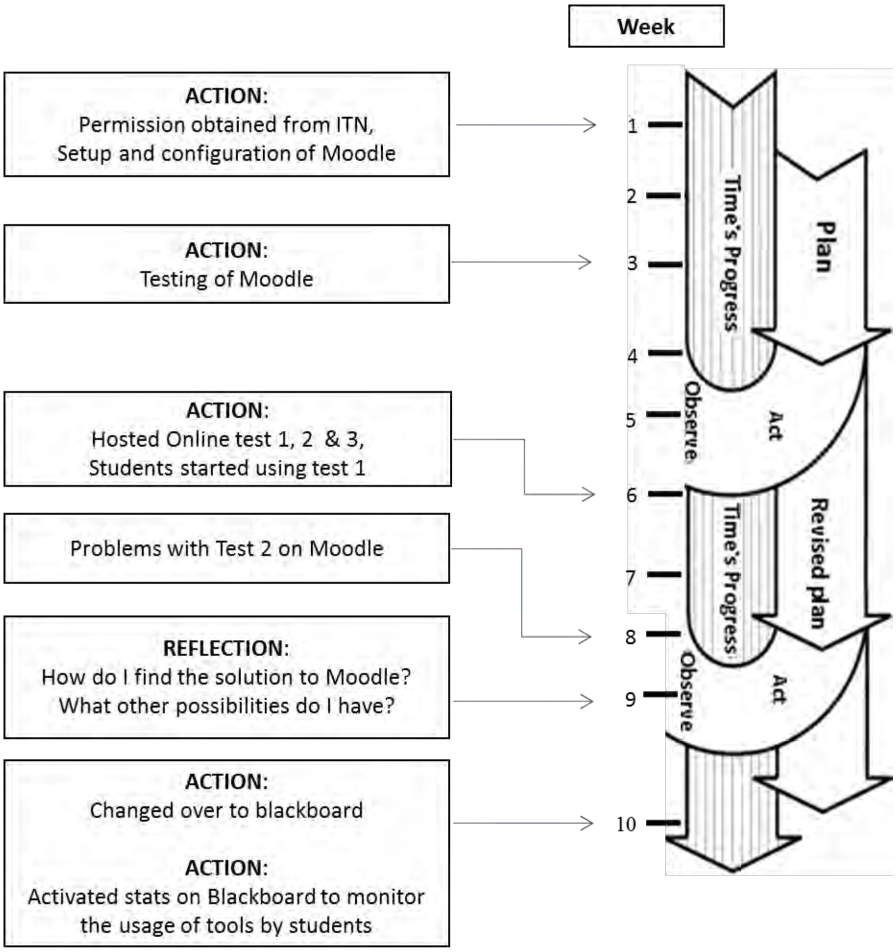

Figure 5.2: Action research transformation of the theory lesson

5.2.3.1 Lecturers engagement

As the lecturer I engaged with the theory lesson by making use of a variety of techniques. Firstly, I always started a lesson by reviewing important concepts that were taught in the previous lesson by asking students questions to determine their understanding. Students were allocated a few minutes to discuss the questions with their friends. Whilst students engaged in discussion with their peers in class, I observed that they were reluctant to speak individually and therefore the majority did not ask many questions.

Secondly, during the theory lesson I engaged in using a computer and projector to demonstrate the development of a computer program and to view the results from the execution. By doing so, I was able to explain concepts, and students were able to visually see the output. In most cases programs were written prior to the lesson. A difficulty was experienced with the projector not always available, requiring me to make use of the white board.

Thirdly, the white board was utilised to illustrate segments of a computer program through the use of examples. I observed that students found the use of examples to be an effective means of learning (SUR03) which helped them to become more confident in attempting other tasks. When illustrating an example of a segment on the white board, I used multiple colour board markers to write different parts of the programs in an attempt to improve student understanding. The use of colour was not randomly used, instead each computer programming structure such as the "if statement" and the "for loop" was written using different colours to enhance the readability of the program. I found that using this method also assisted me as a lecturer to explain the concepts to the students. A similar concept was successfully used by Linden and Lederman (2011) in their creation of animations in computer programming.

Fourthly, I found that students were not responsive to asking questions in class because of being shy or afraid. As a result I requested those students to write their questions on paper. In the first week of introducing this system, two students asked questions using this method. However, this number decreased to one in the following week with no further questions being asked thereafter.

Finally, I was unable to engage with the prescribed textbook as a resource during the theory lesson since the majority of the students did not have this resource. This required me to develop my own set of tasks. With large numbers in class, it was not possible to have hardcopies of the tasks, required me to write them down on the board or dictate them to students, which proved to be a time consuming exercise.

5.2.3.2 Student engagement

Student engagement during the theory lesson was restricted. A small group of students in class always took the initiative and showed the willingness to ask and answer questions. Despite attempting to engage students in discussions, it seemed that many students lacked confidence and doubted their ability in knowing the correct answer. I observed that some students had shy or introverted personalities and preferred not to speak in class.

Student disengagement was also prevalent amongst some students during the theory lessons because of absenteeism and late coming, affecting their understanding of concepts and resulting in them not being able to solve tasks in the practical lesson. I observed a group of approximately twenty students who frequently missed the theory lesson with a few students arriving late to class. In both cases, student understanding was negatively affected.

I observed the majority of students be comfortable with one way engagement during the theory lesson. In this way they simply listened to the lesson without contributing in any way with questions. The problem with this form of engagement resulted in students having gaps in their knowledge when they did not understand concepts taught in class.

Student engagement also took the form of providing feedback at the end of each lesson. This was achieved through the use of an electronic questionnaire that was filled out during the practical lesson. Since there were no computers available during the theory lesson, students were in favour of filling out the questionnaire the next day during the practical lesson.

As a result a number of challenges developed within this activity system which affected students understanding. Those challenges were not limited to the student. I found myself as a lecturer experiencing problems within this activity system as well. These challenges or tensions experienced in the theory lesson activity system are discussed next.

5.2.4 Challenges in the theory environment

5.2.4.1 Lack of projectors

From my experience I found that the engagement in teaching of computer programming in a theory venue can be enhanced by demonstrating programs using a computer and a projector. The execution of a program and the highlighting of errors together with explanations of the errors in a live environment proved to be effective. This visual environment enhanced the learning process. However, this technology was not always available because of the sharing of projectors within the department.

The following comment was made by a student using the electronic questionnaire (EQ12).

> *Student: Sir, why* (are) *you not using the projector any more* (in the theory lesson). *It was useful.*

A tension emerged between the institution (community) and the venues having well-resourced classrooms with screens and projectors (rule). While the institution had endeavoured to equip each venue with a projector and screen five years ago, it was alleged that the equipment was vandalised by students. It seemed that these students showed a total disregard for the equipment by writing on some screens with permanent markers, and tearing others. As a result the projectors were removed from the venues and decentralised to each of the departments. However, there was no one-to-one custodianship of projectors by lectures, which necessitated a policy of sharing. Upon reflection, I recall instances when I required the use of a projector and it was not available. The following diary entry (PD10) was made on the 20 February 2013.

> *Today my theory lesson was based on using the computer and projector to demonstrate a series of programs that used methods and passed parameters. I had made the required booking* (of the projector) *with the secretary in the department but it was not available since the lecturer that used it last had not returned it to the secretary. A change of plan was necessary requiring me to use the board to explain the concepts making use of examples. This was found to be time consuming and I could not complete all the examples as I had prepared.*

On more than one occasion, plans had to change on short notice because of problems related to the diary entry requiring me to make use of the whiteboard. Under these circumstances, I made use of examples and had to ask more probing questions during the lesson. Over the years, I found a way to improve students understanding of interpreting a program in a theory venue as outlined in the following diary entry (PD03) made on the 11 February 2013:

> *I made use of different coloured markers to represent different aspects of the computer program. Based on the student responses in class, I found this technique to be useful which I believe assisted to enhancing student understanding of the concepts taught in class.*

Having reflected on the situation of not always having the use of a projector for my lesson, I believe this effect was a minor contributor towards students' lack of understanding and should not have inhibited them from solving their tasks.

Upon reflection, the following lesson was learnt from engagement in this environment. My planning and preparation of the lesson as a lecturer required greater emphasis especially under those circumstances when my lesson revolved around computer demonstrations and a projector was not available. My planning now required that I have a plan B in the event that such a situation arose, which would have included a different approach with a different set of examples. As a result more thought and effort was required on finding the best way to present material in the absence of well-resourced classrooms.

While planning and preparation is of utmost importance to an academic, the lack of a well-resourced classroom added more pressure to me as a lecturer. This resulted from the total disregard shown by individual that vandalised the equipment in the classroom. However, the institution should have anticipated such an occurrence and should have had measures in place, in the form of security, to prevent this.

5.2.4.2 Students missed the theory lesson

One theory lesson was timetabled for teaching concepts and techniques, which students were then required to implement during the practical lessons. By missing the theory lesson, students would struggle to solve the tasks. The following diary entry (PD01) was made on the 4 February 2013:

> *There were approximately twenty students who missed the theory lesson.*

This seemed to be a trend each week, having monitored the registers after each lesson. I found that a few students regularly missed this lesson while others erratically missed them. As a result, a tension occurred in this activity system. The challenge occurred between the relationship of the student (subject) and their compulsory attendance of the theory lesson (rule).

The following excerpt occurred at a focus group interview (SFGI2) and highlights the comments made by four students. Student 1 and 2 stayed at the university residence in the city centre whilst student 3 and 4 stayed at home a few kilometres away from the institution. The impact on the learning of these students as a result of missing or being late for their lessons is outlined.

Lecturer: What were reasons for you missing the theory lesson this term?
Student1: I sometimes go late to bed on a Sunday and cannot wake up early on a Monday morning
Student2: The 7am bus was late (from residence) *to campus*
Student3: I woke up late and missed the taxi to campus
Student 4: The road works caused too much traffic in the morning which made me late

Lecturer: What effect did this have when you were in the practical lecture?
Student1: I was totally lost
Student2: I did not understand how to do any of the questions

Student3: I could not solve the programs that you gave to us

Student4: I was constantly looking at my neighbours work. I was writing a program that I did not know (understand).

Lecturer: Is it possible to take the earlier bus or taxi

Student3: I can try. (Student 2 agrees)

Student1: The first bus leaves too early for me

Student4: Not sure because the traffic is always busy

One reason given by students for not attending the theory lesson revolved around the issue of transport and traffic as outlined by Student 2 and Student 4. In particular, I found the sentiment cited by Student 2, to be a common remark made by many students, when questioned about their absence or late coming to the theory lesson. As a result of student protest (PD16), this problem, together with other issues, was eventually resolved in the second semester.

Upon reflection of this situation, the following was assumed from this incident. Firstly, some students did not show much concern about the missing of lessons since this occurred frequently. It's worth noting that alternative transport was available in the form of taking the earlier bus or taxis. However, it required those students to make the sacrifice of waking up earlier. It actually became the norm amongst some students, so they accept this situation as part of being at university. It also highlighted the students' lack of organisation skills to enable them to take the first bus or earlier taxi to the institution, in order to be punctual for the first lesson.

Secondly and perhaps more importantly, was the fact that their absence from lectures created serious problems in their learning as they were not able to complete their tasks in the practical lesson. It seems that the majority of the students that missed the theory lesson "did not speak to any friends in class" (SFGI3) to catch up with work missed. They "did not have any time to use prescribed textbooks or the internet" (SFGI3) to learn the work missed. They gave the impression that their circumstances mitigated their incompetence in writing computer programs and solving tasks. This attitude compounded the many difficulties experienced in teaching them. Based on the comments made by all the students, they struggled to solve their tasks in the laboratory resulting in Student 4 copying work from his neighbour's screen with no understanding.

5.2.4.3 Students arrive late for the theory lesson

The following diary entry (PD04) was made on the 11 February 2014:

> *There seems to be a trend with about 15 students being late* (for the theory lesson) *each week*

The late arrival of students for each theory lesson created a similar tension as explained in the previous section when students missed their lesson. These students cited similar reasons for their late coming. I found this particular group of students could be classified into two categories. Firstly, those students that missed a short part of the lesson, approximately fifteen minutes of the ninety minute lesson, and secondly students that missed at least half the lesson. I found that the learning of each category was affected in different ways.

The first category of students struggled to follow the lesson at the beginning but was able to better engage with the concepts taught as the lesson progressed because of the examples provided in class (SFOG03:9). However, there were still some gaps in their understanding by the end of the lesson. They benefitted from the theory lesson because they were able to "solve at least half of the tasks" (SFG03:9) during the practical lesson and "received assistance from friends and tutors" (PD19) to complete outstanding tasks.

On the other hand, the second category of latecomers, as expected, "struggled to follow the lesson" (SFG03:29) and hence were not able to engage with the concepts that were taught in class and confessed that they "were not able to complete any of the tasks (during the practical lesson) without the help of friends" (SFG03:39). Student's understanding in this category was similar to those students that completely missed the lesson. However, their approach towards their learning and engagement in computer programming differed greatly. Those students that completely missed the lesson did not show much interest in finding ways to catch up with work lost. However, those that were late for most of the lesson made an endeavour to "get help from friends" (SFG03:39) prior to the practical lesson. At a focus group meeting (SFG03:17) that occurred on the 21 March 2013, some students, that fell into the second category of late-coming, made the following remarks in terms of how it affected their understanding.

> *Student: I usually receive assistance from my friends and the tutors. We always meet on a Monday evening with some students that attended the lesson to catch up with the*

work lost. This is a very useful support structure which helps us to attempt most of the tasks during the practical lesson.

These students seemed to have more enthusiasm and desire to want to catch up with the work missed, unlike the category of students that totally missed their lesson.

5.2.4.4 Students that attended the theory lesson

The majority of the students that attended the theory lesson were punctual because they realised its importance, which was confirmed by the following comments solicited by students through the electronic questionnaire (EQ13, SUR01).

Student1: The theory lesson is the best for me. It is where I learn the most.
Student2: The theory lesson helps us very much
Student3: I like the theory lesson. With the extra period we are now learning more

Students found the theory lesson important because it contributed to their "understating of concepts" (EQ13). These students indicated that they "made sure to attend the theory lesson" (EQ13) because it helped them to be productive in solving tasks in the laboratory. Despite attending the entire lesson, many students still had gaps in their knowledge, as is evident from the excerpt taken from a focus group meeting (SFG04:7) on the 21 March 2013.

Lecturer: How frequently do you miss a theory lesson?
Student1: Never
Student2: I have not missed a lesson so far

Lecturer: Do you understand all the concepts taught during the theory lesson
Student1: Not all.
Student2: Your explanations are good but some of the concepts are difficult to understand.

One reason for students having gaps in their knowledge arises out of their fear to ask questions in class, an observation which is discussed further in the next section. Other contributing factors for their lack of understanding revolved around their attention and focus during the lesson which is evident from comments made at the first focus group interview (SFG05:1) on 21 March 2013.

Lecturer: Are you able to concentrate during the theory lesson?

Student1: The (theory) *lesson is interesting, but sometimes it is hard to concentrate for the whole period.*

Student2: No. it is hard to focus after about forty minutes.

Comments solicited from student 1 and 2 suggest that they are not able to focus and concentrate for the full duration of the ninety minute theory lesson. All lessons were ninety minutes long and there was a need for me to utilise the full duration of the lesson in order to complete the allocated syllabus. The tough task was to ensure that the syllabus was completed whilst students understood the concepts taught. The pressure of having to complete all the content for one week required me as the lecturer to proceed at a brisk pace.

Upon reflection, it became evident that there were a few factors that influenced student understand in their learning. As a lecturer, I was challenged to complete the syllabus within a specified period of time. On the other hand, the students were also challenged to concentrate for the full duration of the theory lesson. Furthermore, I observed that students were not in the habit of asking questions in class which also affected their understanding.

5.2.4.5 Students afraid to ask questions

During the theory lesson the lecturer was the active participant teaching concepts and the students were passive recipients. Whilst the situation prevailed with students being passive, I always attempted to ask probing questions to students to create interactive discussions and to obtain feedback regarding student understanding. An excerpt from a typical lesson in class is illustrated.

Lecturer: Today we learnt about getting input from the keyboard. What is the package required in order to get input from the keyboard?
Student1: Scanner

Lecturer: Good try, however, that is the class not the package. Any other answers.
(Silence for 15 seconds)
Student2: import

Lecturer: You closer, the answer is found in the same line as the import statement
Student1: (raises his hand to answer the question)

Lecturer: I need other students to also try. It seems like the same students always want to answer the questions. (lecturer waits for a response from other students)
(More silence for about 10 seconds)
Lecturer: What is the answer Student1
Student1: util

Lecturer: Well done.
Lecturer: Student3, did you know the answer?
Student3: Yes, but I was afraid my answer was wrong

Lecturer: How many of you knew the answer?
(15 students raised their hands)

This excerpt illustrates the difficulties I had in attempting to create an interactive environment. A tension occurred between the subject (student) and the rule (student asking questions in class). The student's reluctance to answer questions was a common occurrence that occurred during the theory lesson. I found that approximately fifteen students consistently took the initiative to answer questions. At the first focus group meeting (SFG08:3) students were asked why they were afraid to ask questions during the theory lesson and the following responses were outlined in the excerpt.

Student1: Well, students will laugh at me if my answer is wrong
Student2: Other students will find the answers silly or make some funny comment
Student3: I am not happy speaking in big groups
Student4: I am scared to ask questions

Lecturer: Why are you scared to ask questions?
Student4: They (referring to the students) *will just laugh*

Lecturer: So, what will you do if you don't understand any concepts that are taught in class
Student1: I will get answers from my friends
Student2: I will do the same, sometimes I will ask the tutor
(student 3 and 4 agrees)

Lecturer: Do you ask your friends for answers immediately after the lesson

Student1: Sometimes I do, other times I forget

Student2: I mostly forget

Student3: I ask my friends in the lab

Student4: I ask the tutors

It seems to be the norm amongst students not to ask questions in class which was verified with other lecturers in this department. Students seem to be content having gaps in their knowledge rather than seeking immediate clarification from the lecturer. In many cases these students did not seek clarification from other sources like friends or tutors until the practical lesson, which may have been too late since they may have forgotten the context of their problems. Another tension occurred between the relationship of the student (subject) and their ability to understand concepts taught in the theory lesson (object). As a result, tutors were constantly engaged in answering questions on concepts that were already taught during the theory lesson.

Students' were unwilling to verbally answer questions in class and an attempt was made to address this issue. I requested students to write down questions on a piece of paper and to pass this down to me if they were afraid to ask questions aloud in class. In the two weeks that followed, I received two questions on paper, one of which I thought was of great importance. During my lesson, I used a term that students were unfamiliar with and none of the students questioned the term in class, apart for the question on paper. Having answered the question, I believed that this system had great potential. Unfortunately, as the weeks went by, students stopped asking questions on paper. From the first focused group meeting (SFG09:3) students made the following suggestions why this system did not work.

Student1: I had a question but did not have paper to write on

Student2: In my case, by the time I finished writing my question, you already started explaining something else

Student3: It is easy to speak English, but writing (in English) *takes longer and can be difficult sometimes.*

Student4: I cannot express myself very well on paper

Upon reflection, there are a few aspects of learning that can be assumed from the student engagement in this activity system. Firstly, students were content to be passive recipients of knowledge in a large classroom environment. They accepted and developed a mind-set of acceptance rather than one of critical thinking and questioning. Outside of the class, very few students indicated that they took the initiative to use the textbook or the internet to bridge the gaps in their knowledge to improve their learning in computer programming.

Secondly, it seems that students' were not confident enough to ask questions in a large classroom environment, an issue corroborated by Lipinge (2013). They felt that they would be ridiculed by other students causing embarrassment and would be judged by their fellow peers and frowned upon should they ask inappropriate questions.

Thirdly, and perhaps most importantly, language seems to be a barrier in some students learning as noted by the comments made by Student 4. These students were receiving instruction in their second language which could have negatively affected their understanding. Pillay and Jugoo (2005b) concluded that students who receive instruction in their mother tongue produce better results than those who were learning in a second language. These results were corroborated by Chumra (1998), however a study by Byrne and Lyons (2001) refuted these findings.

5.2.4.6 Students lack of the textbook

The following diary entry (PD16) was made on the 25 March 2013:

> *Only 15 students out of 120 had the textbook after the first term*

Students were expected to purchase the prescribed textbook as a compulsory resource for this subject in order to reinforce concepts taught in class, revise through the examples and work through the exercises to improve their understanding and hence learning in computer programming. However, only five students had the book during the first week of the term. By the end of the first term this number increased to 15. In total only half of the class had the textbook towards the end of the year. In previous years the majority of the students had the textbook because they were able to purchase it from the university book store on their account. However, during the course of this study the situation had changed and students were required to purchase it.

A tension occurred in this activity system between the subject (student) and the rule (student not purchasing the prescribed textbook). A further tension occurred with the prescribed textbook (instrument) since it was an American based book that contained units such as dollars ($), feet and pounds with which students were unfamiliar with. Students had difficulties working with tasks that contained such units. This book was prescribed since I had not found any local books that were able to satisfy the requirements of this course and that contained rich resources to enhance the teaching of the subject, as was provided by the prescribed textbook. The following diary entry (PD02) was made on the 8 February 2013:

> *The textbook prescribed this year* (2013) *contained many* (lecturer) *resources, such as: online test bank, PowerPoint presentations, solutions to exercises and tasks.*

Furthermore, this text book contained tasks that were more commercial in nature rather than being scientific like most computer programming textbooks. This was an advantage since the students using the text book did not have a strong mathematics and science background. Students initially found it a challenge to solve tasks using the American based units since they were not accustomed to using such units. I did not view this as a serious challenge since the focus was on the solving of the tasks. Although these students were initially distracted, they eventually moved beyond the unit in the tasks and focused on the methods of solving the tasks.

Many lessons can be learnt from this activity system. Firstly, students come from a historically disadvantaged background. Consequently, they not have the money to purchase textbooks. As a result, I was not able to utilise this resource as a teaching reference during my lessons. Notes and materials needed to be created during the teaching process which added to the difficulties in teaching these students. More importantly, with the lack of the textbook as a resource, the students' difficulties were compounded when concepts were not understood in class. Despite these challenges, there was no indication that students made use of the internet or the library to address the gaps in their knowledge. Furthermore, they made no effort to consult with their lecturer to clarify any problems that they experienced. However, some students "created their own peer group support" (SFG03:17) structures amongst themselves as a means to address the problems they faced. It would seem that these students were proactive in finding solutions and bridging the gaps in their learning while others made no attempt. As a result, the need for supporting materials became more significant to help these students to pass this subject.

Secondly, whilst some of the students purchased the textbook, I did not observe them using it as a resource during the practical lesson. The following diary entry (PD16) was made on the 25 March 2013:

Most of the students that had the textbook, indicated that they do not make use of it at home. They said: It is not so easy to read.

It seems that these second language students were not attracted to reading in English.

5.2.4.7 Too many concepts taught in one lesson by the lecturer

Students attended a single theory lesson at the beginning of the week. All the concepts needed for each of the three practical lessons were taught in the one theory lesson. The following comments were made by students using the electronic questionnaire (EQ11) with regards to the theory lesson:

Student1: I am getting confused. You teaching us too many concepts in one lesson
Student2:We need more examples
Student3: By the time I get to the last practical period, I forget what was taught in the theory period
Student4: It gets confusing when there are too many new concepts taught. We need another theory period

Students complained that too many concepts were taught in one theory lesson at the beginning of the week. They had forgotten concepts taught earlier in the week, and which were required for the third practical lesson that took place at the end of the week.

Based on all these comments a tension between the lecturer (subject) and the student (community) had developed in this activity system. However, from the lecturer's perspective, a number of concepts had to be taught in one lesson in order to complete the syllabus. This resulted in students having difficulties in comprehending all the concepts and contributed to their lack of understanding.

With use of an action research methodology, improvements to the activity system were possible. I was able to obtain the assistance of the timetabling committee within the department to transform the activity system. This led to the introduction of an innovation in this activity system, that is, an extra theory period was introduced at 11am on a Thursday. After the first theory lesson on a Monday morning, each group had two practical lessons which were followed by another theory lesson and finally the third practical lesson. In this way fewer concepts were taught in each theory lesson. More examples were used during this lesson to illustrate the abstract concepts. Adding another theory lesson increased my workload as a lecturer, however, it was worth the experiment in order to determine the effect of such an intervention. Students made the following comments using the electronic questionnaire (EQ14) about the extra lesson:

> *Student1: This is much better.*
> *Student2: You do more examples. This way we understand better.*
> *Student3: The examples are the best. I'm starting to enjoy the subject now*

Comments from students regarding the introduction of the extra-lesson were extremely positive as seen by the comments made by Student 1, 2 and 3.

Upon reflection, there are several aspects of learning that can be assumed from the students' engagement in this activity system. Firstly, with the introduction of the extra period, fewer concepts were taught during the first lesson. As a result more time was dedicated for examples to emphasise and reinforce the concepts taught during the lesson which helped to improve the students understanding. It seemed that those that understood the concepts well in class started to take a liking to this subject, as outlined by the comments made by Student 3, hence improving their confidence and motivation levels to solve their tasks. The one challenge created with the introduction of the extra lesson, implied that the students receive more contact time for this subject than was prescribed. However, with the benefits that the extra lesson offers, I would be prepared to have it as an unofficial lesson.

Secondly, I observed and reflected that the theory lesson was better attended on a Thursday compared to the Monday as illustrated by the diary entry (PD14) made on the 14 March 2013.

> *For the first time, there was close to full attendance. The timing of the* (Monday morning) *theory lesson needs to be changed next year.*

The 8am lesson on a Monday morning had a negative impact to a small group of about twenty students' that seemed to consistently miss the lesson whilst approximately fifteen students usually pitched late for class. I believe that a lesson of such importance, which impacted greatly on the practical lessons, should not be timetabled as the first lesson on a Monday morning because of erratic student attendance.

5.2.5 Conclusion: theory lesson activity system

A number of tensions surfaced in the theory lesson activity systems from my perspective as a lecturer and the students' point of view.

There were two issues that were identified with my engagement in this activity system. Firstly, with the lack of a projector to demonstrate concepts in class, better planning was required to improve student understanding of concepts. This was achieved through the graphical use of examples by making use of different coloured markers to highlight and emphasise the different segments of a computer program. This helped to improve student understanding of concepts taught.

Secondly, students became confused when they were exposed to too many concepts in the one theory lesson. However, an attempt to improve the student engagement occurred resulting in the introduction of an extra theory lesson. This helped to reduce the number of concepts taught and also helped to increase the number of examples used in class, thereby improving understanding.

Students received examples which seemed to assist them in their engagement and learning of computer programming. This was further corroborated with the following diary entry (PD08) was made on the 18 February 2013.

> *Students learn techniques well through the use of examples*

From the students' perspective, two issues were also identified with their engagement in this activity system. Firstly, most students were content to be recipients of knowledge within a large classroom environment. However, they formed peer groups in an attempt to assist each other to bridge the gaps in knowledge. A small group of students showed a total lack of interest in wanting to improve their grades in computer programming. One possible reason could relate to students making a poor choice in their selection of this course. Secondly, these students were not motivated to uplift themselves by making use of available resources. They were unable to plan and organise themselves frequently, to attend the 8am theory lesson which resulted in their inability to solve their tasks in the practical lesson, possibly producing a decrease in their confidence levels and hence loss of motivation.

In view of the many challenges students experienced in the theory lesson environment, a support activity system was necessitated to help them enhance the understanding in this subject. This activity system is described in detail in the next two chapters. Having described the theory lesson activity system, the next section describes the practical lesson activity system and highlights the issues that surfaced.

5.3 The practical lesson

Week 4 –Start of the practical lesson

Students were split into four groups for their practical lesson. During this lesson they were required to download a series of tasks from the LMS and to write computer programs to solve each task. The software JCreator was used to write the computer programs using the programming language called Java. Students were expected to work independently during this lesson to solve their tasks.

Two tutors were present during the practical lessons to provide assistance to those students who experienced difficulties in solving their tasks. At the end of the first action research cycle, during a focus group meeting on the 22 March 2013, tutors indicated that they were "constantly disturbed by those students that missed the theory lesson" (TFGI2). As a result other students were not able to receive required assistance. They also observed in the laboratory that some students copied solutions from their neighbours without any understanding (TFGI3). These students were satisfied to get their program to execute and produce the correct results without any proper understanding.

5.3.1 Presenting the practical activity system

The activity system that represents this aspect of the BLE is outlined in Figure 5.3.

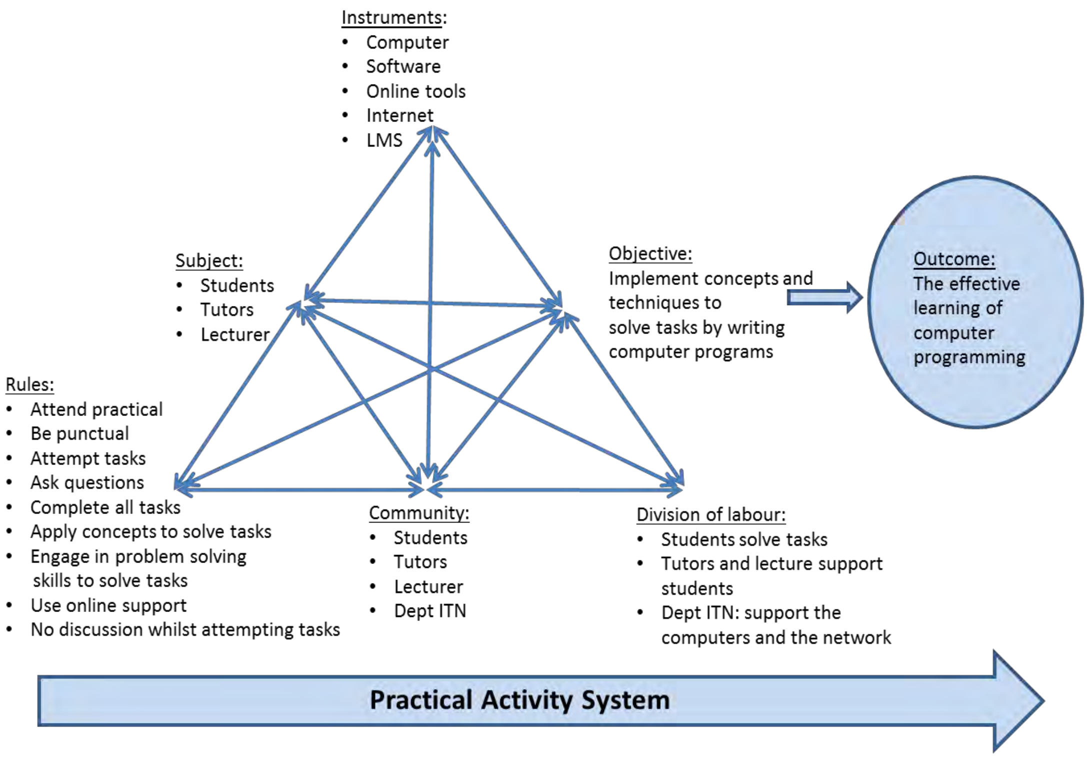

Figure 5.3: Practical lesson activity system

In this activity system students (subject) implement concepts and techniques by writing computer programs to solve tasks (object). This was achieved with the students being active participants in solving tasks assigned by the lecturer (subject) through the use of specialised software (instrument). In this activity system, the students now played an active role in terms of solving their tasks with the tutors (subjects) being passive facilitators that assisted the student when they experience difficulties. The department of ITN (community) was responsible for the maintenance of the computers, software and the network in the laboratory.

The practical lessons were compulsory for students to attend, however the effectiveness of these lessons was based on students' understanding and implementing the concepts taught during the theoretical lesson.

5.3.2 Change in the role of the tutor

One of the problems outlined in the theory lesson activity system concerned the breakdown in student understanding because of absenteeism and late coming causing these students to be unproductive during the practical lessons. Consequently, these students constantly required attention from the tutors with some of them copying solutions from their neighbours with no understanding. This resulted in the following tension within the practical lesson activity system. The tutors (subject) were unable to conduct their duties of helping all students (community) during the practical lesson resulting in their role of the tutor being changed (division of labour) from that of a facilitator to a teacher as outlined in the excerpt taken from a focus group meeting (TFG02:14) with the tutors on the 22 March 2013.

Tutor1: I had to stand in front of the class to teach parameters to about 5 students that missed the theory lessons.

Tutor2: Those students that miss the theory lesson disturbed us a lot so it is easier to explain concepts from the front of the class and teach all of them

Tutor1: I enjoy standing in front and teaching the students

With my presence in groups B and D the tutors did not teach, but spent long periods of time with certain individuals that missed the theory lesson. However, in the second laboratory, tutors assumed the role of a teacher. They believed that it was easier to assist all those that had similar problems by addressing the issue once by teaching in front of the class.

5.3.3 Analysis

Upon reflection, the following assumptions can be made about the engagement that occurred in the one practical laboratory. These tutors seemed to enjoy standing in front of the class and teaching concepts to students as outlined by the comments made by Tutor 1 and Tutor 2. It seemed to give them a sense of power and authority which they possible enjoyed. However, without having proper training and experience they were not aware of the implications of their actions resulting in possible disturbances to other students who were busy solving their tasks. One possible way for them to address this issue was to isolate the students around one computer and to demonstrate the concepts to them. While this was a possible solution in assisting these students, it did not address the cause of this problem, that is, students missed the theory lesson which produced a lack of understanding in solving tasks in the practical lesson.

In order to address this and the many other tensions that were prevalent in the theory activity systems, support materials were created in an attempt to assist students with their challenges in computer programming. Many authors have successfully used support materials in the form of videos, animations, examples and so on to improve the learning of computer programming (Boyle et al., 2003a; Zahnet al., 2010; Goeser et al., 2012; Vincenti et al., 2013; Matthews, 2014).

5.3.4 Reflective moments on the practical lesson

As part of my reflection, the following question arose: What assistance can be provided to students that missed the theory lesson? An attempt was made to resolve this issue with the introduction of supplementary notes that were hosted on the Learning Management System. However, further measures were still required. A further challenge had developed that required attention: How can a student obtain immediate assistance in solving a task in the laboratory, especially if the tutors were busy assisting other students? These questions required actions in order to improve the challenges that were experienced in this BLE.

5.4 Key Issues to address

The theory and practical activity systems have been presented which highlighted a number of key issues that required attention. These are outlined in Table 8.

Table 8: Key issues in this study

	Number	Key Issue
	#1	How can I assist students that miss or are late for the theory lesson, especially since most of them don't have the prescribed textbook?
	#2	How can I assist students that are afraid to ask questions in the theory lesson, because of the large class environment?
	#3	How can students evaluate their gaps in knowledge, especially if they don't ask questions in class?
	#4	How can fewer concepts be taught during the theory lesson, yet still complete the syllabus? An extra theory lesson was introduced and was discussed and resolved earlier in this chapter.
	#5	How can students receive assistance immediately in the laboratory, especially when the tutors are busy assisting others
	#6	How can students receive assistance in small groups outside of the formal classes?
	#7	How can students become active learners, especially if they prefer to receive knowledge rather than produce knowledge?

5.5 Conclusion

The theory and the practical activity systems were introduced in this chapter. A presentation of the lecturer and student engagement was outlined. In the theory lesson activity system, the techniques used by the lecturer are described and included the use of demonstrations using a projector, the implementation of examples and the use of different coloured markers, all of which enhanced the learning process. Within this environment, students experienced many challenges that affected their learning in the form of absenteeism, late coming, being afraid to ask questions and not having the textbook. Each of these factors was exposed and the challenges were highlighted. An intervention was needed to address these issues and to improve the learning environment. This resulted in obtaining a list of key issues that required urgent attention.

The findings in this chapter created a context within which a number of challenges were identified for special attention. It helped to launch the next chapter in which an action research methodology was applied to each of these challenges with an attempt to improve the learning environment. This resulted in the creation of a support facility, hence producing a blended learning environment. This aspect of support within the BLE is discussed in detail in the next chapter.

CHAPTER SIX

6 Findings – Part 2: Support activity system

6.1 Introduction

The previous chapter examined the theory and practical environments in the BLE and explored the engagement by the lecturer and student. In doing so, key issues in the form of challenges were identified.

This chapter attempts to address each of these challenges by creating the following tools and support structures to enhance the learning of students: supplementary notes, online tests, small group discussions, mentors, blog, videos, animations and *Google* to conduct research in solving tasks independently. Each of these tools and support structures are explained as a unit of activity using an Activity Theory diagram. Engagement by the lecturer and student within this activity system is explained with an analysis of the findings.

6.2 Supplementary notes for greater emphasis

Week 3: Started creating supplementary notes on PowerPoint to serve as summaries to those students that missed the theory lesson. Notes were hosted on the LMS.

6.2.1 Setting

The use of supplementary notes was introduced in response to key issue #1: How can I assist students that miss or are late for the theory lesson?

Supplementary notes can be used in the teaching and learning environment to supplement work conducted in class. This helps the student refer to an additional resource outside the formal class in order to reinforce concepts that were taught. In some cases, the prescribed textbook may be regarded as the additional resource to supplement work conducted in class, whilst in other cases it could be summaries in the form of supplementary notes. These notes can also benefit those students that miss the lesson.

6.2.2 *Presenting the activity system*

The supplementary notes presented were in the form of summaries. These notes were created to mainly assist those students that missed the theory lesson. Figure 6.1 outlines the support activity system for this tool.

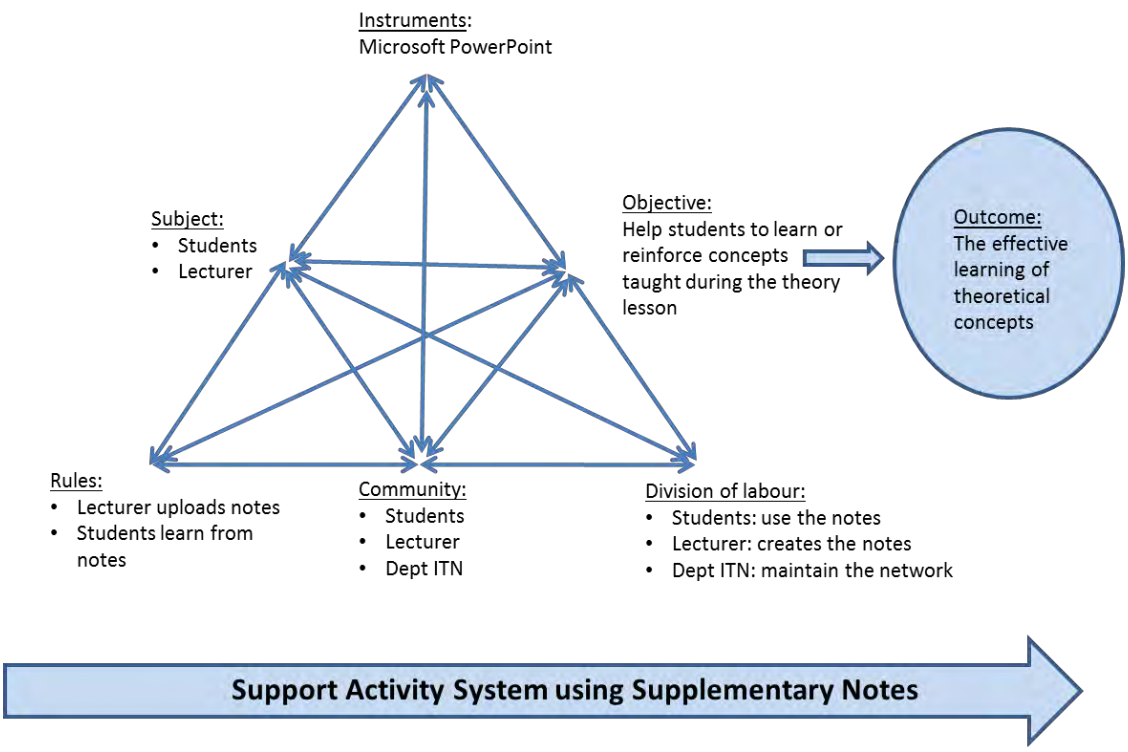

Figure 6.1: Support activity system using lecturer notes

In this activity system, the lecturer (subject) created the supplementary notes using *Microsoft PowerPoint* (instrument) who then uploaded them to the LMS (rule). Students were expected to access the notes on the LMS (rule) in order to learn or reinforce concepts taught during the theory lesson (objective). The department of ITN (community) was responsible for maintaining the computer networks which hosted the notes for students to access.

The engagement that occurred between the lecturer and the student will be described and will highlight the transformation of these notes based on the feedback received from the students.

6.2.3 *Engagement*

As stated previously, the majority of the students did not have the textbook. The following diary entry (PD06) was made on 18 February 2013.

> *Only 10 students out of 120 had the prescribed textbook after the first month of lectures. If a student did not have the textbook and misses a theory lesson, they will*

need to find other resources like the internet or their friends to catch up with work missed.

There was a need for the development of supplementary notes. The lifecycle of these notes depicting all the action and reflective moments undertaken during the transformation process is illustrated in Figure 6.2.

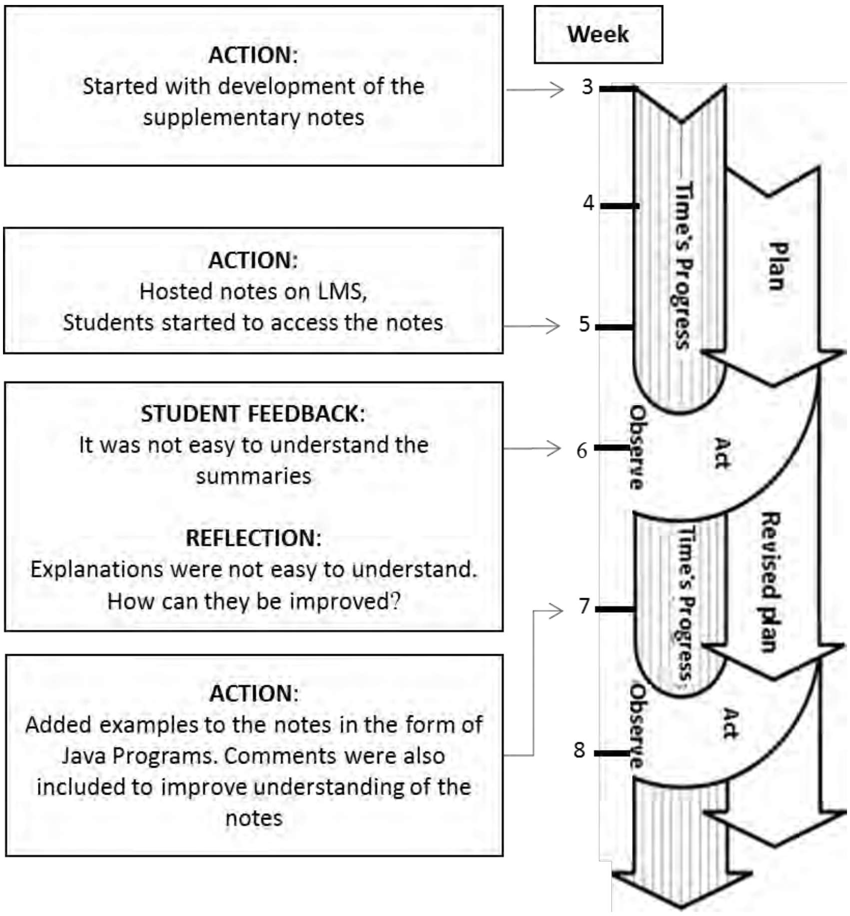

Figure 6.2: Action research transformation of the supplementary Notes

Microsoft PowerPoint was used to create the supplementary notes. A section in computer programming was broken up into approximately three topics, with each topic being represented using a different *PowerPoint* presentation. The first slide in each presentation contained the title of the topic and all subsequent slides summarised the notes on the topic. Each presentation contained at most ten slides in order to facilitate easier reading. After developing the notes for a particular section, they were uploaded to the LMS. The statistics feature was enabled in order to monitor the students' usage of the notes. A sample of a particular slide from the supplementary notes is illustrated in Figure 6.3.

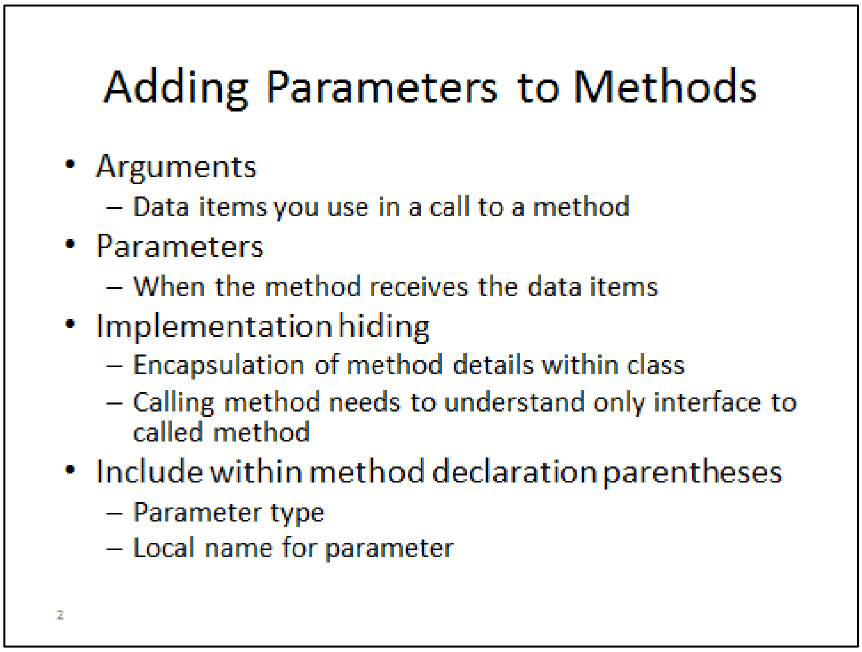

Figure 6.3: Sample slide used in the supplementary notes

These notes were simple summaries of what occurred during the theory lesson and were quickly designed (by me as the lecturer) to help students' bridge the gap for the lessons they missed. The supplementary notes were provided for each section that was taught in the theory lesson.

For the first section that was summarised, statistics obtained from the LMS (see Appendix 9, BB1, p. 245) showed that 80 students downloaded and used the first set of supplementary notes, 50 students used the second and only 20 students used the third. There was a definite decline in the students' usage of these notes.

The following comments about the notes were made on the electronic questionnaire (EQ01) by students who missed the theory lesson:

Student1: Add examples to the notes

Student2: It was not so easy to read and understand on my own. I could not understand all the notes.

Student3: I don't like reading too much and there were no examples

Student4: The notes did not work for me. I don't like reading something because it makes me sleepy. I prefer watching something.

The following comments (EQ02) were made by students that attended the theory lesson:

Student5: Reading the notes helped me to better understand what you taught us in class. For me it was useful.
Student6: The notes helped me to understand your lesson. It can be made better by adding some examples.

A tension developed between the student (subject) and their use of the notes (rule) since many students did not use this resource. The general feedback obtained suggested that the notes lacked examples, as outlined comments made by Student 1 and Student 3 and corroborated by Student 6. Having reflected on the feedback obtained from Student 5 and 6, I realised that students that attended the theory lesson were able to use the supplementary notes to reinforce explanations taught during the theory lesson. Some students hinted about their preference for visual material compared to reading material.

The existing notes were modified during the action research cycle and a second version was developed to include examples and more explanations of the concepts. The supplementary notes included an example of a complete computer program with detailed comments to further explain definitions and concepts. This enabled students to use the comments to understand the programming code. An illustration of how an example was introduced into the supplementary notes, using a computer program, is depicted in Figure 6.4.

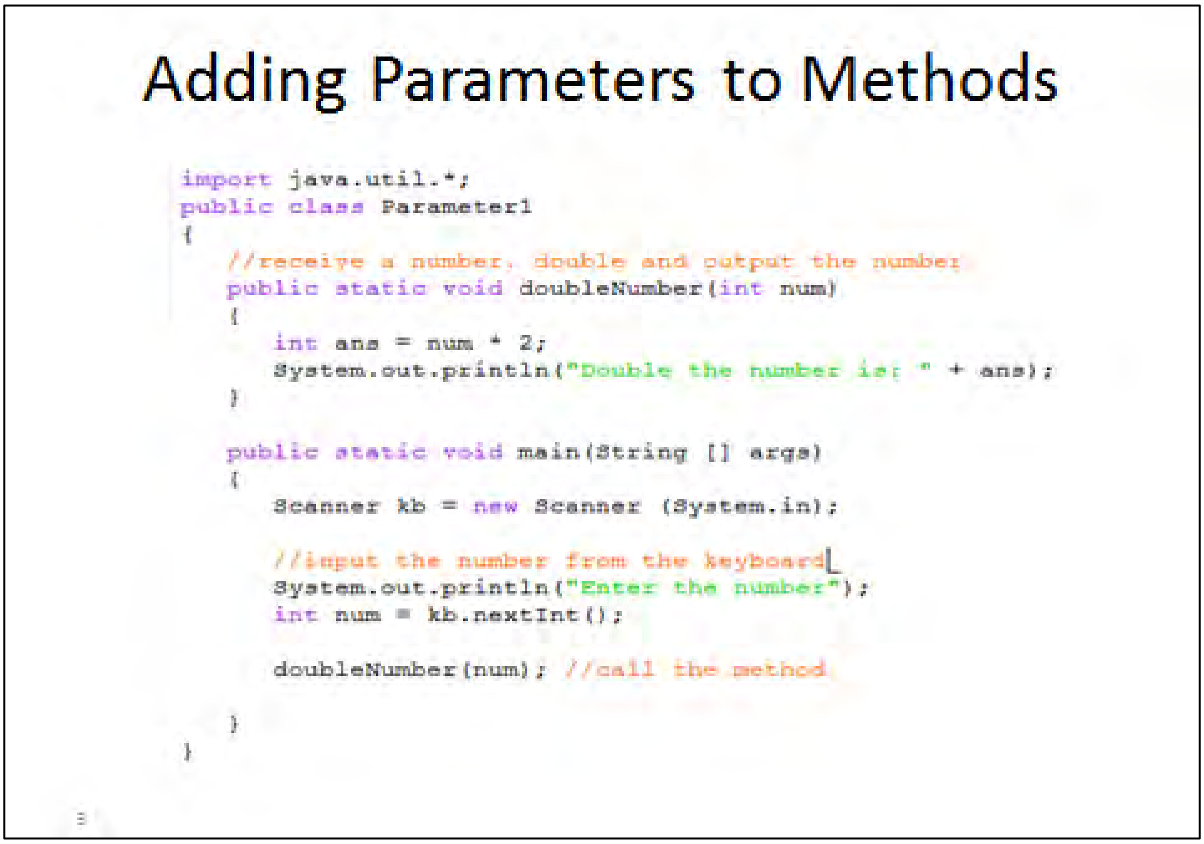

Figure 6.4: Sample slide containing an example using a Java program

Students made the following comments about the revised notes (EQ05, SUR03):

Student: The notes with the examples are much better. Thank you.

Student: Improvement has been noticed in the notes

Student: The notes are now easier to read

Positive comments were received from students after using the second version of the supplementary notes. Further comments were received at a focus group meeting (SFG12:11) on 21 March 2013.

Lecturer: Was the upgraded set of notes helpful?

Student1: I was able to attempt the questions you gave us (in the practical lesson) *even though I missed the theory lesson. The examples in the notes were a big improvement and helped me a lot.*

Student2: It was ok, the examples with the comments helped, but I still had a few problems.

Lecturer: What problems?

Student2: In the theory lecture you explain the concepts very nicely and it is easy to understand. Now I had to figure out everything on my own. Your examples in the notes did help, but I realised that I should not miss another theory class.

Lecturer: Do you find it easier to learn through the use of examples?
Student6: Yes, definitely. Most of us like to work with examples.
Lecturer: What is it about examples that make learning easier?
Student5: Examples help us to see how you get to the solution in a step by step way. Seeing is believing.

The inclusion of examples and comments into the notes seemed to enhance students' engagement and understanding of concepts since at least one third of the students (see Appendix 9, BB2, p. 245) consistently downloaded all subsequent notes to reinforce concepts taught in class or to support their learning when they missed the theory lesson.

6.2.4 Analysis

The following assumptions can be made regarding the students engagement in utilising the supplementary notes. For students that missed the theory lesson, the summaries I provided as the lecturer were insufficient for them to grasp the concepts that were required to solve the tasks during the practical lesson. I realised that the first set of supplementary notes was a quick way of creating materials, in an attempt to help those students that missed the theory lesson, bearing in mind that the students did not possess textbooks. With the lecturer's engagement of the supplementary notes, more thought and effort was required in producing notes that enhanced engagement. Kistow (2011, p. 124) notes that students "prefer that the materials offer more explanations" which was consistent with what the students in this study requested. Simply having a tool on the LMS for students to access was insufficient if the tool did not positively impact the students learning.

A possible challenge that may arise in producing a well-constructed set of supplementary notes is that students could skip attending the theory lesson, thinking that it was sufficient to only read the notes. Despite students appreciating the supplementary notes with examples, the response of one student suggests that students realised the importance of the theory lesson (EQ03, SUR01): "I realised that I should not miss another theory class"

Comments solicited from students suggested that there was a preference for the use of examples in their learning process - a comment that was also highlighted during the theory lesson activity system. Students found the step-by-step working in an example to be an effective means of learning since it moved from the abstract to the concrete, corroborated by the comment: “most of us like to work with examples” (EQ04, SUR03).

I found that many students were not naturally attracted to the reading of notes and there was a comment made that they “felt sleepy reading” (EQ05) this type of content. An informal discussion with a mature part-time student on the issue of students and reading resulted in the following diary entry (PD07) made on the 18 February 2013:

> *You are an academic, you cannot compare your children with the students that you are teaching. Most of your students come from a background where no reading takes place at home and they are not encouraged to read. Nobody forces them to read. They have more important duties to carry out at home. My child goes to a school that encourages them to do 10 minutes of reading every day. If I don’t ensure that he reads then he is not going to read. Most parents do not realise the importance of reading.*

These comments shed some light on why students may not be attracted to reading. Based on the comments, it seems that many students did not come from a background that encouraged and promoted reading. Ivala and Kioko (2013) suggested that language barriers may effect students who are learning in a second language. This may explain why only one third of the students consistently accessed notes that required reading.

In some instances students that missed the theory lesson did not make much of an effort to use the notes as a means to learn the concepts they missed. Consequently, they were unproductive in the practical lesson and some of them copied solutions with no understanding. It would seem that these students lacked the motivation to persevere in class. There was no urgency amongst this small group of students to want to improve themselves in this subject. The following diary entry (PD15) was made on the 18 March 2013 by a student repeating this subject.

Because of my poor planning skills and lack of commitment towards my work I was not able to pass three out of four subjects in my first year of study. This year, having adjusted to university life and having a better plan and being more motivated towards my studies, so far I have distinctions in all of my tests in this subject.

Comments from this student suggest that planning and commitment were two important ingredients for student success. It seems that some students in this study had challenges coping and adjusting to their first year at university and had poor organisational skills. The following diary entry (PD13) was made on the 13 March 2013:

Having checked with other lecturers, the students that are performing badly in this subject are also performing poorly in their other subjects

These students not only struggled in the subject Technical Programming 1, but also with other subjects that they registered for. It is possible that adapting and acclimatising to university life seemed to be a challenge for these students (Sheard, Lowe, Nicholson, & Ceddia, 2003; Mudhovozi, 2012).

It is interesting to find that the notes were designed for those students that missed the theory lesson but seemed to benefit the students that attended the theory lesson. These students were the main beneficiaries of the notes and seemed to be active learners by attempting all their activities and utilising most of the supporting tools.

Finally, I feel students may not have been inspired to use the supplementary notes possibly because the presentation of the content was completely text-based. Djenic et al. (2011) successfully used online notes using interactive and animated multimedia. Perhaps these features need to be introduced to attract students to using this resource.

While engaging with the supplementary notes, many reflective moments occurred. Each of these moments will be described.

6.2.5 Reflective moments on the supplementary notes

The *PowerPoint* lecture notes were created as a means to assist students with work covered during the theory lesson. However, comments elicited via the electronic questionnaire suggested that some students preferred the use of "visual material" (PD09). Having attempted to address the one challenge, the following key issue arose:

Table 9: Key issues added

	#8	How can I assist students that have a visual learning style to better engage in the learning of computer programming? What visual tools can be used to improve the student engagement in computer programming?

Student and lecturer engagement with the supplementary notes was outlined in detail. Focus will now turn to the introduction of another support structure in the form of online tests.

6.3 Reinforcing and evaluating through online tests

Week 6: Started using online tests using the online environment

6.3.1 Setting

The use of online testing was introduced in response to the key issue #3: How can students evaluate their gaps in knowledge, especially if they don't ask questions in class?

Online tests were used as a means to support students to learn the concepts taught during the theory lesson and to evaluate their understanding of these concepts. I was of the opinion that, if students understood the concepts taught, they had a better chance of applying them in completing their tasks.

6.3.2 Presenting the activity system

Figure 6.5 illustrates the support activity system that made use of online tests.

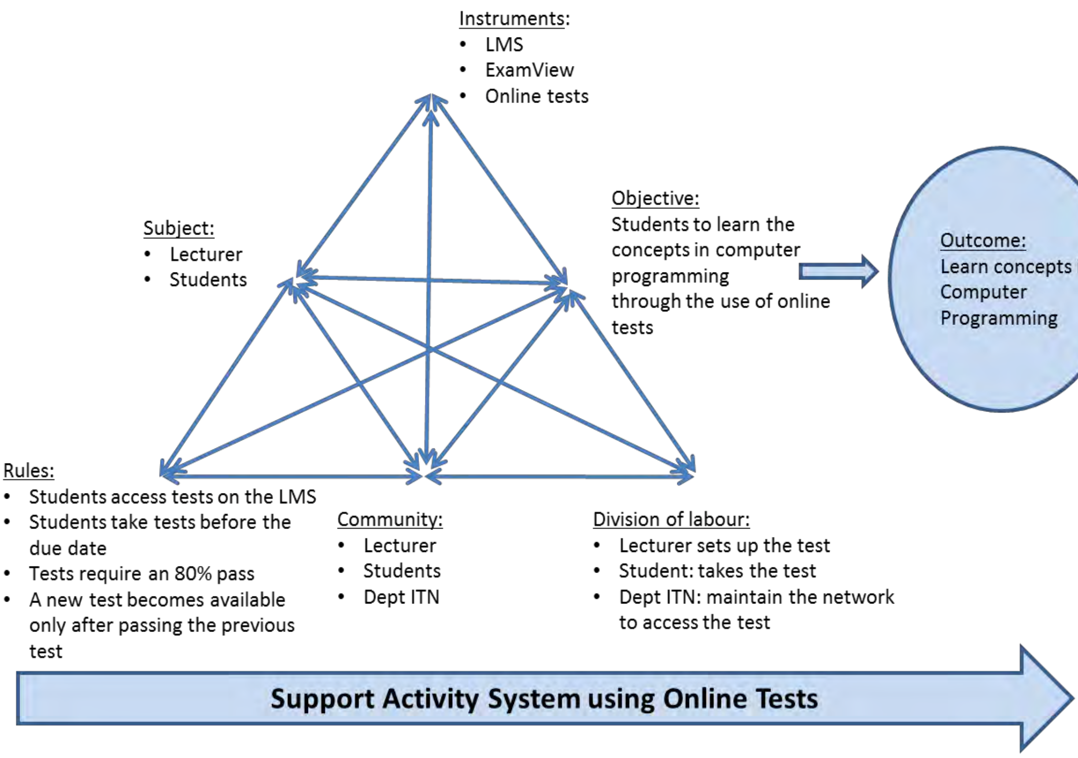

Figure 6.5: Support activity system using online tests

In this activity system, the lecturer (subject) created online tests (instrument) using the software *ExamView* (instrument) and uploaded them to the LMS (instrument). Students (subject) were required to login to the LMS and take the tests (rule). A pass mark of 80% was required to activate the next test (rule) to enable students to thoroughly learn concepts in computer programming (objective). The department of ITN (community) who were responsible for maintaining the university networks needed to ensure that students had access to the LMS.

6.3.3 Engagement

The online theory tests were administered to students in week 6 to enable them to reinforce definitions and concepts taught in the theory lesson. To achieve this task, *Blackboard* test banks, provided in the instructor's resource kit (IRK) of the prescribed textbook, was utilised. These tests served as a form of feedback to the students to reflect and evaluate their understanding of the definitions and concepts taught in the theory lesson. I realised that getting students to learn the definitions and understand the concepts did not guarantee that they will be able to solve the tasks given in the laboratory. However, I believed that it gave them a better chance of solving the tasks.

As the lecturer, I engaged with the test bank which contained questions on each chapter of the textbook. The software *ExamView* was used to configure and prepare the tests. Using this software I prepared a test by selecting twenty multiple choice questions pertaining to the section that was being taught in class. On completion, the test was exported into a format that was compatible with *Blackboard* and thereafter it was uploaded to the LMS. A setting on the LMS was activated to ensure that the questions were randomly displayed and the answers of each question were randomly placed each time the test was taken. To prevent students from rote learning, further configuration occurred to ensure that answers were not made available after a test was attempted. However, students were made aware of the questions that were incorrect after conducting the test. After configuring the test, a link was setup on *Blackboard* for students to access the test with a total of ten tests created. A snapshot of an online test is given in Appendix 8 (OT, p. 244).

There was no time restriction for each test and students were allowed to have multiple attempts in order to achieve the minimum pass requirement of 80%. Although I was aware that friends could help each other, I felt it would contribute to the students learning. Also, the random feature of generating questions proved to be useful since students could not memorise answers each time the test was taken and could not copy from each other.

While students were given one attempt of the test during class time, it was possible that students could fail the test. All subsequent attempts were conducted outside of the formal class time. The following reflection (PD11) was taken from my personal diary on 25 February 2013:

> *If students collaborate and pass the test, is it serving the purpose it is intended to serve, that is, for students to learn the theoretical concepts? In this case, I think some form of learning actually takes place, unless cheating occurs and one student writes the test for another in their absence.*

I believed that the online tests had great potential in helping students to learn concepts in computer programming and hence enhance their learning. The following comments were made the online tests (EQ14:5, SUR05):

Student: Test 5 is too difficult to pass
Student: I cannot get to the next test. Please make the pass mark to 50%

Similar sentiments were expressed at a focus group meeting (SFG11:1) that occurred on 21 March 2013, highlighting that some students found the online tests to be useful but others lost the motivation to continue.

Lecturer: Did you find the tests useful?
Student1: Definitely, since it helped me understand the theory better
Student2: I'll be honest with you Sir, I did not find them useful because I got frustrated when I could not pass the third test and lost interest. I think the pass mark is too high. It should be 50% to pass, not 80%. Also what is the use of doing these tests if there are no marks going to the final mark.

Lecturer: (speaking to Student2) Did you benefit from passing the first two tests that you completed?
Student2: Yes I did (benefit) with the help of my friend. But when you keep failing a test you lose interest.

A tension arose in this activity system, which dealt with the students attitudes towards the online tests. Some students struggled to meet the minimum requirement of 80% in passing a test resulting in them getting frustrated and not completing all scheduled tests. Thus, the central activity system was affected by the external activity system as illustrated in Figure 6.6.

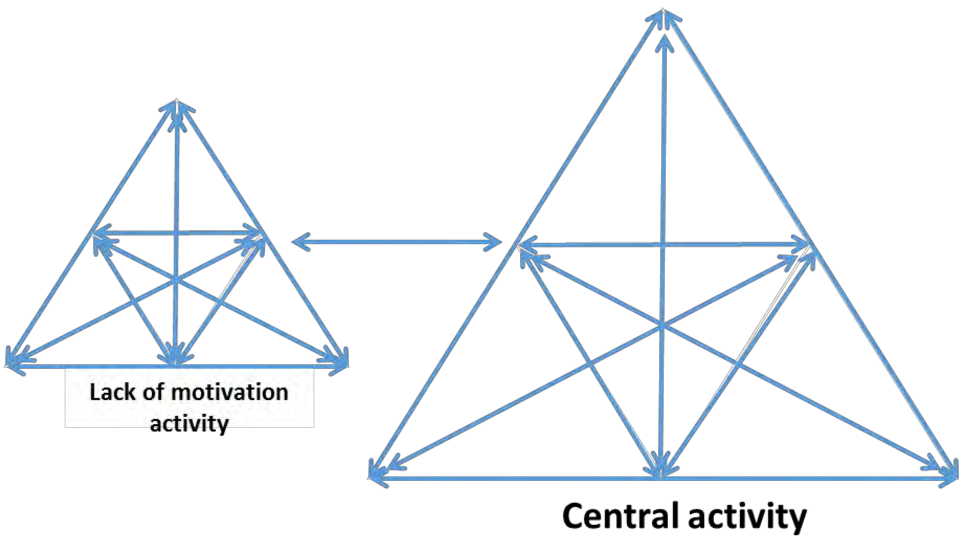

Figure 6.6: External activity system affecting the central activity system

The central activity in this system focused on the use of online tests in learning concepts in computer programming. However, an external tension had developed based on the students' motivation which negatively impacted on the central activity system. The following diary entry (PD2) was made on 15 May 2013:

> *After checking the Blackboard stats, I found that some students are not bothered to complete their online tests*

Statistics obtained from *Blackboard* at the end of the study (see Appendix 9, BB1, p. 245) indicate that only fifteen students attempted all ten tests. I found that thirty-one students passed test five but only fifteen students consistently passed all the tests from test six onwards. These figures suggest that the majority of the students struggled and lost interest after test number five which seemed difficult to pass.

6.3.4 Analysis

Upon reflection, there are a number of points that can be assumed from this activity system: Firstly, I realised that the pass mark of the online tests was too high which caused frustration amongst some students causing them to fail and hence losing their motivation to continue with a particular test. It seems that many students lost confidence in this way.

Secondly and perhaps more importantly, students realised that much effort was required in achieving above 80% in each test but the test marks did not contribute in any way towards their final mark, as outlined by the comments made by Student 2. Although the purpose of this activity system was to assist students and reinforce their learning of theoretical concepts, they were becoming frustrated in learning the concepts. Furthermore, from the last comment made by Student 2, which was corroborated by the tutors (TFGI1), I found that "some students obtained help from their friends to pass a test". During the reflection stage of the action research process, I expected this behaviour and believed it would contribute to the students learning of theoretical concepts.

Finally, I found that this form of testing adds value to the learning process, but based on the comments of Student 1 and Student 2 in the excerpt above, as well as comments given by the tutors (TFGI5), some adjustments were necessary for a more desirable effect in the future. Upon reflection, the following changes can be implemented: to reduce the pass mark closer to 70%. The answers need to be provided to allow the student to move on to the next test. A possible way of administering the online tests is by allowing the student three attempts in achieving the required pass mark. Thereafter, if the student obtains a subminimum of 50% in the test, answers should be displayed giving them the opportunity to learn. Thereafter a final attempt should be given to the student to pass the test. Failing which, the next test should become available. I believe that at least 5% of the marks obtained in these tests should contribute towards the students' final mark. In doing so, these tests become more formal and students will take them more seriously. Furthermore, extra time should be allocated during the practical lessons for students to complete these tests.

6.4 Encouraging collaboration through small group discussions

Week 13: Introduced discussion amongst students in the practical lesson

6.4.1 Setting

The use of small group discussions was introduced in response to key issue #5: How can students receive assistance immediately in the laboratory, especially when the tutors are busy assisting others in the laboratory?

Small group discussion in the form of collaboration can offer support to students in the learning process. Hadjerrouit (2008, p. 206) corroborates this point and is of the opinion that these "collaborative activities are more important to novice students entering the field of computer programming than the acquisition of higher-order thinking skills" Studies by McKinney and Denton (2006) and Gonzalez (2006) outlined that the use of collaboration in computer programming can lead to higher academic performance. Hadjerrouit (2008) also states that students are of the opinion that interactions with other students was important in the learning of computer programming. As a result, collaboration in the form of small groups was introduced as a support structure to assist students in their learning of computer programming.

6.4.2 Presenting the activity system

The lifecycle of the small group discussions depicting all the action and reflective moments that were undertaken during the transformation process is illustrated in Figure 6.7.

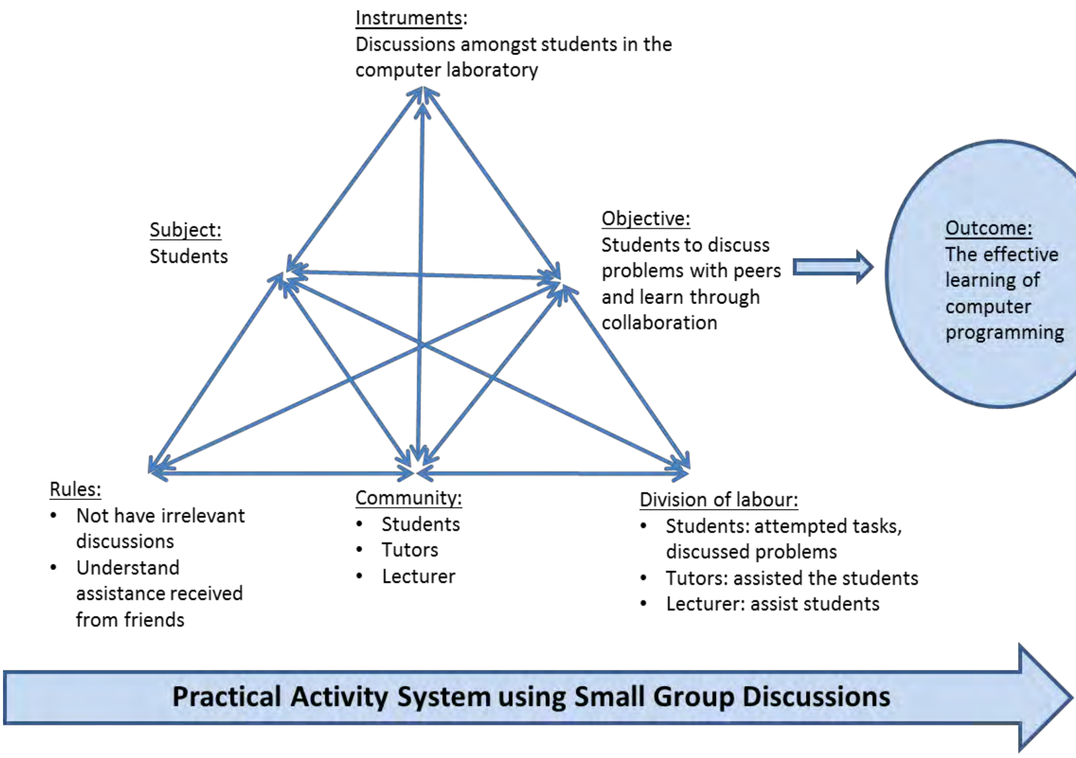

Figure 6.7: Activity system using small groups in the laboratory

In this activity system, students (subject) were allowed to interact with their peers if they experienced difficulties whilst solving tasks in the laboratory (object). Tutors (community) were also present to assist student but their roles included monitoring the discussions that occurred (division of labour). Students were expected to restrict their discussion to the tasks allocated in class (rule). It was envisaged that the student participation would take the form of answering questions and explaining techniques.

6.4.3 Engagement

The lifecycle of the small group discussions depicting all the action and reflective moments that were undertaken during the transformation process is illustrated in Figure 6.8.

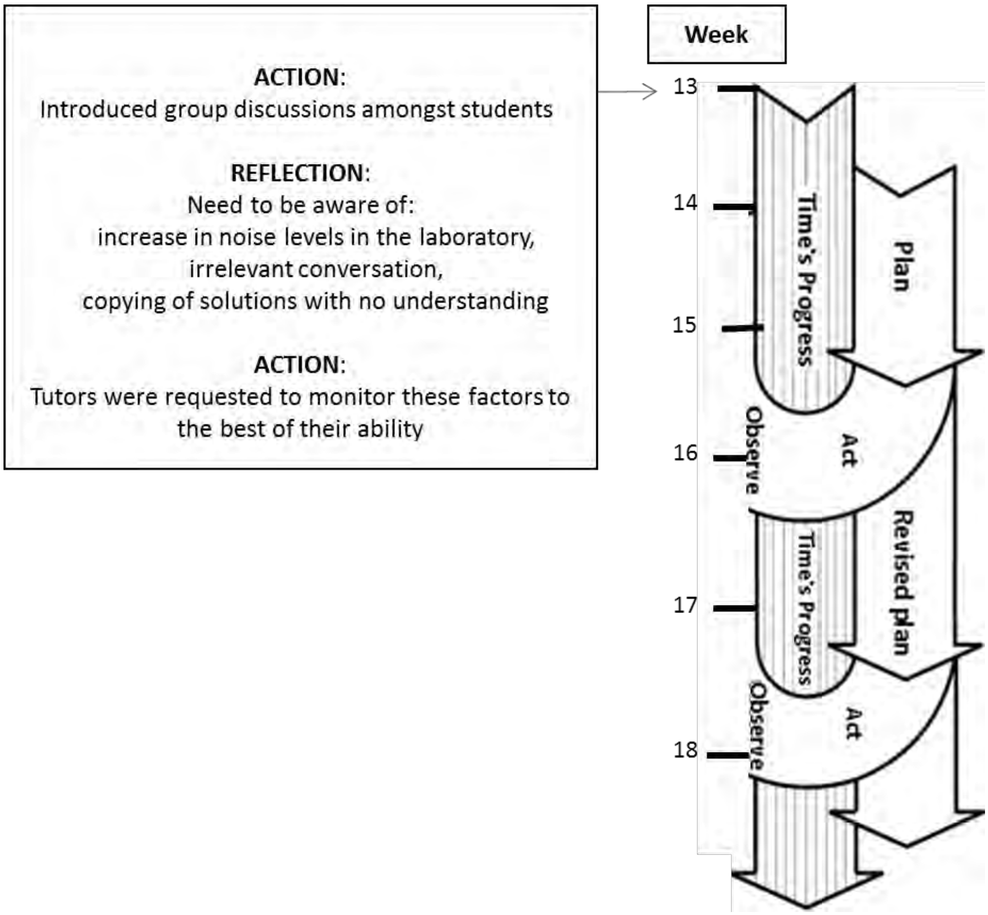

Figure 6.8: Small group discussions

Based on feedback obtained from students (SFG03:18), it seemed that learning occurred through collaboration with their peers. However, this type of support was not allowed during the practical lesson since students were encouraged to solve their tasks independently. Students were totally dependent on the tutors for assistance. However, as previously stated, I observed times when students were unable to obtain immediate assistance from the tutors because of them assisting other students. Comments solicited from the tutors indicated that "students that missed the theory lesson spent lots of time asking questions that were already explained in the theory lesson" (TFGI4). The tutors also observed that some of these students copied solutions from students they sat next to during the practical lesson (TFGI3). The following diary entry (PD05) was made on the 12 February 2013:

> *Some students were unable to get assistance from the tutor because they spent lots of time helping other students in class. I also found a few students copying solutions from their neighbour*

The implementation of group discussions during the practical lesson contained advantages and disadvantages. Students who experienced difficulties in solving a question were able to receive immediate support from other students who understood the question. I was also aware of possible disadvantages of this system which included increased noise levels in class together with students receiving answers from others without proper explanations. In view of these issues, the tutors were requested to carefully monitor these factors. Furthermore, they were made aware of the fact that students could copy solutions without proper understanding.

Students made the following comments from a focus group meeting (SFG16:3) regarding the group discussions in the laboratory.

> *Student1: It is much better now because I can get help from Thabo without waiting for the tutor*
>
> *Student2: I am learning a lot by speaking* (getting help) *to my friend. I am able to solve the questions you give us and I'm happy now*
>
> *Student3: I helped my friend. In this way it helped me to see if I knew* (understood) *my work properly.*
>
> *Student4: I prefer to get help from the tutor*
>
> *Student5: I missed the theory lesson. My friend helped me and I was able to do some of the tasks. This helped me very much. But I can't trouble him too much because he gets upset if he cannot complete his own work.*
>
> *Lecturer: Are all students benefitting from the discussions that take place.*
>
> *Student1: I think they do since we are able to get immediate assistance and we learning*
>
> *Student2: It's useful for most students but a few students just copy the solution. The tutors also try to help them but they not interested.*

In the practical learning environment, I observed students discussing challenges experienced (with the person next to them) in an attempt to solve a task. Those that still experienced problems requested help from the tutor. In most cases it seemed that students preferred collaborating with their friends in attempting to solve a task. I found a common trend emerging amongst students in the laboratory was to first ask a friend for help before getting help from the tutor as depicted by the diary entry (PD17) made on 22 April 2013:

> *Students prefer to get assistance from their friends first. If they still experience problems then some of them ask the tutor for assistance*

This seemed like a natural tendency to first consult with a friend since they related better to their friends than with the tutor or lecturer. Some of the students remarked: "I can relate better to my friends and feel more comfortable getting help from him" (SFG17:6). With the introduction of this system, there was much more discussion taking place in class.

A tension occurred between the student (subject) and them engaging in irrelevant discussions (rule) which caused them to be distracted from what was required. Tutors were made aware of this and were able to manage the situation.

Another tension existed between the student (subject) and them copying solutions (rule). The following diary entry (PD28) was made on 23 April 2013:

> *There seems to be a few students who are content on copying solutions without proper understanding of how the task was solved. They not interested in getting explanations of how the program works.*

A similar diary entry was made on the 12 February 2013 (PD05), with a small number of students receiving assistance in solving tasks from their friends, without clear understanding. These students were only interested in finding the solution with little or no understanding in how they arrived at the solution. As a result, these students were unable to apply similar techniques in solving other tasks.

6.4.4 Analysis

Upon reflection, there are many lessons that can be learnt from this activity system. Students seemed to be more comfortable to get assistance from their friends first and then from the tutor, if required. In most cases these students learnt from the collaboration that occurred.

Some students regularly missed lessons causing them to struggle and be unproductive during the practical lesson. The following diary entry (PD18) was made on 22 April 2013:

> *Two students in particular seem to copy solutions and don't show much interest in wanting to learn how to write computer programs*

Based on the registers, these students had erratic attendance and showed little interest in wanting to learn this subject. It is possible that they had no intention of pursuing the computer programming stream in their second year of study and were hoping to obtain the minimum mark in passing this subject.

I found that a few students were not happy being distracted by other students who required assistance as depicted by the comments made by Student 5. These students preferred to focus on solving their tasks during the practical lesson and did not want to be constantly disturbed. However, others enjoyed assisting students since it helped them to reinforce computer programming concepts as outlined by the comments made by Student 3, an issue corroborated by Linden and Lederman (2011).

The division of labour changed with the tutors within this activity system. The following comments were made by tutors at a focus group meeting (TFG13:2) that occurred on 19 June 2013:

Tutor: With the introduction of the group discussions, we are no longer in demand
Tutor: I hope we will still have a job

With the introduction of small group discussions during the practical lesson, the tutor's role required more monitoring of discussions, noise levels and the completion of tasks by the students. The following comment was made by one of the tutors at a focus group interview (TFG13:3) on the 19 June 2013: "I hope we will still have a job with this new situation (referring to the collaboration in the laboratory)".

The following diary entry (PD19) was made on 22 April 2013:

> *The weaker students seem to have received assistance from students that were coping and in some cases, the stronger students received assistance from the tutors.*

A change in the division of labour was observed in this activity system resulting in a transformation where the stronger students acted as tutors to their friends in helping them solve their tasks. Zhao (2013) states that learning through the use of teaching is an effective approach in order to reinforce concepts taught. The advantage of this system was seen by the following comments: "by helping my friend, I am able to see if I understand my work" (SFG17:4). The situation that prevailed was a win-win position for all the students since the weaker students benefited from the stronger students and the stronger students were able to reinforce their knowledge and expose their weaker areas in understanding. Macdougali and Boyle (2004) claim that programming is an intrinsic social activity since good programs do not develop in isolation but through collaborative discussions.

Student commented they were afraid to ask questions during the theory lesson because of being ridiculed by others for asking a "silly" question. It is possible, they may not have requested for assistance from the tutors for the same reason, thinking that the tutors may find their questions foolish. As a result of this situation, they may have preferred getting assistance from their friends.

Finally, it seems that students preferred to get assistance from their friends (SUR08) because they were sure to receive the answers they required. However, if they requested help from the tutors, they would be guided in solving the task rather than receive a complete solution. If this situation prevailed and they did not receive assistance from friends with proper explanations, it would negatively affect the students understanding in computer programming and result in them developing poor problem solving skills.

6.5 Promoting questions through the blog

Week 14: Introduced the use of a blog to ask questions

6.5.1 Setting

The use of the blog was introduced in response to key issue #2: How can I assist students that are afraid to ask questions in the theory lesson, because of the large class environment?

According to Hsu (2012), "A blog or weblog is a web page that displays a short journal". The entries made are stored in chronological order. Halic, Lee, Paulus and Spence (2010) state that a blog creates a learning community where social interaction takes place.

A blog was used to create a social environment to enable students to ask questions in a large classroom environment. A similar concept was introduced by Ivanović et al. (2013) to promote questions by students through the use of a forum. Narayan and Baglaw (2010) reported that the blog created a more social environment, which stimulated learning. According to Lenhart and Fox (2006), a blog has the ability to improve engagement amongst students. Upon reflection, I also realized that the use of a blog created an environment which allowed students to carefully structure their questions before posting it, using a less intimidating environment

6.5.2 Presenting the activity system

The lifecycle of the blog depicting all the action and reflective moments that were undertaken during the transformation process is illustrated in Figure 6.9.

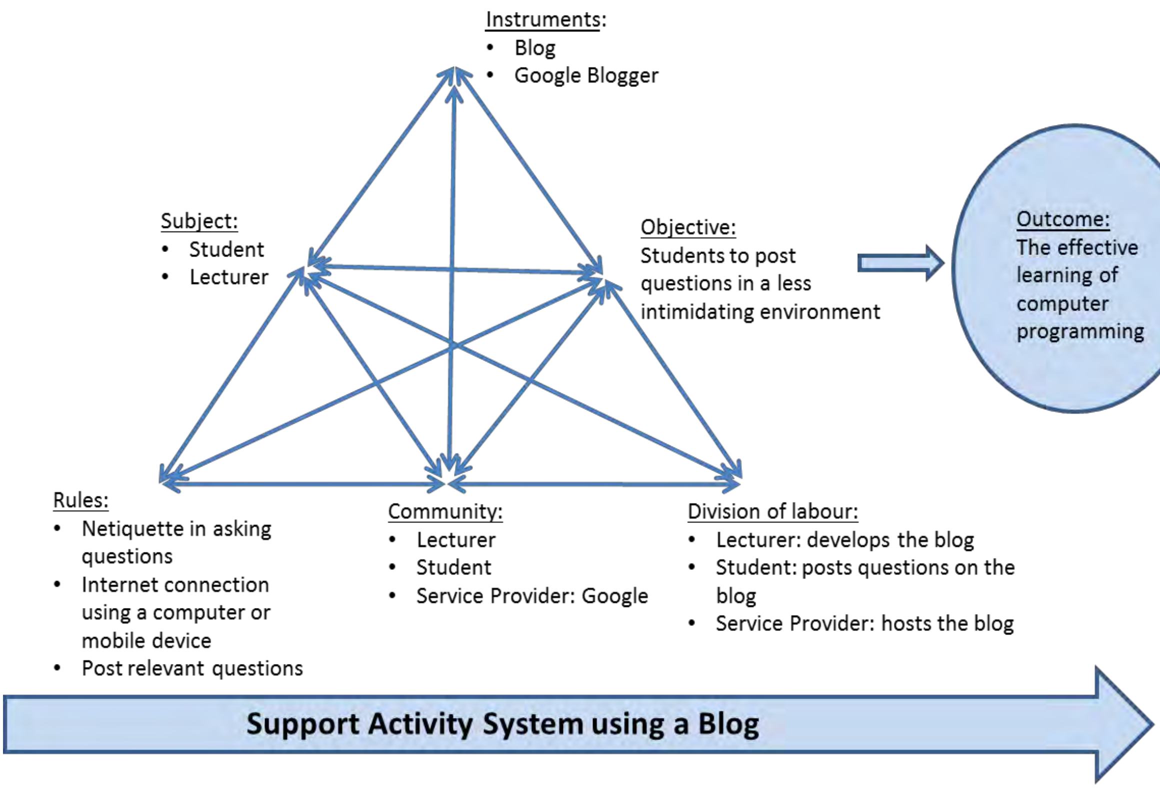

Figure 6.9: The support activity system using a blog

In this activity system, the lecturer (subject) developed a blog using the software *Google Blogger* (instrument). Students (subject) used the blog (instrument) to post questions in a non-intimidating environment. The lecturer (subject) responded to answer the questions to improve understanding of concepts (object). In this environment, students were expected to post relevant questions using the correct *netiquette*[7] (rules) and were encouraged to view and post questions on the blog based on the topics covered during the theory lessons. A deliberate attempt was made not to host the blog on the LMS thereby allowing students to access it from outside the institution network. However, they still required a computer or mobile device with an internet connection.

6.5.3 Engagement

The lifecycle depicting all the action and reflective moments that were undertaken during the transformation process of the blog is illustrated in Figure 6.10.

[7] Computer terminology combining the word "net" from "internet" and "etiquette" which refers to particular etiquette for those engaging with others on the internet.

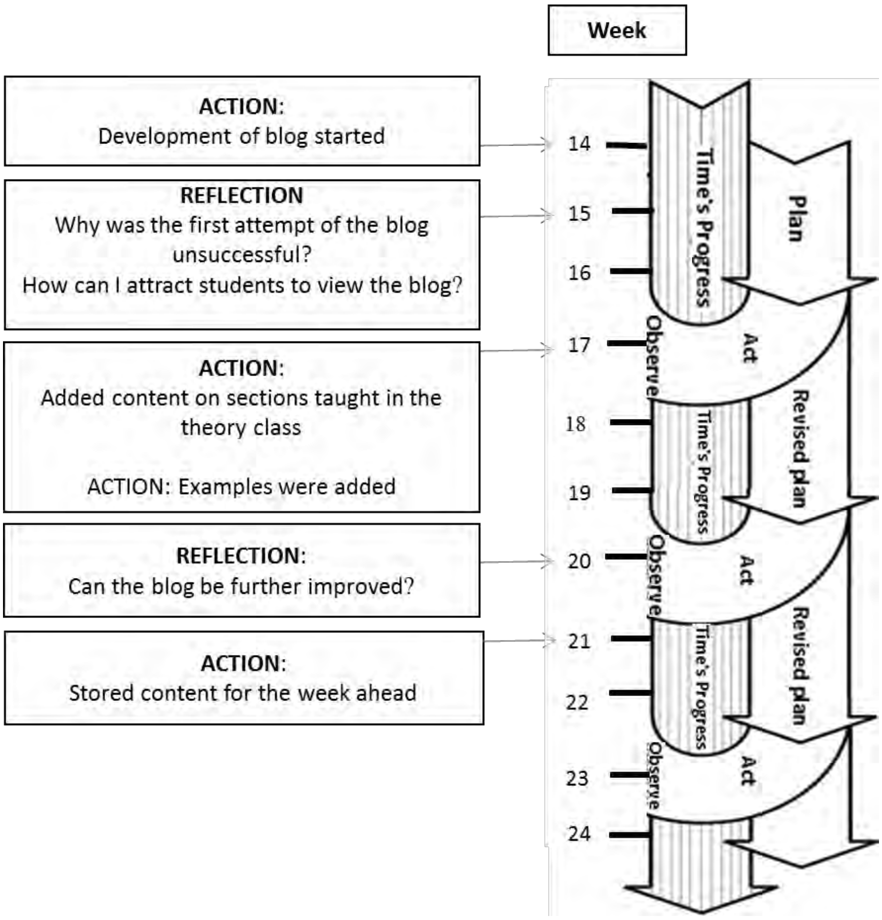

Figure 6.10: Transformation of the blog

I engaged with the creation of a blog by using the free web based software application called *Google Blogger*. In order to create a blog, I was required to login using my *Google* credentials and created the following blog address *http://www.tpee1.blogspot.com* containing the title page Technical Programming 1 as depicted in Figure 6.11. A template was utilised to enhance the look and feel of the webpage. The online software provided a dashboard, which allowed me to create a new post[8] or to view existing posts. It also tracked statistics of the blog usage, types of browsers used and the country of the user that accessed the blog. A home page was created for the blog, welcoming students and requesting them to post questions. The page contained little content since the objective was for students to engage with the blog in the form of questions. Students had the opportunity to post questions anonymously or using their user names, by first logging into their *Google* account. An illustration of the first version of the blog that was created is outlined in Figure 6.11.

[8] An entry made into the webpage of the blog

Figure 6.11: Blog - The first attempt

The web address was made available for students to access the blog. Statistics obtained from the *Google Blogger* dashboard showed that approximately 85% (see Appendix 9, BG01, p. 246) of the students visited this webpage. Only two students posted questions using their usernames, which suggested they were not afraid of being identified.

Upon reflection, I found this tool was ineffective with few students asking questions, despite the possibility of anonymity. The following diary entry (PD20) was made on the 24 April 2013:

> *To my disappointment only two students posted questions on the blog.*
>
> *Having spoken to the students, they indicated that they posted the questions for the fun of it.*

Students made these comments using the electronic questionnaire (EQ15), regarding the blog.

> *Student1: I did not see any link between the blog and our theory lesson*
> *Student2: I was scared because you* (are) *on the internet and anyone can see your question.*
> *Student3: I don't know how to use the blog*

Based on the comments received, I found that students could not relate to the blog since the majority of them had not utilised a tool of this nature previously. Furthermore, they could not see a relationship between the blog and the work carried out during the theory lesson. In some cases students did not know how to use the blog whilst others felt intimidated asking questions on the internet, not realising they could remain anonymous. Despite the limitation arising in this activity system, I still believed that this tool, if setup properly, had the potential to succeed in terms of achieving the desired goal.

As a means to improve the offering, I added content and examples to the blog to supplement the work taught in class, in an attempt to attract more students to engage with it. With this intervention, the activity levels increased immediately with students engaging by posting questions. Many students chose to post questions anonymously whilst a small number of them were prepared to identify themselves by first logging into their *Google* accounts. A sample of some of the questions posted on the blog is given in Figure 6.12.

Figure 6.12: Sample of question posted and the response given

It must be added that by creating the blog using the internet implied that anyone could access this forum and post questions. Based on the questions that were asked, I believe that they were asked by my students since the questions were all related to the work carried out during the theory lesson. In the unlikely event of a question being asked by an outsider, I did not see it as a problem as long as it contributed to the learning of computer programming.

Roblyer et al. (2010) observed that shy students may not ask questions in class and would rather use social media, a similar result found in this study. Other students used the blog as a learning tool (SUR07), as outlined by the excerpt (SFG19:11) taken from a focus group meeting.

> *Lecturer: Did you post any questions*
>
> *Student1: No*
>
> *Student2: No*
>
> *Lecturer: Does that mean that you understood all the concepts that were taught in class or were you afraid to post a question.*
>
> *Student1: No. There was a concept that I did not understand in class. When I went to the blog, another student had asked the question. I then read the answer which helped me.*
>
> *Student2: Just by reading the answers* (to the questions) *on the blog, I am able to learn.*

It became clearer that students did not need to get answers by posting questions since some of the questions were already asked and answered. These students reinforced their understanding by reading answers to questions posted by others.

As part of the action research process, further reflection occurred to find other ways of utilising this tool to benefit students. An innovation was introduced to the blog by posting notes for the theory lesson a week in advance. Based on statistics obtained from the Blog (see Appendix 9, BG02, p. 246), approximately fifteen students consistently accessed these notes. The following comments were made using the electronic questionnaire (EQ19) by these students about reading the notes prior to the class.

Student3: I did not understand everything (I read on the blog before the theory lesson)*. But when you explained in class, it was so much easier*

Student4: After I read the notes (on the blog)*, it was much easier to understand the* (theory) *lesson. The examples were good on the website. Keep it up.*

Firstly, the small number of students who made use of these notes found it useful. These students were unable to grasp all the concepts after reading the notes by themselves. It seems that these gaps in knowledge were addressed during the theory lesson. Secondly, the majority of students did not utilise these notes stating they "did not having enough time" (EQ20).

6.5.4 Analysis

Upon reflection and analysis, the following lessons can be taken from this activity system. The blog served as an alternative forum where students could ask questions. In creating this forum, it seems that I had introduced the problem of fear into students. These students were apprehensive and felt intimidated to post questions having not used a blog previously. The history of the students was not taken into consideration by the lecturer whilst attempting to use technology, rendering the first version to be ineffective.

By using a blog, related information was grouped together facilitating easier learning. Some students utilised the blog as a learning tool by reading questions and answers posted by other (EQ20). This tool proved to serve a dual purpose. Apart from getting students to post questions, students engaged with this tool to improve their understanding of concepts and techniques as outlined by the comments made by Student 1 and Student 2. This is supported by Okan and Ula (2013) who conclude that the blog can have a positive effect on the learning.

Approximately 10% (see Appendix 9, BG02, p. 246) of the students used the blog to read the notes prior to attending the theory class and found it to be useful. The majority of the students, however, did not make use of these notes. This low percentage was evidenced by studies conducted by Hobson (2004) that outline between 20% and 30% of the students reading materials in preparation for a class.

A few students commented on the advantage of having the blog independent of the LMS since they were able to access it using an internet connection from off campus. In particular, two students further indicated they were "able to access the blog on their mobile phones" (PD21) making them more productive and "increasing their learning".

6.6 Mentors as a supporting mechanism

Week 15: Introduction of mentors to assist students in the learning of computer programming from outside the classroom.

6.6.1 Setting

The use of mentors was introduced in response to key issue #6: How can students receive assistance in small groups from outside of the classroom?

I found that students were better inclined to ask questions in smaller groups. The expectation was for students to be more enlivened in a smaller environment causing them to ask more questions and hence improve their knowledge of computer programming. Mentors were used to assist students who had difficulties with concepts in computer programming.

A study conducted by Bagley and Chou (2007) found the use of past year students as mentors to improve the grades of students learning computer programming. Yorke (2004) asserts the introduction of mentor assistance can prevent a student from feeling isolated. Student mentors can be used to assist with challenges when learning programming. The personal interaction and discussions can provide a platform to improve student understanding in this subject.

6.6.2 Presentation of the activity system

Figure 6.13 outlines the support activity system that made use of mentors.

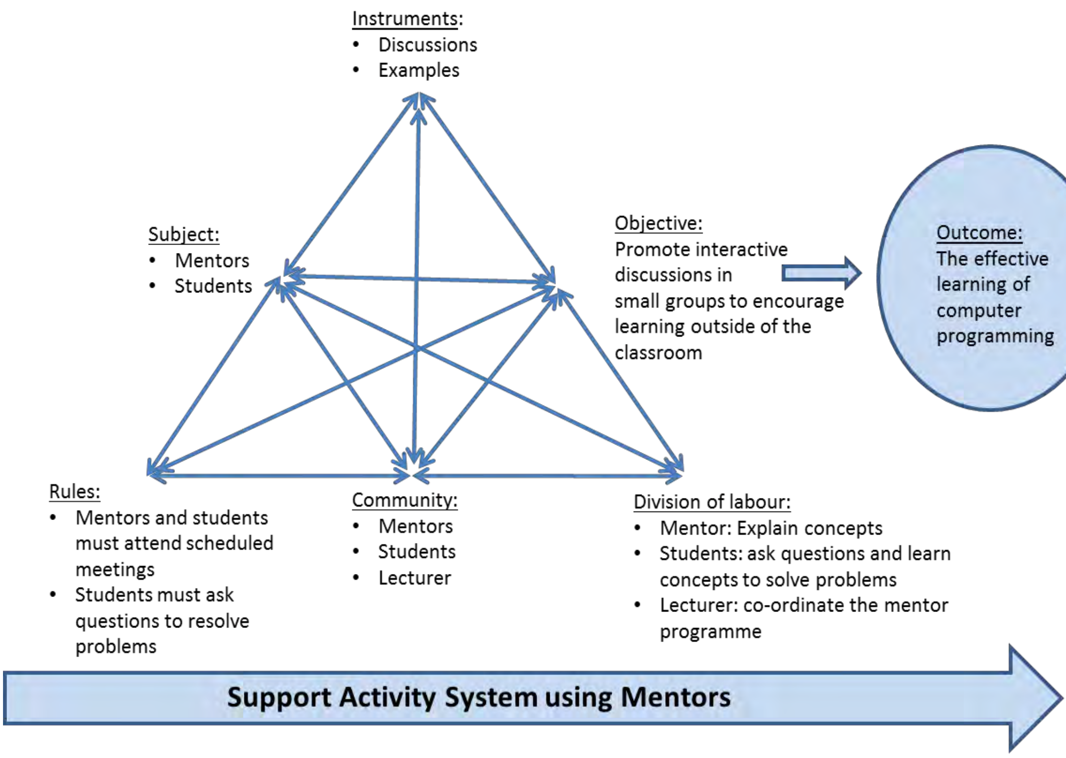

Figure 6.13: Support activity system using mentors

The objective of this activity system is for mentors (subject) to engage with students (subject) in order to encourage interactive discussions (instrument) in small groups to promote learning of computer programming (objective). This was achieved with the mentors and students meeting at scheduled times (rules) to benefit from the question and answer interaction. The mentor was the facilitator of the group serving the role of a guide and teacher whilst the students led the discussions in terms of asking specific questions where they had gaps in their knowledge. The attendance by both the mentors and the students were mandatory (rule) for this system to be successful and hence achieve its goal. The lecturer (community) was required to co-ordinate the mentor programme to address any challenges experienced within this system.

6.6.3 Engagement

The lifecycle depicting all the action and reflective moments that were undertaken during the transformation process of the mentors is illustrated in Figure 6.14.

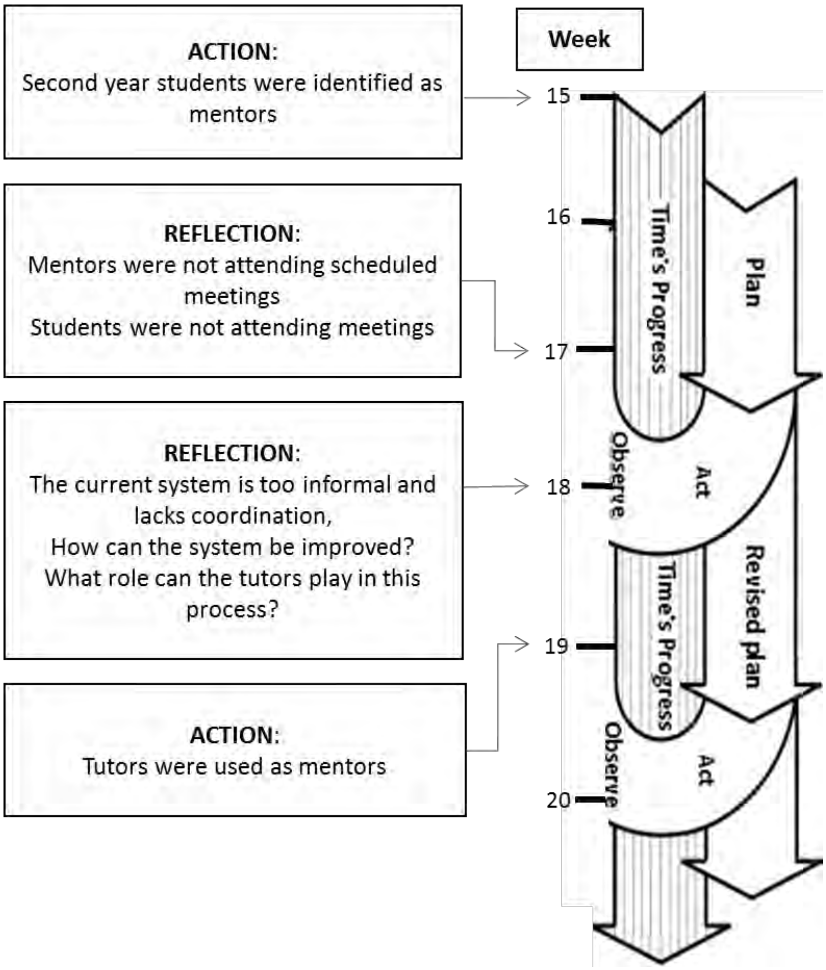

Figure 6.14: Action research transformation of the mentor programme

Second year IT students who were capable and eager to be mentors were identified to serve the role of a student mentor. Their purpose was to provide support to the first year computer programming students outside of the formal classes. I engaged with the mentors by allocating one mentor to a group of approximately six students. This was an informal arrangement with mentors setting their own meeting dates and times based on the convenience of the entire group. The mentor was the main co-ordinator who facilitated the meeting times and the discussions that occurred. They were not remunerated for this service and were satisfied with the fact that the experience would firstly help them to recap their work from first year and that they could use the experience gained as work experience on their curriculum vitae.

Students engaged with the mentors by meeting with them during their allocated times and discussed challenges they experienced in solving a specific task or with a specific topic. The arrangement required commitment from all parties in order to produce effective results. Mentors reported that not all students attended the meetings while some students indicated that the mentors did not attend. Furthermore, there was little communication that occurred between the mentors and myself. As a result of the many challenges that transpired and the lack of coordination on my side as the lecturer, this programme did not yield the desired output. The following diary entry (PD23) was made on 16 May 2013:

> *Only one of the twelve mentors consistently met with their groups over a five week period and they found the mentorship programme to be effective and enhanced their learning. They claimed to have had interactive discussions in their mother tongue in a casual atmosphere where learning with stimulated.*
>
> *Some groups claimed that the mentors did not attend scheduled meetings whilst some mentors stated that students were not attending. I later found that the problem was mainly on the part of the mentors since their academic workload had increased causing them not to find time for this voluntary job.*

An excerpt between the lecturer and students (SFG18:7) that took place at a focus group meeting on the 18 June 2013 is outlined below. The students in the excerpt belonged to different groups having different mentors.

Lecturer: Have you been meeting with your mentors
Student1: We met a few times then he (the mentor) *stopped attending*
Student2: He only attended once
Student3: Our mentor is very good. We meet with him every week and he helps us a lot.
Student 4: Our mentor knew his work but did not explain very well.

Two tensions were found in this activity system contributing to its downfall. Firstly, the mentor and/or students (subject) did not attend all the allocated sessions (rule). In the absence of the mentor, the system failed totally. With the mentor present and some of the students missing, it was still to assist those that attended. Secondly, there was little coordination between the lecturer (division of labour) and the mentor (subject), contributing to its failure. Upon reflection, I realised the importance of having a co-ordinated mentor programme with weekly meetings to determine its effectiveness. As a result of the intense nature of the action research process in this study, it did not take place resulting in the failure of this system.

As a means to improve the mentor programme, a more formal and co-ordinated arrangement was setup where the existing tutors were utilised as mentors. A venue was booked on a fixed date and time whereby students could receive assistance from the two tutors that were present. During these sessions, the mentors made use of the chalk and talk approach to explain concepts to students. The tutors were also remunerated for their efforts which made them take this task more seriously. Registers were taken during each lesson to monitor the students' attendance. Weekly meetings occurred between the mentor and the lecturer to establish the effectiveness of the new programme.

A transformation of the mentor activity system occurred because of the tension experienced in the system. The voluntary informal mentor system evolved into a more formal programme making use of the existing tutors. Boyle et al. (2003a) emphasised the need for supplementary support such as mentors to assist students in their learning.

6.6.4 Analysis

There are some important points that can be extracted from the student mentor programme, despite its failure in this study. It is important for this programme to be formalised since students feel more inclined to attend a formal programme which is part of their work schedule. This programme should also consider some form of incentive for the mentors to take their task seriously. Furthermore, regular meeting should be scheduled between all stakeholders of this activity system to address challenges that arise and to provide support.

Student mentors need to be carefully selected (SUR06). Wang et al. (2008) suggest using talented students to assist slow learners. Additionally, I believe that these students need to be mature enough to balance their academic schedules with being a mentor. The following diary entry (PD24) was made on 16 May 2013:

> *The group that benefitted from the student mentor programme had a mentor that achieved above 80% in all his subjects and he appeared to have good planning skills*

The third point is a general comment on a mentor programme regarding student attendance. The mentor programme poses a danger because it occurred after both the theory and the first practical lessons. A small group of students developed a complacency mind-set, considering the mentor programme as a replacement to the theory lesson. This tendency was found by checking the attendance registers and reflected by the following diary entry (PD25) made on 23 May 2013:

It seems that a small group of students seem to think that they could miss the theory lesson on a Monday morning and could catch up using the mentors programme conducted by the tutors

However, having missed the theory lesson, these students would be ineffective in solving tasks during the first practical lesson. The next section explores the use of visual materials in the form of videos to assist students in their learning.

6.7 Visual stimulus through videos

Week 16: Visual material was created in the form of videos

6.7.1 Setting

The use of videos was introduced in response to key issue #8: How can I assist students that have a visual learning style to better engage in the learning of computer programming?

According to Syers (2011) videos can be used to reinforce concepts in learning. It also helps to better engage students in the learning of computer programming (Guido, 2010). Many students learn more effectively through the use of visual materials. Hobson (2004) asserts that between 75% to 83% of students are regarded as visual learners rather than verbal learners. With the high statistic of visual learners, videos were introduced to enhance the learning process as an alternative learning style. Apart from the visual appeal, students were able to replay the video several times making use of the pause and rewind features to obtain clarification.

Student feedback on the use of the supplementary notes indicated that they preferred visual materials compared to reading materials. Jenkins (2002) outlined the importance of taking the students learning style into consideration since this can influence their learning in computer programming. As a result, I decided to source videos from *YouTube* to provide another support structure to students to improve their learning experience.

6.7.2 Presenting the activity system

Figure 6.15 illustrates the support activity system using videos.

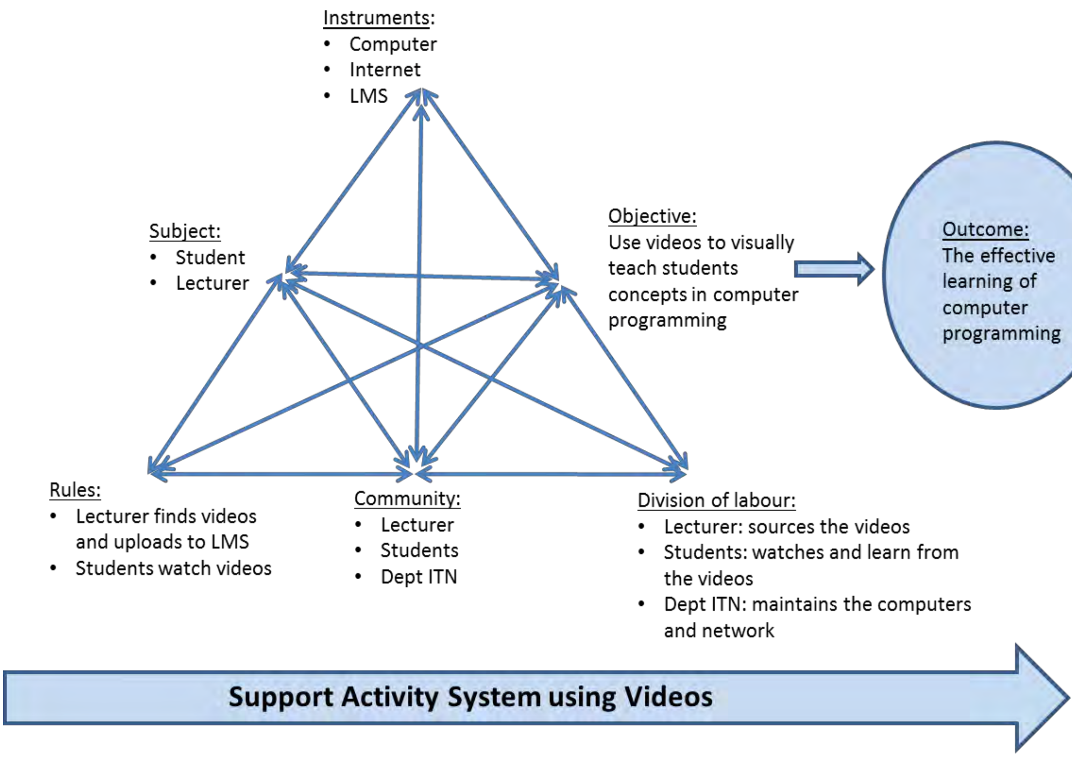

Figure 6.15: The support activity system using video

In this activity system the lecturer (subject) sourced videos from the internet (instrument) and uploaded the address to the LMS (rule). Students (subject) were expected to view the videos and learn concepts in computer programming (objective). The department of ITN (community) were responsible for maintaining the computers and the network.

All videos were in the form of visual tutorials that contained a narrator, who explained concepts by writing and demonstrating the functionality of programming concepts. The videos were located from *YouTube* and in most cases they were produced by foreigners from countries like India and America with the narrators having a distinct accent. The advantage of using videos was the ability to rewind and pause in order to repeat segments of the video for better understanding.

6.7.3 Engagement

The lifecycle depicting all the action and reflective moments that were undertaken during the transformation process of the videos is illustrated in Figure 6.16.

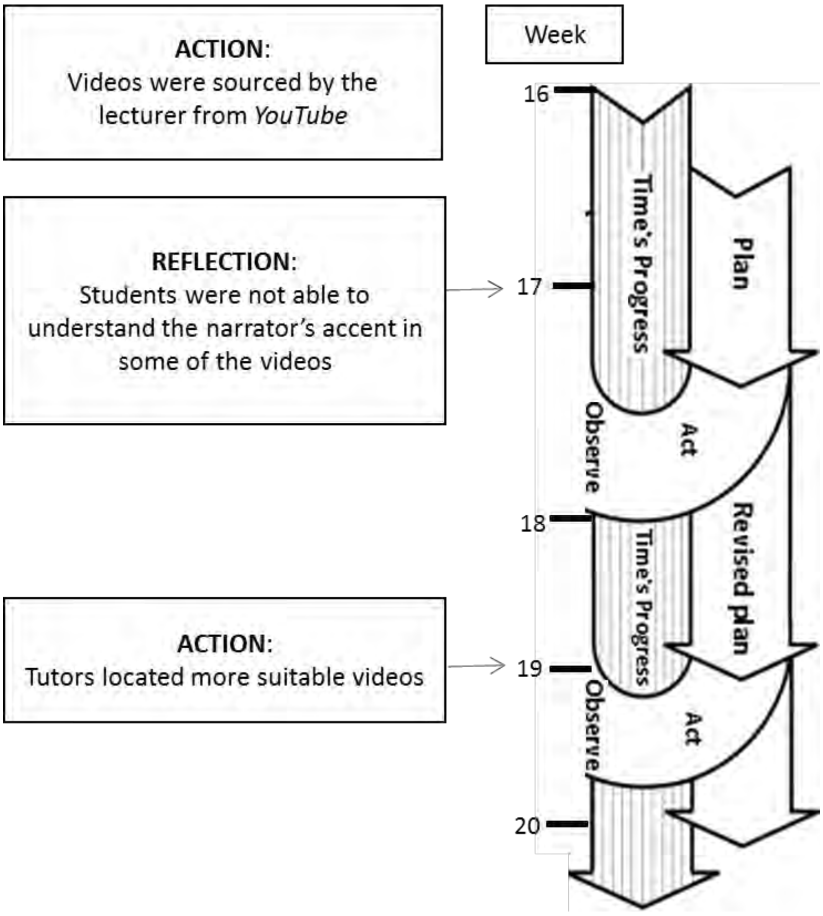

Figure 6.16: Action research transformation of the videos

The lecturer engaged by locating suitable videos on relevant computer programming topics based on sections taught in class. This was achieved by performing specific searches on *YouTube*. One such section where videos were located dealt with two dimensional arrays. The relevant videos were located and the web address of the videos was copied and pasted into the uploaded link on *Blackboard*. Students were requested to use the video links on *Blackboard* in order to activate the videos in a new tab of the internet browser software. In order to hear the audio and not distract others, students required headphones. This was not seen as a challenge since I had observed most students having this facility.

The narrator's foreign accents resulted in difficulties as seen by the following responses on the electronic questionnaire (EQ17):

Student1: I could not understand his way of speaking (accent)?
Student2: These videos were not easy to understand
Student3: He speaks too fast

A tension occurred between the student (subject) and their ability to understand the video (object). Some students lost interest in the videos because of this problem. In locating the videos, I did not realise the impact of the narrators accent, which was a barrier for students to comprehend the concepts taught, thus rendering this tool as ineffective.

As a means to improve this system, I requested the tutors to source videos from *YouTube* since they, having been students in this subject two years ago, would be in a better position to know the type of videos to benefit the students. After the tutors located several videos, I filtered them and uploaded the most relevant ones to *Blackboard*. An attempt was made to ensure that the videos were not longer than ten minutes to maintain the interest of the student.

The following comments about the videos were elicited (EQ24, SUR09):

Student1: These videos are good in helping me to understand and remember
Student 2: I prefer seeing the videos. They are much better to use than the notes
Student3: I like the videos. The one problem is that you cannot ask any questions. That is why I prefer the theory class.
Student4: I missed the theory class. The videos helped me more than the notes.
Student5: Some of the videos are very good and you can learn the work quickly. A few times I was frustrated because the videos were starting and stopping.

Based on the comments made by the four students, the new set of videos located by the tutors was better received by the students. However, not all the concepts explained in the videos were fully understood by all the students, as seen by the comments made by Student 3.

6.7.4 Analysis

Upon reflection and analysis, the following lessons can be learnt from this activity system. I found that visual material in the form of videos can be a powerful learning tool. The following diary entry (PD09) was made on the 20 February 2013:

Students commented that they preferred (learning through the use of) *visual material.*

The positive response to videos, concurs with the assertion by Carlisle (2010), who indicates that short videos can be an effective way of helping students in their learning of computer programming. Vincenti et al. (2013) made a concerted effort to develop a “rich” graphical and visual interface to reduce the amount of reading to help students better engage with the interface. Nonetheless, if the videos are not carefully selected, they can be counterproductive during the learning process. In particular, the narrators accent in the video is an important consideration for learning to occur, as reported by Linden and Lederman (2011). Again, as stated previously with the use of supplementary notes, the tools created need to purposefully influence the learning of the student.

During a focus group meeting (SFG21:5) a student stated that he "was able to play the video many times to properly understand the step by step instructions using the pause and rewind options to better understand". It seems that students like step by step explanations rather than having to read material like the supplementary notes.

It seems that watching videos is a faster way of learning as seen by the comments made by Student 5. However, the danger of using this technology over the internet can result in 'jerking' of the video when traffic over the internet is high and poor bandwidth speeds are experienced. This can lead to frustration and render the videos ineffective. A possible solution to this problem would be to download the video from *YouTube* and upload it to the LMS. In this way, students could download it to their computer and watch them independent of the internet. Another variable introduced is the cost factor when using this type of technology in the home - use of videos takes up more bandwidth, which can increase cost.

With the positive comments received about the videos, I wanted to create another visual tool. As a result, animations were introduced.

6.8 Improving participation using animation

Week 18: Visual material was created in the form of animations

6.8.1 Setting

The use of animations was also introduced in response to key issue #8: How can I assist students that have a visual learning style to better engage in the learning of computer programming?

One of the challenging aspects of computer programming, as identified in the literature, is the abstract nature of concepts (Klopfer et al., 2004) because students need to use these concepts to solve tasks. I observed that students struggle to visualise and understand the internal processes taking place within the computer, hence, they find computer programming challenging. Linden and Lederman (2011) successfully used *PowerPoint* animations to demonstrate programming code. The visual content, together with the step by step illustrations of how the movement occurred can be a useful tool to understand abstract concepts. As a result, animations were used as a support structure for students to visually understand the internal processes that occur in the execution of a program.

In 2012, I conducted a study with my first year students to determine the effect of using multimedia *PowerPoint* animations for a particular section in computer programming (Jugoo, 2012). In this study, animated slides were created for a number of techniques for the section on one dimensional arrays. An experimental group of thirty students, belonging to categories of high, middle and low achievers, utilised the *PowerPoint* slides. Results indicated that the low achievers who were previous failing their tests were able to raise their mark to a pass after utilising the animations. Similar *PowerPoint* slides were created in this study to teach a section on parallel arrays. In this way another visual tool was introduced.

6.8.2 Presenting the activity system

Figure 6.17 illustrates the support activity system using animations.

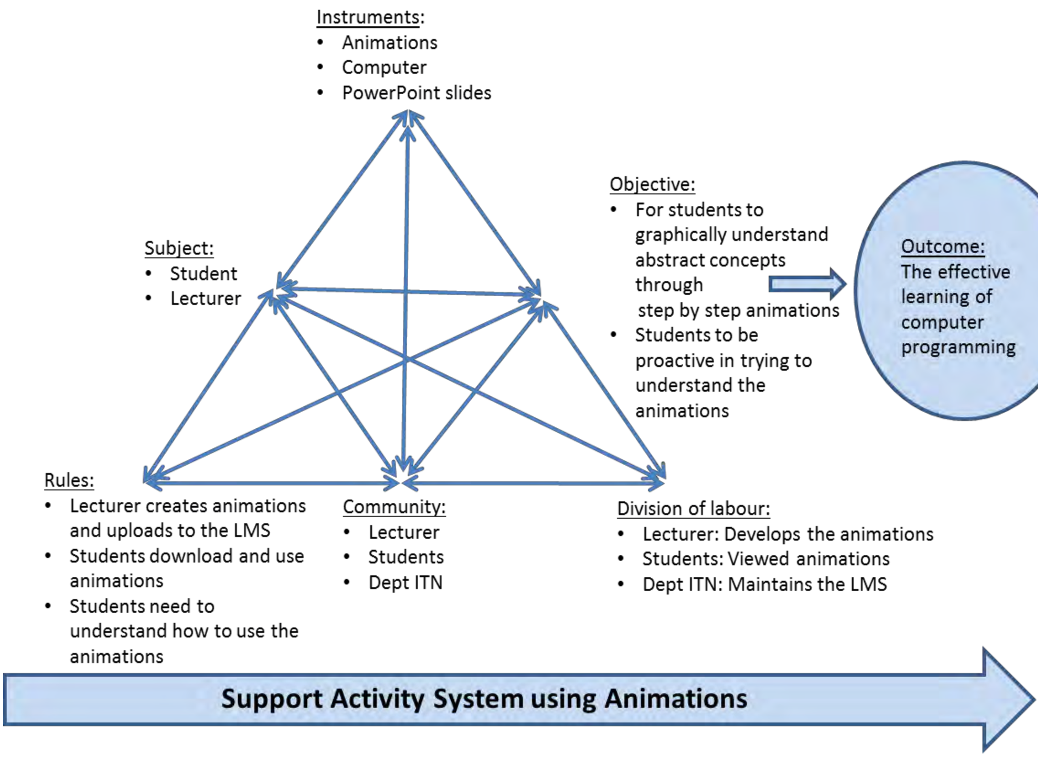

Figure 6.17: Support activity system using animations

In this activity system, the lecturer (subject) developed visual animations using *Microsoft PowerPoint* presentations (instrument) and uploaded them to the LMS (rule). Students were expected to access the animations on the LMS (rule) and were expected to read the instructions carefully to understand what the animations were trying to achieve. The object of this activity system required the student (subject) to understand abstract concepts through the use of graphical step-by-step animations (object). A second objective of this activity system attempted to make the students more proactive in their learning. Students were not explained the functionality of the animations. Instead, instructions were provided explaining its purpose and functionality.

6.8.3 Engagement

The lifecycle depicting all the action and reflective moments that were undertaken during the transformation of the animations is illustrated in Figure 6.18.

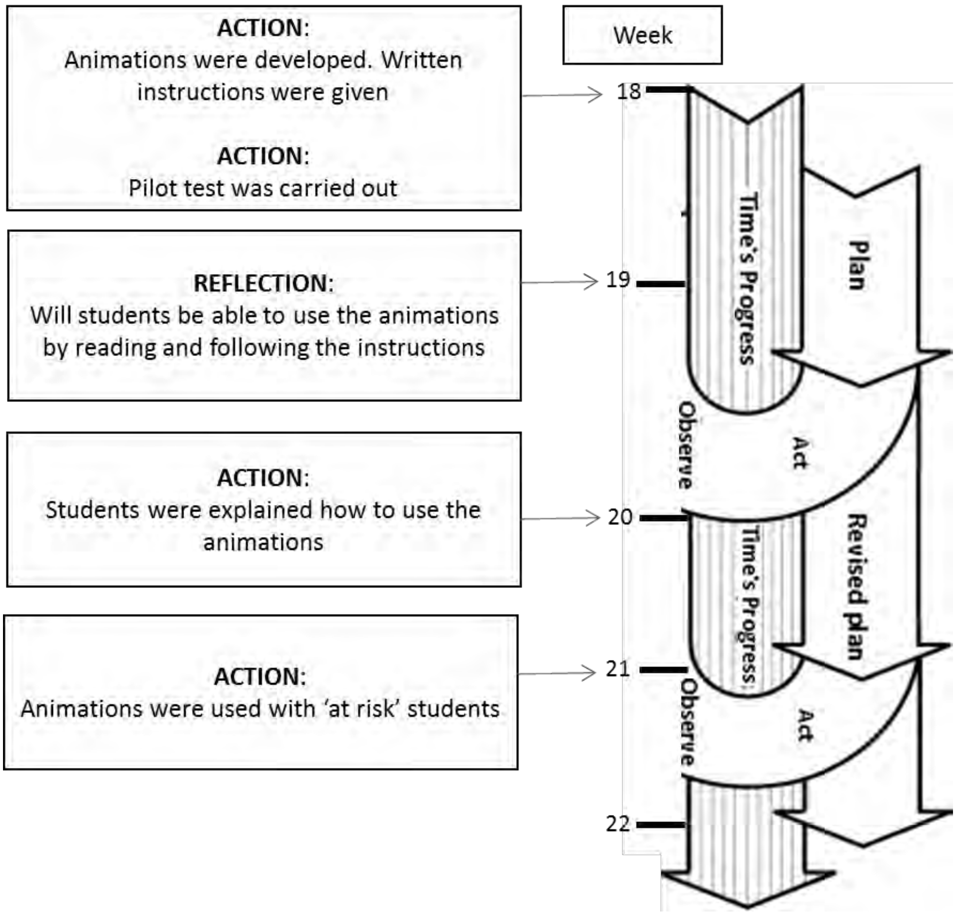

Figure 6.18: Action research transformation of the animations

I engaged with the animations by creating a series of *PowerPoint* slides to explain the abstract concept of parallel arrays in computer programming. An animated effect was created by using the same program segment in multiple slides with a red line at different positions in each of the slides depicting movement to other parts of the segment each time a new slide was viewed. For example, the first slide was created depicting the program segment illustrated in Figure 6.19. The red line of code showed the start of the segment with a table that outlined the values of the variables and an explanation based on the action that occurred by the red line. Furthermore, an array was depicted in blue to illustrate how the values changed.

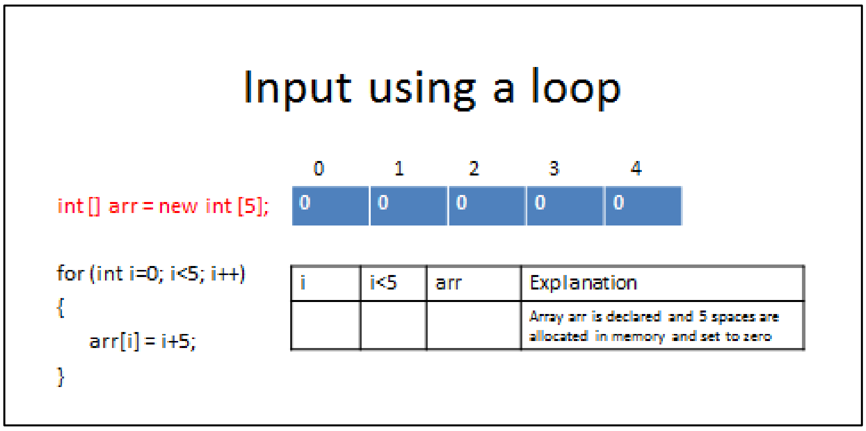

Figure 6.19: Animation slide 1

This slide was duplicated by repeating the segment, table and array to produce a second slide, and the red line in this slide was set back to black and the next statement of the segment was changed to red as depicted in Figure 6.20. An explanation of the change that occurred by the red line was provided whilst simultaneously updating the other values in the table.

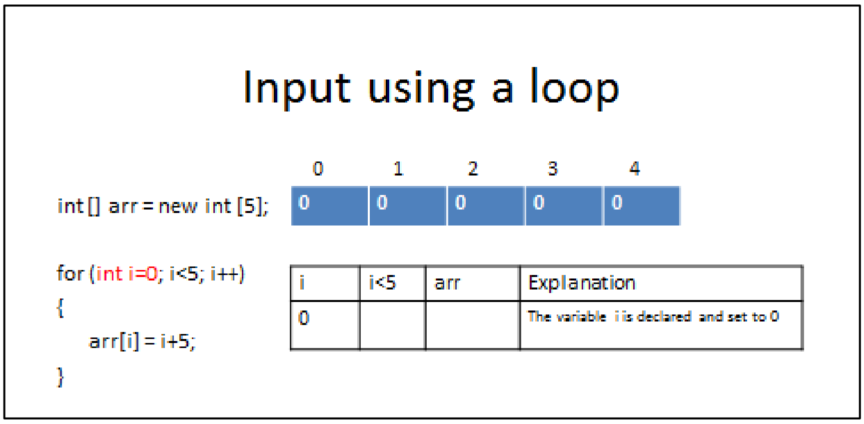

Figure 6.20: Animation slide 2

Thereafter, the second slide was duplicated to create a third slide and the red line being set back to black and the next statement of the segment was changed to red as depicted in Figure 6.21. An explanation of the change that occurred by the red line was provided whilst simultaneously updating the other values in the table.

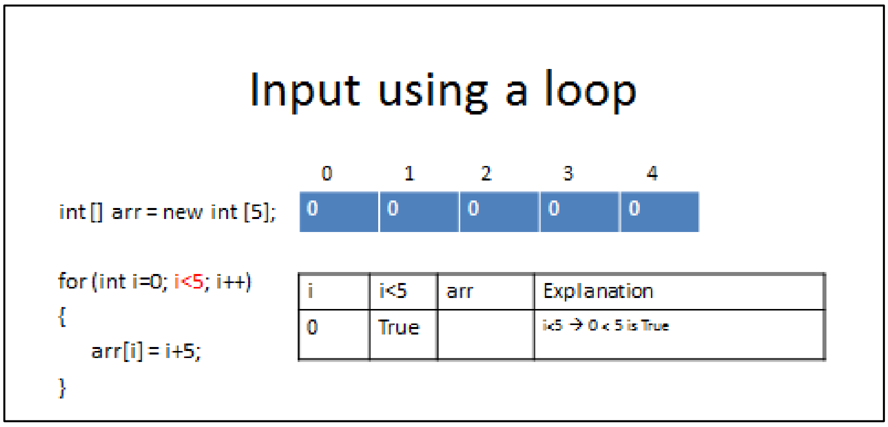

Figure 6.21: Animation slide 3

The process was repeated many times producing an animated effect until the ‘for loop’ was completed and the array was populated. It was time-consuming to create, with each animation containing at least fifty slides.

A series of five animations were created. Students were required to engage with each animation to learn various techniques on the abstract concept of parallel arrays. Each animation had a set of instructions outlining how the presentation worked. Students were expected to read these instructions carefully in order to understand what the presentation was attempting to achieve.

A pilot test of the animations, with the instructions, was conducted with five students from the first year programming class, but who were not part of the sample group. This was to determine whether the introduction of the instructions in the animations was clear enough for students to comprehend and understand. Based on the feedback obtained from these students, a few minor language changes were made and the animations were hosted on the LMS for students to access.

Students were requested to download and use the animations without being given any explanations. They were required to read the instructions carefully on the *PowerPoint* slides in order to understand how it worked. This approach was used to determine whether students showed signs of being proactive in their learning process. The following comments were made by students using the electronic questionnaire (EQ22).

> *Student1: I did not know what it* (the animation) *was doing.*
>
> *Student2: I saw a red line moving in all the slides but did not know what was happening. Maybe because I missed the theory lesson.*

Student3: For the first time I really understood how the for loop (in Java) *works*
Student4: I was lost (using the animations*). My friend helped me and then* (I) *found them helpful.*

Based on the comments received by most students, a tension had developed between the student (subject) and their ability to use the animations (rule). Having reflected on the comments made by students using the electronic questionnaire, the following diary entry (PD26) was made on the 27 May 2013:

> *Many students did not understand what the animations were trying to achieve. It seems that they did not find them useful.*

Students were not given any instructions on how to use the animations and it appeared that many of them were unsure of what the animations were trying to achieve (SUR10). As a result of this tension, the use of the animations was explained in detail by the lecturer to all the students. The following comments were obtained during a focus group meeting (SFG22:7) that occurred on 18 June 2013.

Student1: Now it makes sense. It is very useful when you can see what is happening
Student2: Now I understand the purpose of the red line. These slides are very good because it helps me to understand (my work) *better by seeing the commands step by step. Even after missing the theory lesson, I could follow what was happening and was able to attempt a few of the tasks* (in the practical lesson). *My problem was I did not read the instructions properly* (in the PowerPoint presentation)
Student3: I used the for loop previously but now I can understand how the computer goes through the program
Student4: This is very good. I wish I had these at the beginning of the year

This tool seemed to have a positive result on the students understanding once they were able to understand the functionality of the presentation. Students indicated they found it easier to learn using the animations since they could visualise how the information was represented internally in the computer. Salajan et al. (2009) suggested that the visual and interactive nature of tools played an important role to assist students to understand concepts that are abstract and difficult. This idea was supported by Patil and Sawant (2010) who used multimedia tools to teach computer programming.

6.8.4 Using the animations on students at risk

As previously explained, I had used similar animations on a cohort of thirty students and the results indicated that students who were failing their tests were able to pass having used the animations. An attempt was therefore made to re-test the findings of this study on a group of students who were failing the subject.

Eleven students from my sample population were at risk of not being allowed to write the final examination. These students were identified and called for a special intervention to assist them with their final test. Only five students, three from group B and two from group D, responded to the special assistance. I met with these students twice a week on a Tuesday and a Friday for one hour on each day. These meetings occurred during the month of June. During the Tuesday lesson, these students used the animations, under my supervision, to understand the concepts. Thereafter they implemented their tasks on the Friday lesson. During these extra sessions four of the five students consistently attended every session.

I found the students to be interactive by asking many questions, which they possibly would not have asked during the theory or practical lessons. Furthermore, I got to know the students better on a more personal level because of the small group.

Once the final test was conducted, I found from my mark list that the four students who consistently attended the extra lessons passed obtaining above 55% in their test. Impressively, one of the students had obtained 82%. The fifth student that was erratic in his attendance achieved 43%. These students made the following comments on the usefulness of the animations using the electronic questionnaire (EQ26).

> *Student1: I found the animations useful. It helped to teach me how an array works inside the computer. This made it easier to solve the questions you gave us.*
> *Student2: I liked the small group and individual attention. It made me confident. The animations worked well in learning the work.*
> *Student3: I found it* (the animations) *good.*
> *Student4: It was useful working with the lecturer.*
> *Student5: The PowerPoint helped a little*

Based on the comments made by the first four students who consistently attended the extra sessions, it seemed to make a difference to meaningfully understand their work. It would appear that the animations positively impacted these students. However, these students received more than the animations. Over a period of one month, they asked many questions to which they received answers. The personal support factor during this period cannot be ignored and perhaps also influenced the learning of these students.

6.8.5 Analysis

Upon reflection, there were many lessons that I learnt from this activity system. I found that the majority of the students were not proactive in using the animations after their first attempt. These students did not understand how it worked and simply continued, without making any concerted effort to determine if it could enhance their learning. Some students understood the animations while a few of them received assistance from their peers or the tutors to determine how the animations worked. The general consensus by students was that the animations enhanced their learning once they understood how it worked.

It seems that the majority of students initially ignored using the animations. While instructions were provided on two slides of the animations, it seems that most students "did not pay much attention" to these slides and attempted to "figure it out" (EQ23) as they used it. This flaw seriously hampered their understanding and engagement and can be tracked back to the students' lack of reading as discussed in sections 6.2.4 (supplementary notes) and section 5.2.4.5 (students afraid to ask questions). It is possible that these students preferred to explore and attempt tasks by trial and error (Ceaparu, Lazar, Bessiere, Robinson, & Shneiderman, 2004) rather than wanting to read instructions. A study conducted by Novick, David and Ward (2006) reported that participants abandoned their tasks instead of reading printed instructions.

After utilising this tool, the graphical nature of the slides was appreciated by most of the students. Of great interest is the comment made by a student that despite him missing the theory lesson, he was able to attempt some of the tasks in the practical lesson (EQ24). It would seem that the visual tools used in this study enhanced the learning of concepts in computer programming.

Students that were at risk in passing TP1, and who used the animations, seemed to benefit from them. However, there are other factors that need to be considered, which I believe influenced the positive impact of the animations. One student enjoyed the "small group and individual attention" (EQ26, EQ27) thereby making him "confident". Another student found it "useful working with the lecturer" (EQ26). Based on these comments, it would seem that these factors also contributed to the success of these students. Furthermore, having worked with this small group of students, I found them to be motivated and they were free to ask questions. I believe that they showed enthusiasm, wanting to work beyond the one hour schedule that was allocated. It seemed to me that these students poor performance in this subject was related to their lack of confidence, as well as not knowing how to approach their learning in this subject. It appeared that they needed a personal guiding hand in helping them progress in this subject. The theory lesson with a large group of students (that I considered so important) seems not to contribute to these students learning in the way I anticipated it would. Finally, students enjoyed the visual nature of the animations. It revealed yet again that many of the students had a preference to be taught using visual materials.

6.9 ***Promoting independent learning with Google***

Week 18: Introduced the use of Google – to encourage active learning independently

6.9.1 Setting

The use of *Google* as a research tool was also introduced in response to key issue #7: How can students engage actively in solving their tasks through the use of research?

According to Schwartzman (2006) students need to be accountable in finding ways of solving their tasks in computer programming. He further states that through confusion and uncertainty, students are able to engage and learning takes place. According to Simon et al. (2006) students need to be active learners and be motivated to work independently in solving tasks, and those who are active learners in engaging and solving tasks on their own, tend to produce better results. The confusion and uncertainty that appears during such a process is considered important for learning (Patil & Sawant, 2010).

Within the context of this study, there was an expectation from students to receive knowledge rather than produce their own knowledge in this subject. Most students that enrolled for this subject were dependent on receiving assistance from the lecturer, tutor and mentors in solving their tasks.

6.9.2 Presenting the Google *activity system*

Figure 6.22 depicts the support activity system using *Google* as a research tool as a means to solve tasks.

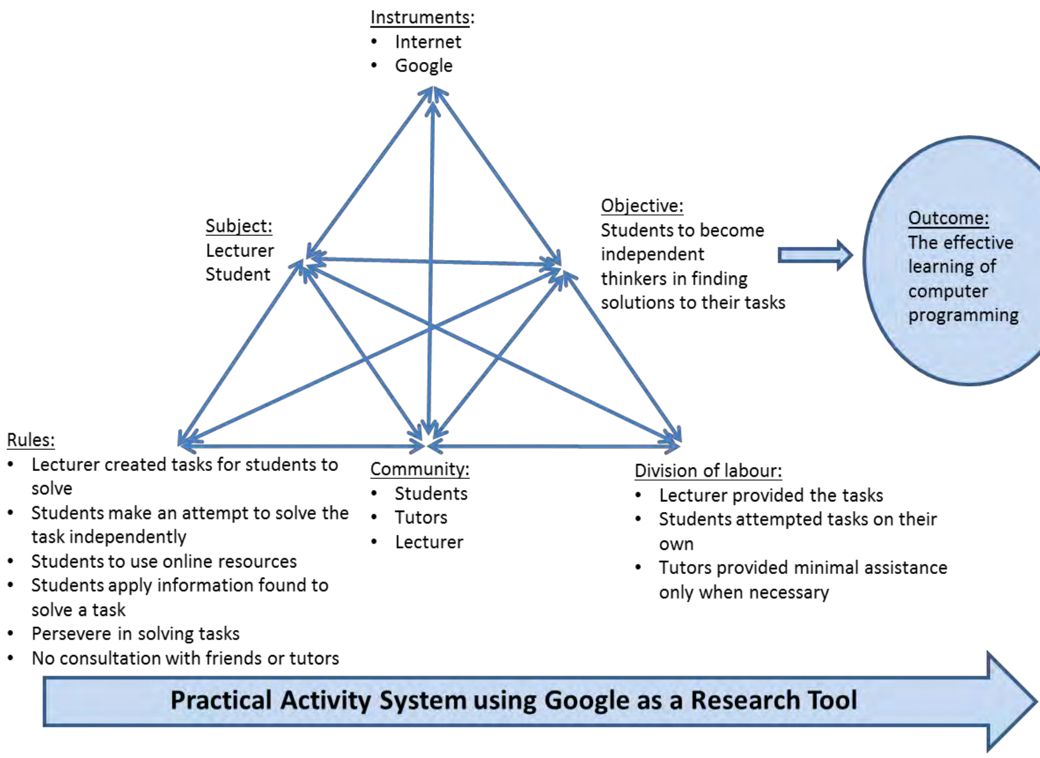

Figure 6.22: Practical activity system using *Google* as a research tool

In this activity system the lecturer (subject) created tasks for students to solve independently (rule). Students (subject) were required to use online resources like *Google* (instrument) to solve their tasks. The objective of this activity system was for students (subject) to become independent thinkers in finding their own solutions to tasks in computer programming (object). The tutor (community) provided little support while students were expected to find relevant information and correctly apply it in solving their task (rule). This activity system required the student to be the active participant with the tutor and lecturer being passive facilitators in guiding the students.

6.9.3 Engagement

The lifecycle depicted in Figure 6.23 highlights all the action and reflective moments that were undertaken during the transformative process of using *Google* as a research tool.

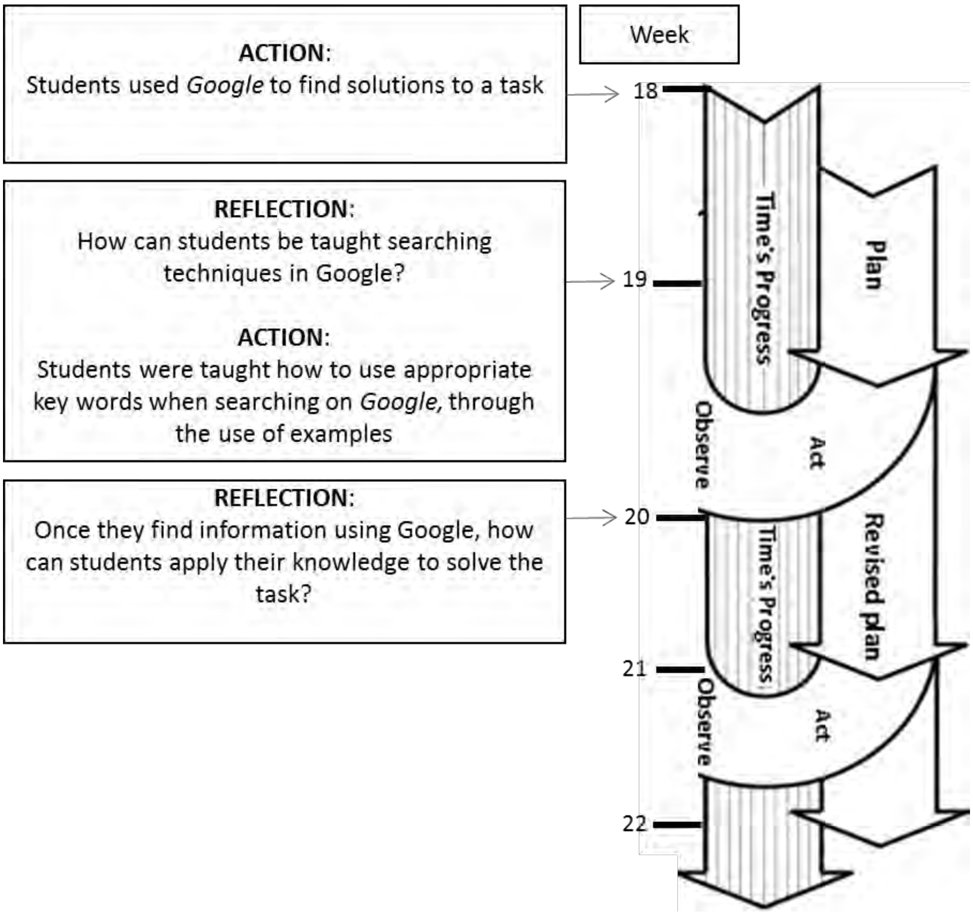

Figure 6.23: Action research transformation of the use of *Google*

Most students in this study depended on the resources that were provided in the BLE which was in the form of tutors, mentors, notes, blog, videos and animations. It was time to remove the support structures to determine whether students were still capable of solving their tasks independently.

Carefully chosen tasks were given to students, which required them to perform research since some of the concepts required in the solution were not taught in class. Students were clearly informed about the research nature involved in solving the tasks and the tutors were requested to provide minimal assistance to the students during this process. As a result, students had to be more proactive in finding their solutions.

The first task administered to students in this activity system was a simple one in which the instrument *Google* was used to locate relevant information to solve a task. The idea was to try to build students' confidence before attempting successive tasks of a complex nature in a similar way. The following comments were received (EQ25, SUR11) from students after the first task:

Student1: This is hard, finding information on our own

Student2: It is your job to be teaching us this information

Student3: I can find the information on the internet but I don't know how to use it in my program to get the correct answer

Comments solicited from the electronic questionnaire verify the argument that students prefer to be taught rather than construct their own knowledge. The following diary entry was made on 29 May 2013.

Students were not able to use Google effectively and had difficulty obtaining relevant information. Those students that did find the correct information had difficulties in applying the information to solve their tasks.

Tensions developed within the activity system. While students (subjects) were engaged in solving their tasks (rule), I noticed their ineffectiveness in using *Google* as a tool to find relevant information. These students were not using appropriate keywords in their search criteria to extract the relevant information resulting in unrelated search results.

A tension occurred between the student (subject) and their ability to apply the information correctly to solve the given task (object), which proved to be a more serious tension to address. Many students tried using the information found on *Google* in exactly the same way to solve their task. I observed only five students who were able to find and apply the information in the correct way.

As a means of addressing these two issues, students were firstly taught how to use appropriate keywords when searching for information; a problem that was easily addressed. The second problem was more challenging to address because students had to transfer their knowledge to solve their task, requiring them to use their problem solving abilities to find the solution.

6.9.4 Analysis

Upon reflection, there are few points that I learnt from this activity system. The students' historical context did not expose the vast majority of students to the internet despite some students being introduced to the computer at secondary school level. As a result, students were being introduced to the internet for the first time at this level. At the time this activity was introduced, students would have had exposure to the internet, but this exposure would have been limited and in most instances self-taught. Furthermore, having spoken to other lecturers teaching these students, I found that they did not engage the students with internet related tasks which required independent work. This suggests that students may have become comfortable with a teaching style, as was suggested by Student 2 comments, believing that it was the responsibility of the lecturer to impart knowledge to students. I believe that students need to be formally exposed to the internet early at university and taught how to effectively retrieve information using search engines like *Google*, especially those who are enrolling in IT.

Students had problems expressing themselves in English, as it was their second language, and were therefore unable to use the correct search words to find the relevant information. They were able to speak in English but many found written English more difficult, which had also surfaced in section 5.2.4.5 (students afraid to ask questions). This contributed to the unnecessary feedback obtained from the *Google* searches.

Perhaps more importantly, students struggled with the problems solving nature of this subject. Although they were eventually able to find information on the internet related to solving their task, they were unable to apply the information correctly to solve the task. In many instances I observed students' attempting to use the information in exactly the same way as it was found. This stems from the fact that these students did not understand how to apply the information (PD27) to solve their task. Their poor problem solving skills can be traced back to the poor results produced in both Mathematics and Science.

Students were found to give up too quickly when faced with solving their tasks. I observed that whilst students were given projects at second and third year level, which forced them to conduct internet research using *Google*, students were quick to get assistance from other students or friends when in difficulty rather than attempting to persevere on their own. It must also be noted that each year there are always a small group of students that push the boundaries and are constantly working on the internet and striving to solve challenging tasks or learning new technologies. Other students tend to become reliant on this small group of students for help.

6.10 Conclusion

This chapter discussed the support aspect of the BLE and described the action research process employed to address a series of challenges that were exposed in the theory and practical environments, which were outlined in the previous chapter. The action research methodology played an integral part in developing a support tool whilst activity theory proved important to identify tensions within the activity system of the support tool.

Each of the support structures were described through the use of the action research methodology. The lecturer engaged by creating each tool and support structures to assist students, who engaged in using these resources. Analyses of the findings suggest that students preferred visual materials in the form of videos and animations. Student support was effectively acquired through the use of small group discussions in the laboratory and peer assistance outside of the classroom. The blog was also found as a suitable learning resource because of the examples. On the other hand, students did not favour reading materials like supplementary notes and the textbook. This is attributed because of a barrier having to learn in a second language. Students also struggled to use research tools like Google to solve tasks independently.

The use of online testing and student mentors as support structures were found to be unsuccessful in this study. However, I am now of the opinion that they have great potential in improving the learning process if implemented effectively. A process of evaluation is required to determine the effectiveness of the support structures and to find innovative ways to utilising them to improve learning.

Language has proved to be a barrier in the learning experience of many students. These second language students required examples to reinforce the concepts taught. These examples served as a support structure in helping them to better understand content. They also appreciated the visual content which proved to be more successful in understanding concepts compared to reading materials. There was also a hint of purposeful planning amongst some student that enhanced their overall learning experience. All of these concepts will be further elaborated upon in the next chapter.

CHAPTER SEVEN

7 Synthesis of research findings

7.1 Introduction

The previous two chapters presented the findings of this study. In Chapter Five a number of key issues in the theory and practical environments were identified, and in Chapter Six the tools and support structures to address these key issues were introduced. In doing so, these two chapters addressed the two critical questions:

1. How does engagement of computer programming take place within a BL context using an action research approach?

2. Why does engagement of computer programming take place within a BL context using an action research approach, in the way it does?

This chapter commences with a summary of how the critical questions were answered and then identifies key themes that surfaced from the data namely, 1) student engagement with examples and visual materials 2) importance of support and 3) the importance of planning. Themes were categorised into three main action research components: engagement, feedback, and reflection.

The concept of dual engagement, emerging from this thesis, is illustrated using the three main components outlined. First, student engagement as outlined by Kuh, Cruce, Shoup, Kinzie, and Gonyea (2008) is discussed. Ivala and Kioko (2013) identify factors that affect engagement. Second, feedback as outlined by Baumfield et al. (2013) is highlighted introducing the 'feedback loop' between the lecturer and the student. Third, reflection as presented by Selener (1997) emphasises the importance of the reflective stage during the action research process.

Finally, these three ideas are incorporated into a new model, influenced by the works of McNiff (2013). The model presented extends the existing plan, act, observe and reflect action research process. The chapter concludes with final thoughts by the researcher on his main experiences during this study.

7.2 Responding to critical questions

As a lecturer, I engaged in a BLE by developing a host of tools and support structures to assist students in their learning. Supplementary notes were introduced to assist those students that missed the theory lesson. This was followed by the introduction of online tests to help students learn the necessary concepts and techniques required to solve tasks. These tests also served the purpose of providing feedback to students by highlighting areas of weakness. Students reported that help was not always available as tutors were busy for long periods of time with specific students. Small group discussions were therefore introduced in the laboratory to facilitate collaboration amongst peers when difficulties in solving tasks arose. The next support structure was the introduction of mentors to support students in small groups outside of the classroom. Thereafter, a blog was created as an alternate environment to receive answers in order to assist students who were afraid to ask questions in class. Additionally, videos were introduced to supplement the work conducted in class, thereby making use of visual tools. This was followed by the use of animations to teach abstract concepts. Finally, the use of the search engine, *Google* was utilised to determine student effectiveness in solving tasks independently. Having introduced all these tools and support structures, students engaged with them and found some to be more effective than others. Themes were extracted from the data to highlight important findings and will be outlined in the sections below.

7.2.1 Engagement with examples

Within the context of this study, a number of scenarios arose requiring examples to enhance student understanding in computer programming. In the first instance, examples were used during the theory lesson to explain concepts and techniques, which helped students' better understand concepts and techniques. Thereafter, examples were utilised in the supplementary notes to clarify the meaning of the theoretical definitions. Another instance when examples were introduced revolved around the blog. In this case, the use of examples attracted students to utilise this tool as a means to enhance their learning. During this process, students felt enthused to post questions on the blog, and the answers received were also used by other students to improve their learning.

It appeared that the approach of using examples during the learning of concepts in computer programming aided students to move from the known to the unknown. Moreover, it improved their understanding of the concepts and gave them the confidence to attempt other tasks that were more challenging. The step by step nature of the examples coupled with explanations, helped students better understand and apply the concepts in solving their tasks.

Some authors agree that using worked examples as a teaching approach for student learning can improve general problem solving skills and computer programming ability (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Atkinson, Derry, Renkl, & Wortham, 2000). For instance, Ning and Wuzi (2011, p. 2584) suggest the following: "prepare examples well and present to students a lot of interesting standardized programs… so that students can grasp basic conceptions, expressions and programming skills through examples". They further elaborate that students programming ability can be enhanced by using a comprehensive set of examples. Additionally, these authors outline that the use of comprehensive examples in the form of case studies allow students to practice and "enhance their ability of programming" (p. 2584).

7.2.2 Visual engagement

An attempt was made in this study to utilise visual materials in presenting information, taking the students learning style into consideration. Videos and animations were employed and found to be an effective means of reinforcing concepts in the learning process. Other visual attempts were made through the use of a projector during the theory lesson to demonstrate computer programs to a large group of students. It was found that students appreciated the step-by-step visual demonstration of program execution. The whiteboard was used to visually represent computer programs during this lesson and concepts were explained through the use of different coloured board makers to highlight the various aspects of a program. Furthermore, animations were used to teach abstract concepts to students, which they found valuable in their learning.

Many studies conclude that visual material is an effective way to enhance the learning of students (Fowler, Allen, Armarego, & Mackenzie, 2000; Thomas, Ratcliffe, Woodbury, & Jarman, 2002). According to MD Derus and Mohamad Ali (2014, p. 94), "program visualization (PV) can be defined as a visual representation of program or algorithm execution in the form of graphical components". Through the use of program visualization, processes that are hidden by the computer can be explained by visual means (Bednarik, Moreno, Myller, & Sutinen, 2005). One reason for students having difficulties in learning computer programming concepts relate to their inability to visualise the sequence of the program (Ahmad Rizal, Mohd Yusop, Abdul Rasid, & Mohamad Zaid, 2011). Pears et al. (2007) state that these complex processes are easier understood through a visual means.

7.2.3 Engagement with language

There were many instances when the use of English as a language negatively influenced the students' comprehension and attitude towards the tools and support structures. Consequently, it seemed that these second language students were not attracted to reading the prescribed textbook. Also, the majority of students did not make use of the supplementary notes, which required reading in English. This was further highlighted through the use of *PowerPoint* animations. Students initially did not utilise this resource because many of them omitted reading the instructions, essential to understand what it was trying to achieve. Failure to do so resulted in students not taking advantage of this resource. Further evidence of the English language being a barrier was seen when students were requested to write questions on paper if they felt apprehensive to verbalise their questions in the large classroom environment. Some students attributed the failure of this option to problems expressing themselves appropriately on paper i.e. poor written skills. Finally, English also proved to be a difficulty for students when they used *Google* to search for information whilst solving their tasks. They used phrases that led to irrelevant information because of their inability to express themselves well in English.

In this study it appears that requiring students to write and read in English affected their use of important tools, rendering some of these resources ineffective. Mgweto, cited in McNiff (2013, p. 99) makes an interesting comment on the issue of reading:

> *To be honest, reading is not of the normal practices for us Africans, because we have a long history of passing information orally from generations to generation*

Based on the comments made by Mgweta, it appears that students within the context of this study have a similar culture of not wanting to read and preferring to receive knowledge "orally". This may also explain why students were attracted to the theory lesson where they were satisfied to receive knowledge through one way communication. Furthermore, students were attracted to the videos which also promoted a similar way of receiving knowledge.

Ivala and Kioko (2013) had suggested that language barriers may affect students who are learning in a second language whilst Su and Ow (2004) note that students' proficiency in English contributes to achieving better results amongst computer science students. This was supported by Pillay and Jugoo (2005b, p. 110) who conclude that "students whose first language is not the same as that used in the instruction of the course did not perform as well as the rest of the class". On the other hand, Aina and Olanipekun (2013) reported that English language had no influence on the academic performance of second language students learning in Computer Science and Physics.

7.2.4 Building a support structure

The notion of feedback and support was prominent at different stages of this study. Students were constantly providing feedback on the BLE. Based on the feedback obtained, I was able to provide support structures to the student, in an attempt to enhance the learning environment.

Three main levels of support were identified as important, based on the feedback received from students during the course of this study. Firstly, the lecturer required support to address technical challenges experienced with the LMS. Secondly, students required support in terms of their learning of computer programming. Finally, support was required from the institution to ensure the effectiveness of the BLE. Each of these three levels of support will be discussed.

The first level of support was required by me as the lecturer who utilised *Moodle* as the LMS to host the tools in this study as I had no previous experience or knowledge of using this tool. Based on the feedback received from students, I was made aware of a technical difficulty they experienced whilst utilising the online tests. With the lack of support, these challenges were not resolved directly with the *Moodle* software, resulting in a changeover to the *Blackboard* LMS. As a result of not having support structures in place to address the original problem with *Moodle*, a drastic change over to Blackboard was required that could have jeopardised the study. Fortunately, the challenges were experienced early in the study and a solution was implemented without too many disruptions. I found the notion of feedback and support is essential to combat these technical difficulties. However, these support structures need to be embedded prior to commencement with the study so as to address the challenges efficiently.

A second level of support was required to assist students in a subject that was found to be difficult to pass. Apart from the many tools and support structures utilised and discussed in detail thus far, feedback obtained from students suggested that too many concepts were taught during the theory lesson. As a result, a further support structure was provided with the innovation of a second theory lesson. This was an attempt to teach fewer concepts to them in order to reduce the pace of the lessons. Students found this form of support effective since they were able to absorb fewer concepts at a time before applying them during their practical lesson. It was only possible to introduce this support structure as the result of the feedback obtained from the students.

Peer support was provided in the form of small group discussions during the practical lesson. Students seemed to be more comfortable receiving help from their friends, which stimulated discussions amongst them and resulted in learning. Furthermore, some students took the initiative to create their own support groups to assist each other, found to be useful, especially when they missed the theory lesson.

Support was also essential to a group of students that were ‘at risk’ of failing this subject. These students were identified and supported with personal assistance using animations to learn a specific section. The personalised support environment coupled with the use of animated tools helped students improve their learning and pass their test.

Finally, the third level of support was required from the institution. The LMS which hosted most of the tools used in this study could not be accessed from outside the institution. Students indicated that their busy work schedules prevented them from utilising the tools while on campus. As a result, they needed remote access to the LMS via login to utilise the resources. Throughout the study, students were unable to login and utilise the tools because the department of ITN, responsible for maintaining the networks, was unable to setup the LMS system for this purpose. Students therefore needed to spend longer hours at the institution to utilise the tools.

Support has been outlined as an important structure to assist students and lecturers in enhancing the learning environment. One of the reasons why students drop-out from university is linked to the lack of support. Huges (2007, p. 349) outlines that “students from poorer backgrounds are more likely to withdraw from a course”. All students within this study came from disadvantaged backgrounds and were attempting a subject that was already difficult to pass. Additional support was thus of major importance to improve the pass rate in this subject. Huges (2007, p. 350) state that students have difficulties because of the “poor support” structures provided by the lecturer.

Support structures for students at risk are also important to implement. Huges (2007, p. 351) suggests “identifying ‘at risk’ learners and then offering additional support”. She elaborates that these students can be identified by the tutors and “time spent supporting ‘at risk’ students is worthwhile” (p. 352) and concludes that the “combination of a well-designed and supported blended learning with proactive help and encouragement for ‘at risk’ learners can improve coursework submission” (p. 361). Support has been outlined as an important structure to assist students and lecturers in enhancing the learning environment.

Support is not only essential for the student. As Bennett, Agostinho, and Lockyer (2014, p. 2) state, it is important to determine “how best to support university teachers to design effective online learning experiences for their students”. Lecturing staff require support in many different forms. This can be achieved through the sharing of design examples coupled with lecturer support and guidance (Conole & Culver, 2010). Furthermore, by supporting students, lecturers can obtain a better understanding of their students (Bennett et al., 2014). They further outline the need for creating external networks of support, something I lacked while working with *Moodle*.

This section outlined the necessity for support. Apart from support, feedback was also identified as an important ingredient to identify the areas of weakness so that support structures can be developed and introduced.

7.2.5 Purposeful planning of activities

In this study, planning was required on two levels. First, an action research methodology was employed requiring planning at various stages. Apart from the planning, the process of reflection was also vital to this methodology. The advantage of using this methodology allowed me as the researcher to reflect on a situation and to re-plan to improve the situation. Secondly, planning was also required by the students to be effective in their learning. They had to reflect on their learning on different levels to improve this process. Each of the two levels of planning by the lecturer and the student will be discussed.

Apart from the planning and organising, which is mandatory for any academic in preparation for their class, the following discussion will focus on the planning required in the creation and setup of the tools and support structures that were introduced in the BLE. The planning phase of each action research process was usually triggered by the feedback obtained from students and critical reflection by the lecturer on the data obtained. Based on these reflective moments, the most appropriate plans were initiated by thinking of innovative ways to assist students with their purposeful engagement in computer programming. Further reflection and planning was required during the implementation of the plan to achieve the result in the most effective, yet simple way. Once the plan was implemented, I required a plan to observe the students whilst they engaged with the tools. I found during each of the action research steps, careful reflection was required which kick-started the processes of plan, act and observe.

I found that planning from the students' perspective was also important for them to succeed in a higher education environment. However, it appeared that some students lacked proper planning which affected their learning and ultimately resulted in them underachieving. An instance of their lack of planning was around transport issues. Some students were unable to take the first bus from the student residences to the institution timeously to attend the first lesson on a Monday morning. As a result, these students did not understand the concepts required to solve their tasks during the practical lesson.

On the other hand, two positive cases on planning were identified in this study. Firstly, a second year student mentor with good planning skills led to him being successful in his studies and in his extra-curricular activities of being a mentor. Secondly, a repeating student commented on how his proactive planning skills coupled with commitment in his second year of study enabled him to produce distinctions in subjects that he had previously failed.

Planning and reflection was also required by the student in solving a computer programming task. This required them to carefully plan their solution on paper and to reflect on the correctness of their plan before implementing it on computer. Studies have shown that this phase is sometimes omitted and students attempt to break down a task while they solving it (Manlove, Lazonder, & de Jong, 2009). A similar problem was observed in this study. In most cases the planning phase was non-existent prior to implementing the solution, as corroborated by Perkins et al. (1989). More time and effort is required by students to carefully plan their tasks and to reflect on their plan before attempting it on computer.

In an educational environment, planning is required by the lecturer and the student. Planning is considered to be an important aspect of learning (Hattie, 2009). However, according to Bonestroo and de Jong (2012, p. 559) "in traditional educational settings, planning activities are not typically performed by learners themselves, but by others, such as teachers, schools or educational publishers". Bonestroo and de Jong (2012) outline the following important aspects related to student planning: firstly, students need to know the type of actions that need to be carried out, secondly, it deals with making time, putting in the effort and obtaining the required assistance. Finally, the appropriate choosing and execution of the content is required. Moreover, during the process of planning, students are expected to set milestones during their learning in order to determine their progress (Butler & Winne, 1995). Studies conducted by Butler and Winne (1995) have shown that students who plan their activities well achieve better results in those activities. However, other studies have not reported on a positive correlation between the learning outcome and the use of planning (Moos & Azevedo, 2008).

Both planning and reflection were identified as critical factors in this study. It is important to reflect carefully on a situation before implementing a plan of action which was evident during the action research process. The next section will consider the key principles of engagement, feedback and reflection used in the action research methodology of this study.

7.3 Key Action Research principles used in this study

7.3.1 Engagement

Student engagement as given by Kuh et al. (2008) hinges on two components, firstly it is student based and secondly it is linked to an institutional setting, which deals with the time and effort that students spend on educational and other activities that lead to success. Student based factors deal with habits, tasks, staff-student interaction and motivation (Eccles & Wigfield, 2002). However, these factors are insufficient to encompass engagement since engagement deals with factors such as academic activities and experiences, lecturer interactions, co-curricular activities and peer collaboration (Eccles & Wigfield, 2002). Ivala and Kioko (2013) believe that student engagement goes beyond the barriers of student and institutional interactions and they argue that the socio-economic background and the language barriers within a South African context plays an important role. All these factors have an impact on the dual engagement between the lecturer and the student.

The process of dual engagement in this study played a vital role and was achieved with the lecturer constantly developing tools and support structures and the students engaging by using them in an attempt to enhance their learning in computer programming. This dual form of engagement between the lecturer and the student is represented in Figure 7.1.

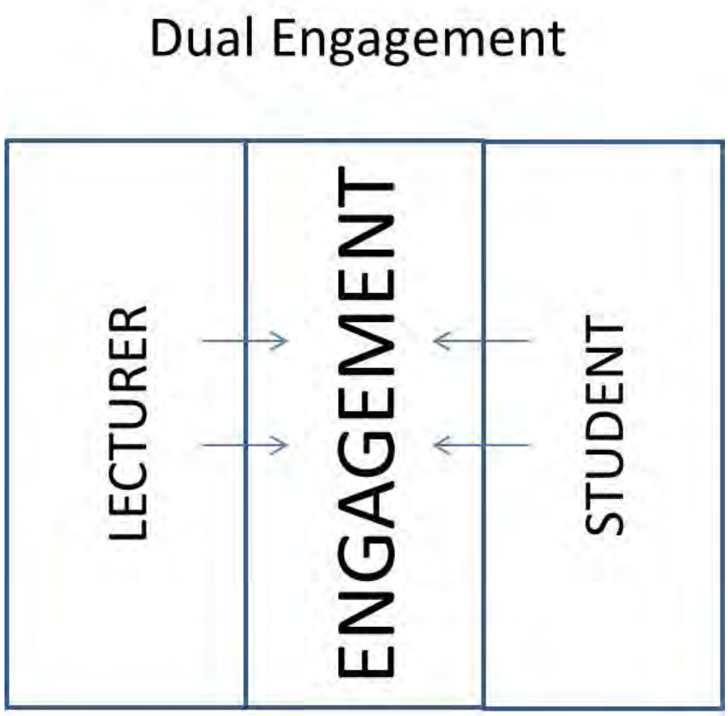

Figure 7.1: Dual engagement

In this dual engagement environment, students constantly provided feedback to the lecturer on their experience in the BLE. Constant reflection was required by the lecturer to analyse the comments and to enhance the tools and the support structures. In some instances, the analysis led to the introduction of new tools and support structures. This form of engagement that occurred was dynamic and constantly led to improvements and changes within the BLE. The next section will describe the concept of feedback as utilised in this study.

7.3.2 Feedback

Ruddock (2006) indicated there has been an increase in perception regarding policy, practice and research. Baumfield et al. (2013, p. 96) argue that "teachers are finding that all learners, regardless of age, can have useful things to say about their experiences of the institution, teaching and learning. However, we would argue that there is a need to make sure that the process is truly authentic and to do this the process needs to be as transparent as possible". They further argue it is important to get the students perspective on the outcome and to open up a dialogue about the learning and teaching that occurs and provide a feedback loop as illustrated in Figure 7.2.

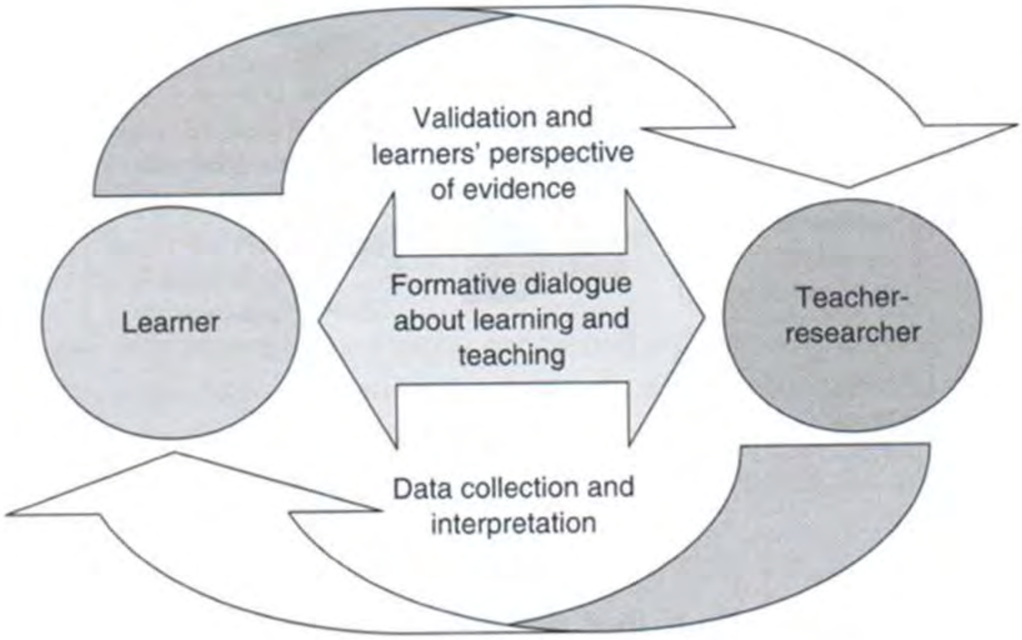

Figure 7.2: Feedback loop (Baumfield et al., 2013, p. 96)

Through the use of this feedback loop, refinements can take place to the environment in an attempt to enhance the learning process.

Feedback is an important part of the education process (Clariana & Koul, 2006). During the course of this study, feedback from students on the use of the tools and support structures played an important role to understand their experience using these resources. Based on their comments, refinements were made by the lecturer in an attempt to improve the resources. Student feedback was obtained on the theory lesson, practical lesson and the support environment aspects of the BLE, occurring after each lesson. An electronic questionnaire was developed as part of the Dr.Q customised software to capture the feedback from students and to produce reports to analyse the data. This process of feedback played an important role to improve the BLE. Once the feedback was received, the process of reflection was required for analysis.

7.3.3 Reflection

Reflections occurred by the lecturer and the student and are discussed below. Firstly, the lecturer reflected during the action research process in an attempt to improve the tools and support structures developed and secondly reflection was required by the students to solve their tasks. They were also expected to reflect on the BLE and provide feedback on their experience. Each of these levels of reflection will be discussed.

By using an action research methodology, I found myself constantly reflecting at each stage. Selener (1997, p. 105) states that with action research, "change does not come about as a result of spontaneous acts, but through reflection on and understanding of specific problems within their social, political, and historical contexts". Through the process of critical reflection, I was able to explore and understand how and why the engagement occurred which was also corroborated by Sankar, Bailey and Williams (2005).

Students were required to reflect on two issues. The first required reflection on their computer programming tasks before implementing on computer. This process of reflection is considered important in the learning process (Sugerman, Doherty, Garvey, & Gass, 2000). Through the process of reflection, students can create new knowledge from existing knowledge (Sugerman et al., 2000). Ertmer and Newby (1996) claim that students in computer programming do not plan their solutions beforehand leading to bad techniques and resulting in a poor solution - a problem that was observed during the course of this study. These authors recommend that students be more reflective whilst planning their solutions. These comments are corroborated by Schwartzman (2006) who argue that a reflective approach is required to eliminate the confusion whilst solving a program, and to better understand how it should be solved. Within the context of this study, I found that most students simultaneously planned, reflected and implemented their solution, which was not an effective way of solving a task.

The second issue revolved around students reflecting on their use of the tools and support structures before providing feedback to me as the lecturer. The feedback obtained helped me as the lecturer to enhance the learning process. The next section presents my model of dynamic engagement based on the ideas of engagement, feedback and reflection utilised in this study.

7.4 Action Research methodology extended

In using an action research methodology, the basic framework of:

PLAN → ACT → OBSERVE → REFLECT → REPLAN

as outlined by Lewin (1946), was employed at the start of the action research process. Whilst this process is cyclic in nature, the steps involved are executed in a sequential manner, resulting in the introduction of multiple cycles. Many different cyclic approaches of action and reflection have been presented (Elliott, 1981; Kemmis & McTaggart, 1982; Ebbutt, 1985; McKernan, 1991). However, my representation of the action research process was most influenced by the ideas outlined by McNiff (2013, p. 62) who states that these models "are sequential and predictable" and argues that "they are potentially prescriptive and are disconnected from real-life practices". Instead, the model that she presents "aims to communicate dialogical processes with infinite transformational processes appropriate to the emergent nature, fluidity and unpredictability of practical living and the improvisatory knowledge base that underpins it" (p. 64). A graphical representation of this process is outlined in Figure 7.3.

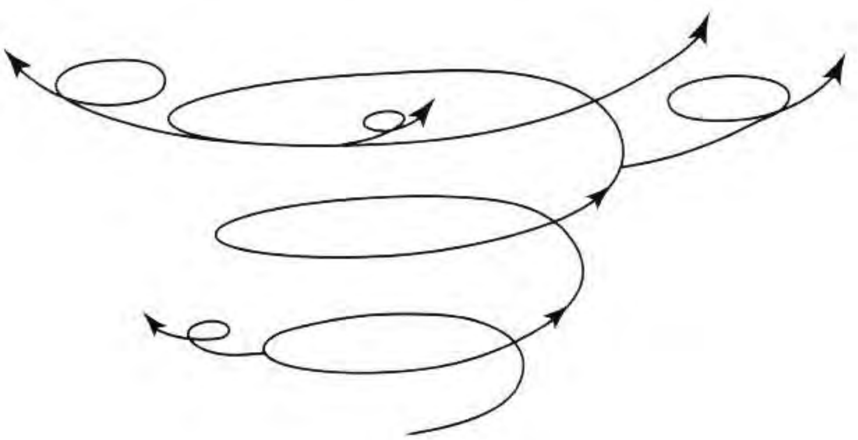

Figure 7.3: Generative transformational evolutionary process (McNiff, 2013, p. 66)

McNiff (2013, p. 67) outlines her ideas of this process:

> *I have come to see action research as a spontaneous, self-recreating system of enquiry. I like the notion of a systematic process of observe, describe, plan, act, reflect, evaluate, modify, but I do not see the process as sequential or necessarily rational. It is possible to begin at one place and end up somewhere unexpected. The visual metaphor ... represents an iterative spiral of spirals, an exponential development process. I have come to see the process as beyond words. While it may be analysed in terms of an action research approach, I do not think it should be so confined. The spirals of action reflection unfold from themselves and fold back again into themselves. They attempt to communicate the idea of a reality that enfolds all its*

previous manifestations, yet which is constantly unfolding into new versions of itself, constantly in a state of balance within disequilibrium. I am certain of uncertainty; I am balanced within my own disequilibrium. In action research terms, it is possible to address multiple issues whilst still maintaining a focus on one, a realisation of Plato's idea of holding together the one and the many.

I am in agreement with McNiff's comments that the action research process is not sequential and can contain smaller cycles within the larger action research cycles. However her illustration is too general. She does however outline that "to propose that action research models can be imposed on practice is to turn action research into a technology, an oppressive instrument that can potentially distort other people's creative practice. The best thing, perhaps, is for you to create your own, to communicate metaphorically the way you live and learn" McNiff (2013, p. 64). For this study, a similar framework as presented by McNiff was utilised for the action research process. Although she subscribes to a "systematic process of observe, describe, plan, act, reflect, evaluate, modify", a different sequence of events unfolded herein, which utilised a process of plan, act, observe, and feedback, with the process of reflection forming a foundation for each step. An illustration of this process, based on an extension of Lewin's framework, is depicted in Figure 7.4.

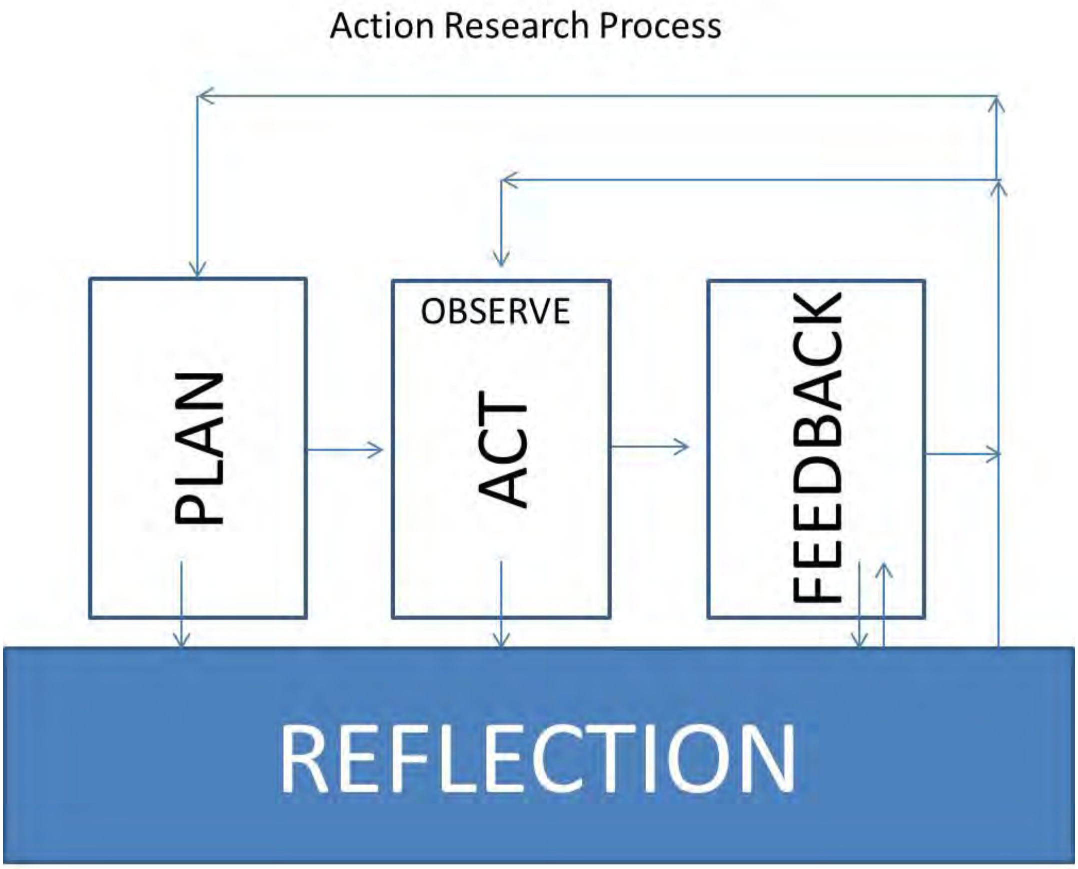

Figure 7.4: Action research cycle used in this study

This study started with reflection by the lecturer on the teaching and learning of computer programming. Through the process of reflection, a problem was identified, that is the low pass rate in this subject. Thereafter a plan was initiated to address this problem. The second stage required action or engagement which deals with the execution of the plan by the lecturer. During this phase the lecturer is required to constantly reflect on finding the best way to execute the plan. The planning phase involved developing tools and support structures to enhance the BLE. During the act phase, the lecturer constantly reflected on finding the best possible way to execute the plan. Once the plan was executed, further reflection occurred by the lecturer to determine the best possible way to observe the students whilst they engaged with the tools and support structures. Once the student engagement started, the lecturer observed the students in the theory and practical lesson. While the lecturer observed the students in the formal environment, students also utilised the supporting materials outside of the formal lessons. As a result, a feedback process was created where students provided comments on their experience in using the support materials. During the feedback process, students were expected to reflect on the BLE and on their usage of the support materials before providing feedback.

The action research model introduced in this study used the process of plan, act, observe and reflect. However, during the course of the study, a new process of feedback evolved, which students constantly provided after each lesson. This repetitive feedback process was similar to the feedback loop represented by Baumfield et al. (2013) in Figure 7.2. Based on the feedback obtained from students, further reflection was required by the lecturer which allowed two options. The first option was a refinement process that resulted in returning to the act process (see Figure 7.4). Hence, smaller cycles were created within a larger action research cycle. McNiff (2013, p. 67) introduces this notion of there being an action research cycle within cycles when she explains that "it is possible to address multiple issues while still maintaining a focus on one". In this study, the creation of these secondary cycles was evident. When no refinements to the tools were required, the option that emerged was to return to the plan phase, thereby creating a new tool or support structure. In each of the action research steps, the process of reflection was a common factor and served as a foundational aspect of the action research process.

Having presented models of the two main components of dual engagement (see Figure 7.1) and action research used in this study (see Figure 7.4), the final model is a culmination of these two models. The result is a novel dynamic action research engagement model, as described above and illustrated in Figure 7.5.

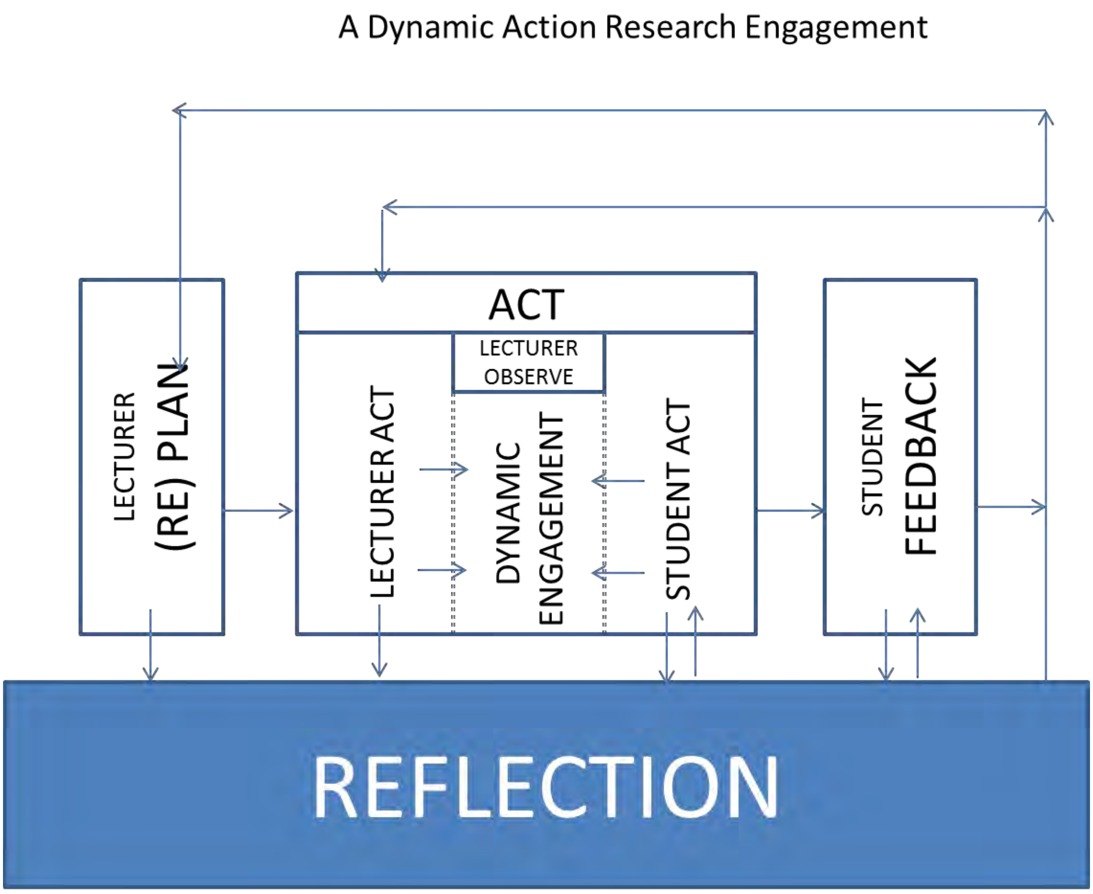

Figure 7.5: Dynamic action research engagement model

Whilst the findings in this study yielded important results, I believe the greatest contribution lies in the methodology that was used. The process of action research with dual engagement between the lecturer and student creates a dynamic engagement environment. With a base of reflection and feedback, the dynamic environment can be refined and enhanced to improve the learning experience of the student. From the lecturer's point of view, a repository of tools can be created and used each year in the learning process using this dynamic action research engagement model. An evaluation of the learning process can take place each semester to update and enhance the learning environment. In particular, the model created is flexible and is not restricted to the field of computer programming.

7.5 Researchers thoughts

During the course of this study a number of ideas emerged that are worth highlighting. These range from the approach used to my personal reflection and the dual engagement by the lecturer and student. The customised software Dr.Q proved to be a useful tool during the action research approach. Students were able to provide feedback quickly and easily to a centralised database. Reports were available to extract summaries of the student feedback on a weekly basis and at the click of a button. Furthermore, the software allowed me, as the lecturer and researcher to keep a diary of comments, and grouped by category. Thereafter lecturer reports were generated over a specified period of time grouped by a selected category. The analysis of the data obtained from the reports was simplified with the categorisation of information.

I found the use of an action research methodology to be useful for a number of reasons. This was my first experience using such a practice and I found it extremely valuable. Being directly involved in my research, I was required to view the environment with an open mind, in an attempt to make improvements. In particular, the feedback process was of great importance in such a dynamic environment. As an academic, I have always understood the importance of receiving feedback from students, however, this was usually conducted at the end of each semester. Now, I am of the opinion that feedback needs to occur on a more regular basis. A system similar to Dr.Q can be designed for students to provide compulsory feedback at regular intervals, allowing the student to provide anonymous feedback at any stage, if the need arise.

Furthermore, having utilised an action research process, I see the process of reflection from a new perspective. It has taught me the importance of finding time to reflect on my actions frequently and to identify innovative ways of improving the environment. The practice of reflection is seen as insufficient in my current environment, which now requires a reflexive practice.

Engaging in a study of this nature required areas of expertise in a variety of forms, all of which I attempted on my own. Upon reflection, I believe that a team of experts are required in setting up a project of this nature. These would include computer programmers, multimedia creators and technical expertise. Additional members of the team can be expanded based on the nature of the study.

Having a computer programming background helped me tremendously in this study. I was able to develop customised software to simplify the large volumes of data received. Thereafter, the ambitious plan of using *Moodle* as the preferred LMS failed, I was able to develop a contingency plan. Moreover, many support tools were created and used, which included the use of a blog and the creation of animations.

It is interesting to note that the pass rate statistics obtained from the university student record system showed that the average pass mark in TP1 two years prior to conducting this study was 45%. During the year in which this study was conducted, the pass rate increased to 64%. I would like to think that the tools and support structures had an impact on the increase in pass rate. I realise that other variables could have influenced the outcome of this result. It must be stated that the only difference from a teaching approach that was made during the course of this study was the introduction of the support tools and support structures.

7.6 Conclusion

In computer programming, a major concern is the low pass rate of first year students. As a computer programming lecturer myself, I find that this concern translates into a pressure felt by academics. In South Africa, the poor Mathematics and Science results further hampers students passing in computer programming. This study interrogated the engagement between the lecturer and the student to examine a BLE through the use of an action research approach.

The data was the engine to developing a further contribution, to action research, and resulted in a novel, dynamic action research model. Three core components within the dual engagement approach were found to be engagement with examples and visual materials, support, as well as planning. The dual engagement approach contributes to a more holistic way of addressing the above mentioned concern, as it takes into consideration both student and lecturer perspectives, with constant refinement or development of new resources.

As the action research process methodology progressed, the three core components gradually took on a new form, namely, engagement, feedback and reflection. This gave rise to the dynamic dual engagement action research model. This model is underpinned by reflection, which sustains the action research process.

The model is of benefit to both the student and lecturer in a variety of ways. The student becomes empowered through an enhanced and supportive learning experience. Accordingly, students are afforded the opportunity to produce better results. The good pass rate is mutually beneficially to the student and lecturer. The lecturer benefits through an improved sense of accomplishment and it builds the relationship with their students through a more interactive process. Moreover, the model allows for adaptation to the changing needs of the student thereby enhancing the quality of learning.

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9 Appendices

List of Appendices

9.1 APPENDIX 1: Letters

Permission from University

Date: 7 January 2013

VICE-CHANCELLOR & PRINCIPAL
RECEIVED DATE: 07/01/2013
REFERRED TO: MR JUGOO
07/01/2013

I am a senior lecturer in the department of ICT and currently registered for a PhD degree at UKZN. As part of my thesis, I need to observe first year computer programming students, in an e-learning environment, within the department of ICT. This environment will contain notes, videos, demonstrations and tests which will be hosted on a learning management system. All the tools will be developed and setup within the department. This study will be carried out to determine whether the e-learning environment will help students to improve pass rates in a subject that currently yields poor results.

This approach of lecturing has been supported by the department of ICT. There are no additional resources that will be required to conduct the study. I hereby request permission to carry out this study at in the department of ICT.

MR JUGOO.

Kind Regards

Vikash Jugoo

Letter of consent from student

PERMISSION: LETTER OF CONSENT FROM STUDENTS

Dear Student

I am currently a Senior Lecturer in the department of Information and Communication Technology at . There is tremendous interest throughout the world in the way computer programming is being taught at universities. My interest is in the area of blended learning in computer programming. This research that I am conducting will assist us in making the teaching and understanding of computer programming much better. As part of my research, I would like to interview you on your experiences in the blended learning environment that you will be exposed to in the subject Technical Programming 1.

In order to conduct the research I need to have your permission to interview and observe you working in this environment. This will help us to better understand the environment so that improvements can be made. The interview will take approximately 30 minutes and will be tape recorded. The data from the interview will only be used for my research purposes and will not be used for any other purpose without your consent. The recorded tapes will be lodged with the university authorities. Participation is voluntary and you are not obliged to answer all the questions that I ask you and you are free to withdraw from the interview at any time. Please note that no real names will be used in any material that I write up and every attempt will be made to keep the material confidential.

Thank you for your assistance. If you require any further information, please contact me on the number 0319077230.

Yours sincerely

____

Vikash Jugoo

DECLARATION

I, Tseph Dlamini (full name of student) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that my real name will not be used in any write-up and that my responses will be treated confidentially. I also understand that I will not be under any threat to participate and am at liberty to withdraw from the study at any time.

Signature: Dlamini Date: 4/02/2013

Confirmation of proof-reading

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ACADEMIC / PROFESIONAL EDUCATION CONSULTANCY
& EDITORIAL SERVICES

Director: S.M. Ramson

Editor's Report

Editing Work for Mr Vikash Ramanand Jugoo, Student no. 871875097

Critical review/edit/proofreading of PhD dissertation

The following have been undertaken:

- The entire dissertation was read. Editing has been done in accordance with SA language, spelling, grammar and usage.
- Suggestions have been made about the continuity between subsections and chapters. It was suggested that clear signposting be inserted at the beginning of chapters and at the end leading into the next chapter. Examples of how to do this were shown to student.
- Bibliography and Referencing was checked against APA standards, alphabetical sequence.
- Missing references were identified and student notified
- Some in text references correctly inserted and standardized to font style and size. The student was notified of errors and requested to correct the others.
- Language usage, grammar, sentence construction have been adjusted where necessary.
- Several language and sentence reconstruction changes have been made to the document directly in the text.
- The entire text was reformatted to Times New Roman or Arial, 12 point, 1.5 line spacing.
- Chapter Titles standardized. Chapter headings were centralized.
- Headers were added.
- The Table of Contents was checked but the student was requested to finalize it. Cross-referencing of pages done.
- Page layout and design were neatened, especially diagrams and tables, which the student was made aware of. The student was notified to insert References alongside captions.
- Where dashes were used for punctuation or effect, adjusted from short dashes in accordance with the em-rule – long dash. Hyphenated words do not use the em-rule.
- Where clarification was needed in the interrogation of the literature and student's arguments in the document, these have been pointed out in comments.

- The Research Methodology was checked for strength of argument/motivation, and issues of ethics.
- Discussion chapters were read with a view to check constructed arguments were logical and based on the data emanating from the study.
- The voice and particular stylistic nuances of the student have not been adjusted or interfered with.

WAIVER:

Any substantive changes made, are only to CLARIFY the meaning, NOT to change the meaning of the student's work.

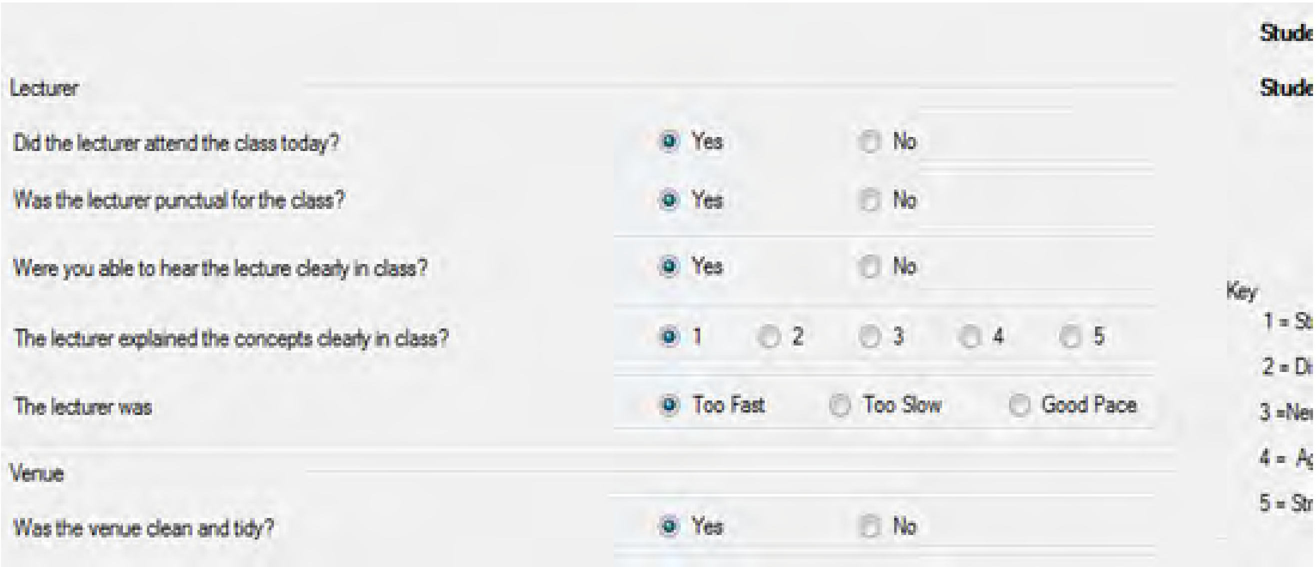
The student has engaged my services as editor for the purposes of examining and correcting the technical aspects of the work. It is assumed that at this stage the student's supervisor(s) has sufficiently examined the thesis and advised the student with reference to research, research methodology, data generation, reporting, knowledge production and content. It is also assumed that the student is sufficiently proficient in these matters. The editor waives any claim of responsibility regarding the student's type of research, research process, research methodology, data generation, reporting of data, knowledge production and content, and cannot be held accountable for any plagiarism by the student or the examiner's final assessment of the student's effort.

S.M. Ramson

9.2 APPENDIX 2: Electronic questionnaire (EQ)

<u>Snapshot of Electronic Questionnaires</u>

Theory Lesson Electronic Questionnaire (TLEQ)



Practical Lesson Electronic Questionnaire (PLEQ)

Stude

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Did you attend the theory lecture this week?	Yes		No		
How many practicals did you misss this week?	0	1	2	3	
Was the objectives of the lesson clearly outlined to the class?	Yes		No		
The tools were easy to use.	1	2	3	4	5
I was motivated using the tools.	1	2	3	4	5
I enjoyed using the tools.	1	2	3	4	5
Will you be able to finish the work outside of the laboratory?	Yes		No		

Key
1 = Str
2 = Dis
3 =Neu
4 = Ag
5 = Str

Student Comments from Electronic Questionnaire (EQ)

EQ01 13/02/13	Student: Add examples to the notes Student: It was not so easy to read and understand on my own. I could not understand all the notes. Student: I don't like reading too much and there were no examples Student: The notes did not work for me. I don't like reading something because it makes me sleepy. I prefer watching something.
EQ02 13/02/13	Student: Reading the notes helped me to better understand what you taught us in class. For me it was useful. Student: The notes helped me to understand your lesson. It can be made better by adding some examples.
EQ03 13/02/13	Student: I realised that I should not miss another theory class
EQ04 19/02/13	Student: Most of us like to work with examples
EQ05 19/02/13	Student: I felt sleepy reading the notes Student: The notes with the examples are much better. Thank you. Student: Improvement has been noticed in the notes Student: The notes are now easier to read
EQ06 20/02/13	Student: We do not have enough time to use the online tools on campus
EQ07 20/02/13	Student: The free computer laboratories were not always available for use to use when we are free
EQ08 20/02/13	Student: There were too few open access computer facilities on campus
EQ09 21/02/13	Student: We work in small groups to learn our work
EQ10 26/02/13	Student: We need to access the tools from outside Student: Everything is fine for the moment. I am able to access it from my residence Student: I don't stay at residence. How can we access the tools from home? The link does not work. Please help us Student: Sir. Many of us want to access the materials from home or library but cannot do so. What can we do?
EQ11 28/02/13	Student: I am getting confused. You teaching us too many concepts in one lesson Student: We need more examples

	Student: By the time I get to the last practical period, I forget what was taught in the theory period Student: It gets confusing when there are too many new concepts taught. We need another theory period
EQ12 12/03/13	Student: Sir, why you not using the projector any more. It was useful.
EQ13 16/03/13	Student: The theory lesson is the best for me. It is where I learn the most. Student: The theory lesson helps us very much Student: I like the theory lesson. With the extra period we are now learning more Student: The theory lesson helps us to understand concepts very well. Student: I make sure to attend the theory lesson
EQ14 19/03/13	Student: This is much better. Student: You do more examples. This way we understand better. Student: The examples are the best. I'm starting to enjoy the subject now Student: Test 3 is difficult to pass Student: I cannot get to the next test. Please make the pass mark to 50%
EQ15 23/04/13	Student: I did not see any link between the blog and our theory lesson Student: I was scared because you (are) on the internet and anyone can see your question. Student: I don't know how to use the blog
EQ16 14/05/13	Student: Out mentor is excellent. He is there during all the sessions and we learn a lot from him. He explains very well. Student: Our group did not miss any sessions. Our mentor is very dedicated.
EQ17 16/05/13	Student: I could not understand the guys accent Student: some of the videos were too long to watch and I got bored after 10 minutes. Student: I could not understand his way if speaking (ascent)? Student: These videos were not easy to understand Student: He speaks too fast
EQ18 20/05/13	Student: The demos don't make sense to me. Don't know what's happening

EQ19 22/05/13	Student: I did not understand everything (I read on the blog before the theory lesson). But when you explained in class, it was so much easier Student: After I read the notes (on the blog), it was much easier to understand the (theory) lesson. The examples were good on the website. Keep it up.
EQ20 22/05/13	Student: The Blog is a good learning tool. We can read the comments on the blog and learn our work. Student: I received answers my questions by reading question posted by other students Student: I did not have enough time to use the notes.
EQ21 23/05/13	Student: I plan to choose the Networking stream next year and have no intension of doing software development
EQ22 23/05/13	Student: I did not know what it (the animation) was doing. Student: I saw a red line moving in all the slides but did not know what was happening. Maybe because I missed the theory lesson. Student: For the first time I really understood how the for loop (in Java) works Student: I was lost (using the animations). My friend helped me and then (I) found them helpful.
EQ23 23/05/13	Student: I did not understand how it worked Student: The animations are difficult to understand. I'm not sure what is happening in each slide Student: I found them very useful. Student: I did not read the instructions and tried to figure it out by looking at each slide
EQ24 24/05/13	Student: These videos are good in helping me to understand and remember Student: I prefer seeing the videos. They are much better to use than the notes Student: I like the videos. The one problem is that you cannot ask any questions. That is why I prefer the theory class. Student: I missed the theory class. The videos helped me more than the notes. Student: I found the videos easier to learn from. It makes it easier. Student: I did not understand his way of speaking Student: I do not have enough time to use the videos

EQ25 30/05/13	Student: This is hard, finding information on our own. Student: It is your job to be teaching us this information Student: I can find the information on the internet but I don't know how to use it in my program to get the correct answer
EQ26 11/06/13	Student: I found the animations useful. It helped to teach me how an array works inside the computer. This made it easier to solve the questions you gave us. Student: It liked the small group and individual attention. It made me confident. The animations worked well in learning the work. Student: I found it (the animations) good. Student: It was useful working with the lecturer. Student: The *PowerPoint* helped a little
EQ27 13/06/13	Student: The following comments were made by the students that were at risk and who had made use of the animations. Student: The small group and individual attention that we receive was very helpful. Student: Working with the animations made me more confident to understand my work Student: I found it useful working with the lecturer. I was able to ask many questions whilst working in a few students

9.3 APPENDIX 3: My personal diary comments (PD)

PD01 04/02/13	There were approximately twenty students who missed the theory lesson.
PD02 08/02/13	The textbook prescribed this year (2013) contained many resources, such as: online test bank, *PowerPoint* presentations, solutions to exercises and tasks.
PD03 11/02/13	I made use of different coloured markers to represent different aspects of the computer program. Based on the student responses in class, I found this technique to be useful which I believe assisted to enhancing student understanding of the concepts taught in class.
PD04 11/02/13	There seems to be a trend with about 15 students being later (for the theory lesson) each week
PD05 12/02/13	Some students were not able to get assistance from the tutor because they spent lots of time helping other students in class. I also found a few students copying solutions from their neighbours
PD06 18/02/13	Only 10 students out of 120 had the textbook after the first month of lectures. If a student did not have the textbook and misses a theory lesson, they will need to find other resources like the internet or their friends to catch up with work missed
PD07 18/02/13	You are an academic, you cannot compare your children with the students that you are teaching. Most of your students come from a background where no reading takes place at home and they are not encouraged to read. No body forces them to read. They have more important duties to carry out at home. My child goes to a school that encourages them to do 10 minutes of reading every day. If I don't ensure that he reads then he is not going to read. Most parents do not realise the importance of reading.
PD08 18/02/13	Students learn techniques well through the use of example

PD09 20/02/13	Students commented that they preferred visual material.
PD10 25/02/13	Today my theory lesson was based on using the computer and projector to demonstrate a series of programs that used methods and passed parameters. I had made the required booking with the secretary in the department but it was not available since the lecturer that used it last had not returned it to the secretary. I change of plan was necessary whereby I used the board to explain the concepts making use of examples. This was found to be time consuming and I could not complete all the examples as I had prepared.
PD11 25/02/13	If students collaborate and pass the test, is it serving the purpose it is intended to serve, that is, for students to learn the theoretical concepts? In this case, some form of learning will actually take place, unless cheating occurs and one student writes the test in the absence of the student.
PD12 01/03/2013	It was great learning how to work with *Moodle* but it's taking up too much of my time which can be better utilised elsewhere in this study. It's time to migrate to Blackboard
PD13 13/03/13	Having checked with other lecturers, the students that are performing badly in this subject are also performing poorly in their other subjects, except for a few exceptions.
PD14 14/03/13	For the first time, there was close to full attendance. The timing of the theory lesson needs to be changed next year
PD15 18/03/13	Because of my poor planning skills and lack of commitment towards my work I was not able to pass three out of four subjects in my first year of study. This year, having adjusted to university life and having a better plan and being more motivated towards my studies, So far I have distinctions in all of my tests in this subject
PD16 25/03/13	No lessons took place today because of student protest Only 15 students out of 120 had the textbook after the first term Most of the students that had the textbook indicated that they do not make use of the textbook at home. It is not so easy to read.

PD17 22/04/13	Students prefer to get assistance from their friends first. If they still experience problems then some of them ask the tutor for assistance
PD18 22/04/13	Two students in particular seem to copy solutions and don't show much interest in wanting to learn how to write computer programs
PD19 22/04/13	The weaker students seem to have received assistance from students that were coping and in some cases, the stronger students received assistance from the tutors
PD20 24/04/13	To my disappointment only two students posted questions on the blog. Having spoken to the students, they indicated that they posted the questions for the fun of it.
PD21 29/04/13	Two students indicated during the theory lesson that they accessed the blog using their mobile phones. They indicated that this was a productive way of learning since they have their mobile phones with them all the time. It must also be noted that these are the few students that have internet on their phones.
PD22 15/05/2013	After checking the blackboard stats, I found that some students are not bothered to complete their online tests
PD23 16/05/13	Only one of the twelve mentors consistently met with their groups over a three week period and they found the mentorship programme to be effective and enhanced their learning. They claimed to have had interactive discussions in their mother tongue in a casual atmosphere where learning with stimulated. Some groups claimed that the mentors did not attend scheduled meetings whilst some mentors stated that students were not attending. I later found that the problem erred mainly on the part of the mentors since their academic work workload had increased causing them not to find time for this voluntary job
PD24 16/05/13	The group that benefitted from the student mentor programme had a mentor that achieved above 80% in all his subjects and he appeared to have good planning skills
PD25 23/05/13	It seems that a small group of students seem to think that they could miss the theory lesson on a Monday morning and could catch up using the mentors programme conducted by the tutors
PD26 27/05/13	Many students did not understand what the animations were trying to achieve. It seems that they did not find them useful

PD27 29/05/13	Students were not able to use Google effectively and had difficulty obtaining relevant information. Those students that did find the correct information had difficulties in applying the information to solve their tasks.
PD28 23/04/13	There seems to be a few students who are content on copying solutions without proper understanding of how the task was solved.

9.4 APPENDIX 4: Student focus group interview (FGM1)

Questions for the first focus group meeting with students: 21 march 2013

1. Theory lesson –
    a. problems
    b. language barrier
    c. positive aspects
    d. the use of example in learning
    e. Students are afraid to ask questions – WHY? How to overcome.
    f. How do you catch up with work missed
    g. Text book usage as a resource in learning

2. Practical lesson –
    a. problems
    b. positive aspects
    c. How much help do you receive from the tutors?
    d.

3. Tools used in the learning process
    a. When did you use the tool/s
    b. How did you use the tools
    c. Why did you use the tools

4. Internet access

5. How important is it to have Internet access?

6. What motivates students in learning computer programming

7. How can the BLE be improved

Student Focus Group Interview 1 (SFG)

Date: 21 March 2013 – Group B at 9.15am
Date: 21 March 2013 – Group D at 11.00 am

Code	Line #	Conversation
SFG01	1	**Lecturer: Do you find the theory lesson to be useful?**
		Student: Very useful. This is where were learn all the work needed to solve our tasks.
	4	Student: It helps us with the understanding of concepts. I make sure to attend the theory lesson.
	6	Student: Really helpful. But if a student misses the lesson then they will be in trouble.
SFG02	1	**Lecturer: What were some of the techniques that were used by the lecturer in the theory lesson that made you understand your work?**
	3	Student: Using lots of examples. And we were writing everything down step by step.
	5	Student: When you make use of the projector to demonstrate programs, it is easy to see how the program works.
	7	Student: The examples and your explanations are the best.
		Lecturer: Some students indicated that they did not understand all the concepts taught in class. Why do you think this happens?
	10	Student: I'm not sure. All is well for me so far.
	11	Student: I agree
	12	Student: Sometimes the pace is too fast.
	13	Student: This lesson should not be the first lesson, especially on a Monday morning. I sometimes get late and it is difficult to understand what you are teaching.
	16	Student: Sometimes you teach too many concepts in class.
	17	Student: Yes I agree. You teach us the work on a Monday. I sometimes forget the work by Friday and cannot solve the tasks.
		Lecturer: Do you think it will be better to have another theory lesson?
	20	Student: Definitely.
	21	Student: Please have another theory lesson and all of us will get distinctions.

		Lecturer: Do you think that all students understand English well to understand my lectures?
	25	Student: Yes, I don't think English is a problem. They would not have passed grade 12 if they did not understand English.
	27	Student: Yes. Students would not have passed the aptitude test if they did not understand English.
SFG03	1	**Lecturer: How many of you were late for some of the theory lessons**
		(4 students raised their hands)
		Lecturer: How many minutes were you usually late
	5	Student1:about 15 minutes
	6	Student2: about the same time
		Lecturer: Were you able to follow the lesson after being late
	9	Student1: Yes, through the use of the examples I could follow the lesson and was able to solve at least half of the tasks during the practical lesson.
	11	Student2: The examples help a lot.
		Lecturer: Were you able to solve the tasks during the practical lesson
	14	Student2: Not all, maybe about half of the tasks.
		Lecturer: How did you'll catch-up with the work that was missed?
	17	Student1: I usually receive assistance from my friends and the tutors.
		We always meet on a Monday evening with some students that attended the lesson to catch up with the work lost. This is a very useful support structure which helps us to attempt most of the tasks during the practical lesson.
	21	Student2: Mainly from my friends but sometimes from the tutors.
		Lecturer: How many minutes late were you for the theory lesson?
	24	Student3: A few times I was about 45 minutes late.
	25	Student4: In the first term there were times when I missed more than half the lesson because the bus was late.

		Lecturer: Were you able to follow the lesson after being late?
	29	Student3: I struggled to follow the lesson. When you miss so much of the lesson then it is difficult to understand
	31	Student4: You can't understand much of the lesson
		Lecturer: How did you catch up with the work that you missed?
	34	Student4: A few times my friend helped me
	35	Student3: There is no time to get help from my friends because there is too much work in all our subjects. I ask the tutors for help during the practical lesson.
		Lecturer: Were you able to solve the tasks during the practical lesson?
	38	Student3: No.
	39	Student4: I was not able to complete any of the tasks without the help of my friend.
SFG04	1	**Lecturer: How many of you have never missed a theory lesson so far and have not been late of the lesson?**
		(3 students raise their hands)
		Lecturer: Did you understand all the concepts taught during the theory lesson?
	7	Student: I understood most of the concepts. If there is something I did not understand, I referred to the textbook for further explanations.
	9	Student: No all.
	10	Student: Your explanations are good but some of the concepts are difficult to understand
SFG05	1	**Lecturer: Are you able to concentrate during the theory lesson?**
	2	Student: The lesson is interesting, but sometimes it is hard to concentrate for the whole period.
	4	Student: No. it is hard to focus after about forty minutes.
	5	Student: I like to write notes in class which helps me to focus. Also the examples that you give us are very interesting.
SFG06	1	**Lecturer: I notice that some students are either late or sometimes misses the theory lesson. What are some of the reasons for this?**
	3	Student: I sometimes go late to bed on a Sunday and cannot wake up early on a Monday morning.

	5	Student: The 7am bus fetches the students late and we arrive on campus.
	6	Student: I woke up late and missed the taxi to campus.
	7	Student: The road works caused too much traffic in the morning which makes us late.
		Lecturer: What effect did this have when you were in the practical lecture?
	11	Student: I was totally lost
	12	Student: I did not understand how to do any of the questions
	13	Student: I could not solve the programs that you gave to us
	14	Student: I was constantly looking at my neighbours work. I was writing a program that I did not know.
		Lecturer: Is it possible to wake up earlier or to even take the earlier bus or taxi?
	19	Student: I can try.
	20	Student: The first bus leaves too early for me.
	21	Student: Not sure because the traffic is always busy.
SFG07	1	**Lecturer: How do you catch up with the work that you miss?**
	2	Student: I speak to my friends and get help from them.
	3	Student: I try to get help from the tutors. It's difficult to find time to get help from my friends.
	5	Student: I use the prescribed textbooks or the internet to catch up with the work.
SFG08	1	**Lecturer: Many students are afraid to ask or answer questions in class. What is the reason for this?**
	3	Student1: Well, students will laugh at me if it is a stupid question.
	4	Student2: Other students will find the answers silly or make some funny comments.
	6	Student3: I am not happy speaking in big groups.
	7	Student4: I am scared to ask questions.
		Lecturer: Why are you scared to ask questions?
	10	Student4: They will just laugh

		Lecturer: So, what will you do if you don't understand any concepts that are taught in class?
	14	Student 1: I will get answers from my friends
	15	Student 2: I will do the same, sometimes I will ask the tutor
		Lecturer: Do you ask you friends for answers immediately after the lesson?
	18	Student 1: Sometimes I do, other times I forget
	19	Student 2: I mostly forget
	20	Student 3: I ask my friends in the lab
	21	Student 4: I ask the tutors
SFG09	1	**Lecturer: I introduced the system of allowing students to write questions on paper. Why do you think this system did not work?**
	3	Student: I had a question once but did not have paper to write on.
	4	Student: In my case, by the time I finished writing my question, you already started explaining something else.
	6	Student: It is easy to speak English, but writing takes longer and can be difficult sometimes.
	8	Student: I cannot express myself very well when I write in English.
	1	**Lecturer: Do you do any work in this subject outside of the theory lesson?**
	2	Student: I meet with my friends and we work in the evenings at the residence.
	3	Student: I do some work on the weekends, but I like to work alone.
	4	Student: I work with a group because we all share ideas then if maybe you don't know something then the other person will explain it to you.
	6	Student: I cannot do much work because I don't have the textbook and I don't have any friends that live nearby.
		Lecturer: Do you think many of the students work in groups?
	10	Student: No, not really.
	11	Student: No. Some of them are not motivated to work.
SFG10		**Lecturer: How many of you have the textbook?**
		(2 students raise their hands)
		Lecturer: Do you find the textbook useful?
		Student: Yes. But it is not so easy to understand to understand everything.

		Student: Not really. I only use it when you give us tasks from the textbook.
SFG11	1	**Lecturer: Did you find the theory tests useful?**
	2	Student1: Definitely, since it helped me understand the theory better
	3	Student2: I'll be honest with you Sir, I did not find them useful because I got frustrated when I could not pass the third test and lost interest. I think the pass mark is too high. It should be 50% to pass, not 80%. We are doing all these tests, what is the use of doing these tests if there are no marks going to the final mark?
		Lecturer: (speaking to Student2) Did you benefit from passing the first two tests that you completed?
	10	Student2: Yes I did (benefit) with the help of my friend. But when you keep failing a test you lose interest.
SFG12	1	**Lecturer: Did you'll make use of the first set of supplementary notes?** (6 students indicated that they used the notes)
		Lecturer: Did your find these notes useful?
	5	Student: No. It was not so easy to understand.
	6	Student: No.
	7	Student: No. I did not like reading.
	8	Student: Yes. It helped me to better understand the work you taught us in class.
		Lecturer: Was the upgraded set of notes helpful?
	11	Student: Yes. I was able to attempt the questions you gave us even though I missed the theory lesson. The examples in the notes were a big improvement and helped me a lot.
	14	Student: It was ok, the examples with the comments helped, but I still had some problems.
		Lecturer: What problems?
	17	Student: In the theory lecture you explain the concepts very well and it is easy to understand. Now I had to figure out everything on my own. Your examples in the notes did help, but I realised that I should not miss another theory class.
		Lecturer: Do you find it easier to learn through the use of examples?
	21	Student: Yes, definitely. Most of us like to work with examples.
		Lecturer: What is it about examples that make learning easier?
	23	Student5: Examples help us to see how you get to the solution. Seeing is believing.

SFG13	1	**Lecturer: How many of you have access to a computer outside of campus?** (4 students raise their hands) **Lecturer: Does it help having your own computer?**
	4	Student: Yes. Because you can practice your own programs at your own place, anytime.
	6	Student: Definitely. I don't need to wait late at school to do my work. I can do it at home. This helps me a lot. **Lecturer: do you have internet access outside of campus?** Only one student indicated yes.
SFG14	1	**Lecturer: How can the blended learning environment be improved?**
	2	Student: Give us more examples.
	3	Student: Another theory lesson will help.
	4	Student: Give us tools like videos instead of notes where we need to read.

Student Focus Group Interview 2

Date: 18 June 2013 - Group B at 9.15 am
Date: 18 June 2013 – Group D at 11.00 am

Code	**Line #**	**Conversation**
SFG15	1	**Lecturer: How did you'll find having an extra theory lesson?**
	2	Student: It is very good. I understand the work much better.
	3	Student: Thank you Sir for giving us this extra lesson. I can speak of the entire class that we are benefitting from this.
SFG16	1	**Lecturer: What impact has the small group discussions had in the practical lessons?**
	3	Student: It is much better now because I can get help from Thabo without waiting for the tutor
	5	Student: I am learning a lot by speaking to my friend. I am able to solve the questions you give us and I'm happy now
	7	Student: I helped my friend. In this way it helped me to see if I knew my work properly.
	9	Student: I prefer to get help from the tutor
	10	Student: I missed the theory lesson. My friend helped me and I was able to do some of the tasks. This helped me very much. But I can't trouble him too much because he get upset if he cannot complete his own work.
		Lecturer: Are all students benefitting from the discussions that take place?
	15	Student: I think they do since we are able to get immediate assistance and we learning
	17	Student: It's useful for most students but a few students just copy the solution. The tutors also try to help them but they not interested.
SFG17	1	**Lecturer: Do you find the new system of group discussions to be useful in the laboratory?**
	3	Student: Yes definitely. In this way I can get assistance immediately.
	4	Student: I often help my friends. By helping my friend, I am able to see if I understand my work.
	6	Student: I can relate better to my friends and feel more comfortable getting help from him.

SFG18	**Lecturer: Do you think making use of student mentors can assist students with programming?** Student: No. They are too busy with their own work. Student: Yes they can help us but you must get dedicated mentors. **Lecturer: Have you been meeting with your mentors** Student: We met a few times then he stopped attending. Student: He only attended once. Student: Our mentor is very good. We meet with him every week and he helps us a lot. Student: Our mentor knew his work but did not explain very well. **Lecturer: Did you find the tutors effective as mentors?** Student: I did not attend those mentor sessions Student: Neither did I **Lecturer: Why?** Student: I attended once and they were helping those students that did not attend the theory lesson. They did not teach me anything new. Student: I did not have time.
SFG19	**Lecturer: Did you find the blog useful?** Student: Yes, especially when you gave us examples. Student: Yes **Lecturer: Did you post any questions on the blog?** Student: No Student: No **Lecturer: Does that mean that you understood all the concepts that were taught in class or were you afraid to post a question?** Student: No. There was a concept that I did not understand in class. When I went to the blog, another student had asked the question. I then read the answer which helped me. Student: Just by reading the answers (to the questions) on the blog, I am able to learn.

	16	Student: We don't have enough of time to use the notes. The other three subjects that we doing are also very demanding.
SFG20	1 5 6	**Lecturer: How many of you read the notes prior to attending the lesson?** (2 out of 8 students raised their hands) **Lecturer: Did you find them useful?** Student: Yes. It was easier to understand your lesson. Student: When you reading the notes for the first time, it was difficult to understand everything. After attending the theory lesson the concepts taught became much clearer to me.
SFG21	1 5 7 8 10 11	**Lecturer: Did you'll make use of the videos?** (All 8 students indicated yes) **Lecturer: Were they useful?** Student: Yes. I was able to play the video many times to properly understand the step by step instructions using the pause and rewind options to better understand. Student: It is much easier when you see how things work. Student: Yes. The explanations were very good and I could go back and reply them many times. Student: The step by step explanations make it easy to understand. Student: I like to be taught the work similar to the way you teach during the theory lesson
SFG22	1 7 8	**Lecturer: Did you'll understand the animations when they were first given without any instructions?** (3 students indicated yes) **Lecturer: Once you understood how the animations worked, did you find them useful?** Student: It is very useful when you can see what is happening Student: These slides are very good because it helps me to understand better by seeing the commands step by step. Even after missing the theory lesson, I could follow what was happening and was able to attempt a few of the tasks. My problem was I did not read the instructions properly.

	12	Student: I used the for loop previously but now I can understand how the computer goes through the program
	14	Student: This is very good. I wish I had these at the beginning of the year.

9.5 APPENDIX 5: Tutor focus group interviews (TFG)

Tutor Focus Group Interview 1

Date: 22 March 2013, 11am

Code	Conversation
TFG01	**Lecturer: Are there any problems in the laboratory with regards to the computers?** Tutor: Most of the computers are working. Tutor: The technicians check the computers in the morning to ensure that they all working. Tutor: The problem was with the Air conditioning system. It frequently does not work.
TFG02	**Lecturer: Are the students understanding the work given to them?** Tutor: Yes they do, but some of them don't understand what the question requires. They don't take time to plan their solution before attempting it on computer. Tutor: When the students miss the theory lesson then it is a big problem. Some of them take up a lot of our time. We are constantly disturbed by those students that missed the theory lesson. Sometimes were cannot help other students that need help. Tutor: Some of the students don't want to figure out how to apply their knowledge to solve the question. They want us to help them immediately they have a problem. Tutor: We find that students that missed the theory lesson spent lots of time asking questions that were already explained in the theory lesson (The following comments were made by tutors in group A and C) Tutor1: I had to stand in front of the class to teach parameters to about 5 students that missed the theory lessons. Tutor2: Those students that miss the theory lesson disturbed us a lot so it is easier to explain concepts from the front of the class and teach all of them Tutor1: I enjoy standing in front and teaching the students **Lecturer: Why do you think some of these students don't understand the concepts taught in class?**

	22	Tutor: Sir, when you give them the solutions in the theory lesson, they copy it down without trying to understand what is happening in the solution. If you give them something a little different to solve, they have a problem. It's like they trying to rote learn the solutions.
TFG03	1 3 4	**Lecturer: Do you think teaching the students in English is a barrier in any way?** Tutor: All of them are able to understand English Tutor: I think they understand when you speak. The problem is when they read the question they are not always able to understand what is required to solve the question. It's more about them being able to break down the problem in order to come up with a solution.
TFG04	1 2 4	**Lecturer: How frequently do the students request assistance?** Tutor: Some don't call us at all, but most of them they do call us when they have a problem. Tutor: Others just call us to see whether they are on the right track.
TFG05	1 2 4	**Lecturer: Do you find that some students are afraid to ask you'll questions?** Tutor: Some are shy and just don't ask questions. But we check their work to see if they on the right track. Tutor: Most of them ask questions. They are in a smaller group so I don't think they will be afraid to ask questions. Probably in the theory lesson they may not ask any questions because it is a big class.
TFG06	1 2 4 7 11	**Lecturer: Do the students complete all the tasks assigned to them?** Tutor: I think sometimes there are too many tasks that are given and they not able to finish all of them. But most of them complete their tasks. Tutor: Some of them finish their tasks before coming to class. One of the girls in group D, she is very good. She has her own laptop and finishes most of the questions before hand. Tutor: Yes, there are also two guys in group B that also finish their work early. **Lecturer: So what do these students do in class if all their work is completed before hand?** Tutor: They do the challenge programs in the text book.

TFG07	1 3 4 5	**Lecturer: Do you think all students do work in this subject outside of their classes?** Tutor: Some definitely do, like these good students. Others work in groups. Tutor: There are a few students that are not interested. Maybe they are having some personal problems. But they miss their practical lessons. Tutor: I think that programming is not for them.
TFG08 TFGI3	1 2 4 7	**Lecturer: Do you think students are motivated in learning this subject?** Tutor: I think most of them are motivated and they try. There is only a few students that don't attend. Tutor: There are some boys that sit at the back. They go onto Facebook or YouTube and they quickly switch back to their work when they know where checking their work. Tutor: Sometimes you get students copying solutions from their friends screen with no understanding
TFG09		**Lecturer: Do you see students using the textbook in class?** Tutor: Not really. I don't think many of them have the text book. Tutor: Just a few of the students use the textbook. Tutor: Many of the students do not like to read. So even if they have the textbook, they don't make use of it.
TFG10	1 2 3 4	**Lecturer: Do you'll see the students attempting the online tests?** Tutor: Sometimes Tutor: Some students obtained help from their friends to pass a test Tutor: Some students are losing interest in the online tests because they having problems passing a particular test and cannot move to the next test. They say that they don't plan on completing them.
TFG11	1 2 4	**Lecturer: Have the students been using the supplementary notes?** Tutor: When you first put them on Blackboard, all the students downloaded them, but I did not see them use it for the other sections. Tutors: I don't think they have enough of time in class to read the notes. They spend most of their time solving the tasks.

TFG12	1 3 4	**Lecturer: What improvements can be made to better assist the students in learning computer programming?** Tutor: Give them more exercises to attempt in the theory lesson. Tutor: You need to do similar questions that are being done in Development Software 1. These students cannot see the link between the two subjects.

Tutor Focus Group Interview 2 (TFG)

Date: 19 June 2013, 11am

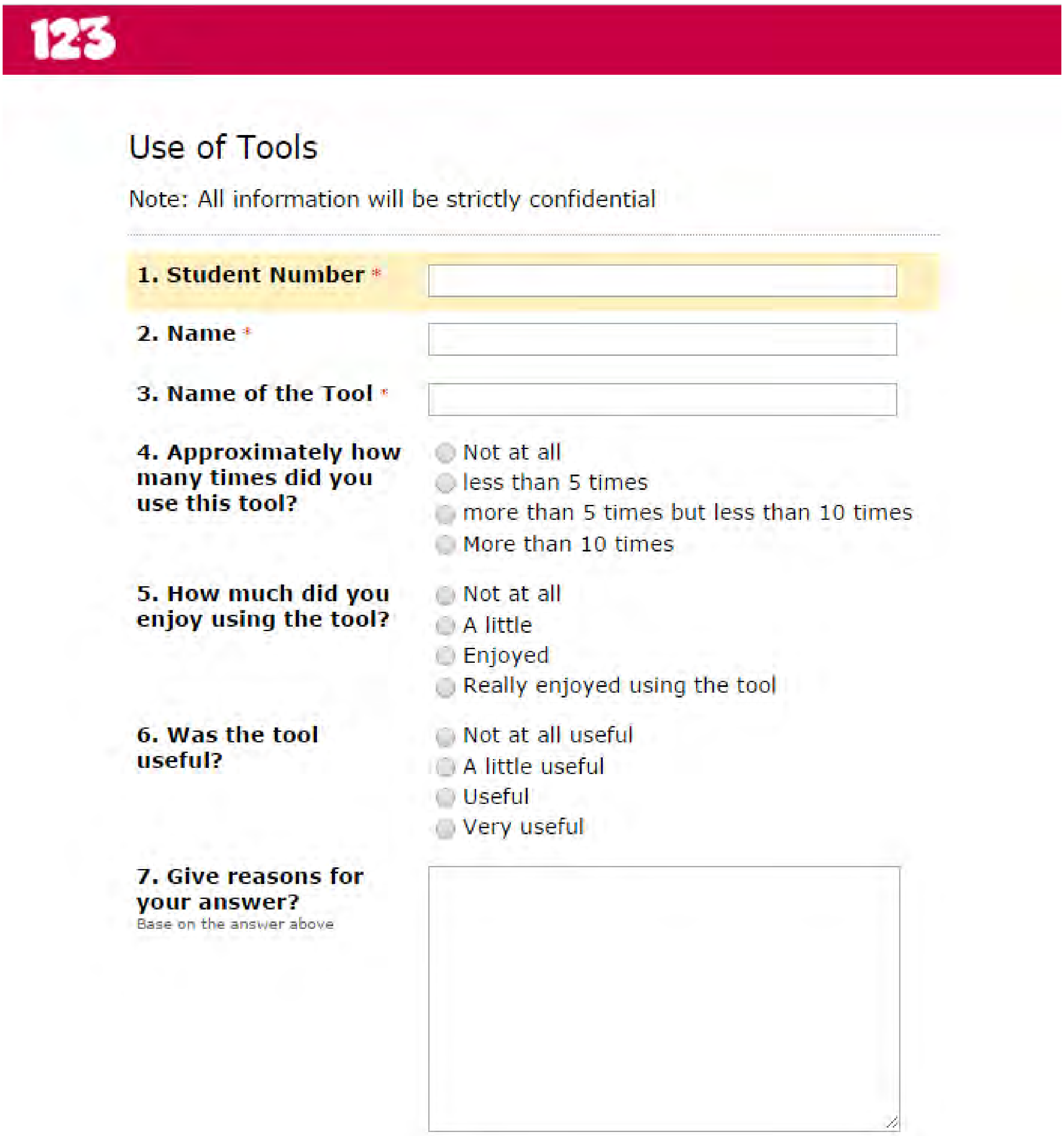
Code	Line #	Conversation
TFG13	1 2 3 6 7 9 13 14 17	**Lecturer: How are the group discussions in class?** Tutor: With the introduction of the group discussions, we are no longer in demand Tutor: I hope we will still have a job **Lecturer: Are the students benefitting from this?** Tutor: Yes. Most of them do benefit. Tutor: I have notices that some students just copy the solutions from their friends and don't understand the solution. These are just a few of the students. Tutor: They discuss and share ideas with their friends. **Lecturer: Is there a trend of them first getting assistance from their friends before asking you'll for help?** Tutor: Yes, this happens in most cases. Tutor: Some of them are also shy to ask us so they rather start asking a friend first and if the friend does not know how to answer that question then he will approach us. Tutor: I think on average it will be a friend first.
TFG14	1 3 4	**Lecturer: Students seem to be dependent on their friends or the tutors. Why do you think they not able to solve the tasks themselves?** Tutor: Some of them are too lazy and want help immediately. Tutor: If you look at the background of our schools, we don't usually use research or go to the libraries and we do not develop this skill. If I don't know something in schools I go straight to my teacher or I will ask my tutor.

	7	Tutor: I think some of them may have chosen IT because they were not able to get space in Engineering. In this case they may not be enjoying this subject.
	9	Tutor: Another thing is that since they think programming is hard they just want to pass it and others do not even care whether they pass or not because they just say I will go to networking next year because programming is too hard.
TFG15	1	**Lecturer: How was the mentor programme?**
	2	Tutor: I found that mainly students that missed the theory lesson attended. So we had to reteach the concepts that you already taught.
	4	Tutor: A few of the students would walk out because they already understood what we were teaching the students.
		Lecturer: How do you think this programme can be improved?
	8	Tutor: Maybe you need one class to teach students that missed the theory lesson and another class to help students with individual problems.
	10	Tutor: I don’t think this is the solution. Some of the students will deliberately miss your lesson on a Monday so that they can attend the tutor lesson. I think we need to just help with individual problems that students have.
	13	Tutor: The student mentor system was better because students like to work in small groups
TFG16	1	**Lecturer: Do you think the Blog was a useful tool for the students?**
	2	Tutor: Yes. I’ve seen students using the blog many times.
	3	Tutor: I saw one of the students make use of the blog when she was solving one of the tasks. Using the examples on the blog she was able to solve her question.
	5	Tutor: I think the blog is the best tool you have created so far. Students can ask questions, read answers and look at the examples. I think most of the students are making use of it.
TFG17	1	**Lecturer: What about the videos?**
	2	Tutor: I haven’t seen too many students using videos in class.
	3	Tutor: Some of the students made mention that they prefer the videos compared to the notes.

TFG18		**Lecturer: Did the students know how to use the animations?** Tutor: Many of them did not read the instructions and could not figure out what was happening.
TFG19	1 2 4 6	**Lecturer: What other tools can be developed to help the students?** Tutor: Sir, you have done so much for to help them. I don't think it is about having a specific tool. Some of the students need to be motivated. Tutor: It's also about time management. Some of the students cannot find the time to use the tools. Students need to learn how manage their time properly. Tutor: Another problem is between Development Software 1 and Technical Programming 1. Students think that these subjects are not related. Maybe, the same lecturer needs to teach both the subjects.

9.6 APPENDIX 6: Student comments from survey

Contact 123 Form Survey (S1)



123

Use of Tools

Note: All information will be strictly confidential

1. Student Number *

2. Name *

3. Name of the Tool *

4. Approximately how many times did you use this tool?

- Not at all
- less than 5 times
- more than 5 times but less than 10 times
- More than 10 times

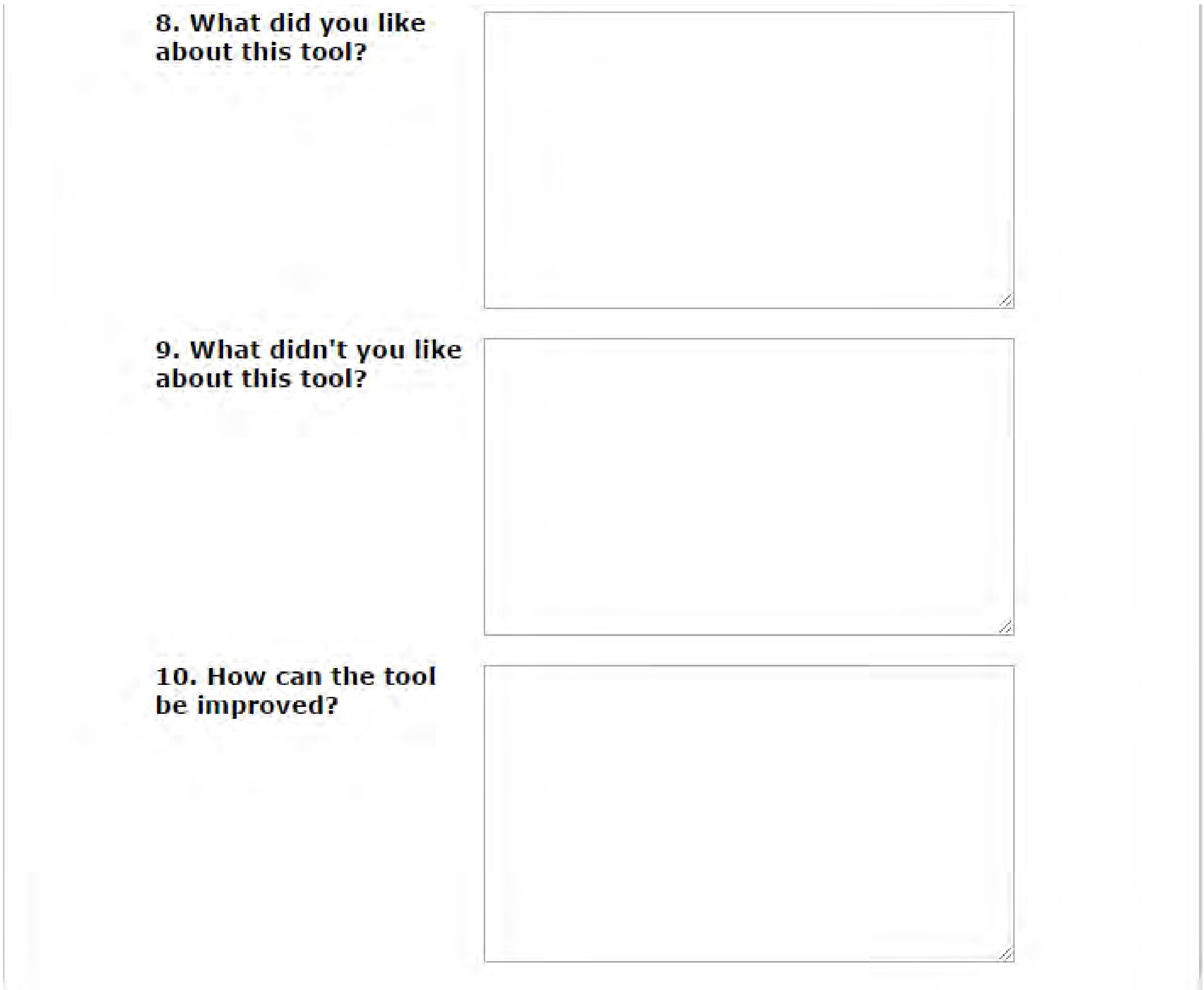
5. How much did you enjoy using the tool?

- Not at all
- A little
- Enjoyed
- Really enjoyed using the tool

6. Was the tool useful?

- Not at all useful
- A little useful
- Useful
- Very useful

7. Give reasons for your answer?
Base on the answer above


8. What did you like about this tool?

9. What didn't you like about this tool?

10. How can the tool be improved?

Survey (SUR)

SUR01	Student: The theory lesson is the best Student: We learn through the examples that are done in the theory lesson Student: Having the extra theory lesson was very useful. It helped to slow down the speed. You were able to do more examples which helped us to understand things better
SUR02	Student: Using the projector when teaching (in the theory lesson) grabs our attention and makes us focus Student: It becomes easier to understand how the programs worked when you use the projector and the computer in the lesson Student: It helps me to understand especially the errors that can be made in a program. Student: The projector (to execute a program) shows you how to go about writing a program Student: It is easier to remember and understand when you use the board with the different markers is also very good but with the projector we can see how the results

	when you run the program. Student: The examples on the board are the best. I can see the program well by the way you write them on the board. Student: The projector is good. I can see the output. I like the examples that you do on the board. It is easy to learn.
SUR03	Student: I love the examples… because you show us step by step how to solve the problem Student: The exampled help me the most. when I see how the example works then I can use it to solve the other questions Student: When I understand the examples in class then I feel confident to answer the questions Student: The notes simplified everything with the examples because the examples show us how the question is solved Student: If you go over the examples in the theory lesson and the notes it becomes much easier to solve the questions because it shows us everything step by step Student: When I understand the examples. I am able to do the tasks
SUR04	Student: I don't like to read notes. It makes me sleepy Student: Reading is not for me Student: These were very useful The examples on the notes were helpful
SUR05	Student: It was too tough Student: The pass mark was too high Student: It was a waste of time. I could not pass.
SUR06	Students: The mentors did not attend Student: Our mentor was the best. I think you need to find mentors like Sabelo for the other groups. Student: If I miss a theory lesson, I catch up with the tutors Student: I did not find the mentors to be helpful
SUR07	Student: it gives enough examples and freedom to ask anything concerning any problems that we came across in our program Student: I like the step by step approach with the examples on the blog it makes it

	better to understand Student: I find the examples on the blog very useful because even if I miss a lesson I can learn how to answer some of the tasks in class Student: I could learn from the answer that you gave. The blog was the best for me.
SUR08	Student: It was easy for me to get help from my friend (during the practical lesson) even when the tutors were busy Student: I like to get help from my friends since we discuss the question together and come up with answers. In this way both of us learn. Student: I like to get help from my friends and not the tutors because they explain better and give me the answers. The tutors don't give us the answers.
SUR09	Student: It is easy to pause, rewind and playback a video when you watching. Student: They (the videos) make our lives more easier because we don't have to read we just watch and listen Student: They (the videos) are very helpful especially replaying something if you did not understand. Student: He explains the work step by step Student: I tried the videos for the 'for' and the 'while' loops. It was clear and helped me to understand how it works. Student: Sometimes you read something and you do not understand but when you watching someone show it to you, your can see it and it makes sense. Student: I believe that something that I see stays long time in my memory
SUR10	Student: At first I did not understand, but now it's very clear because the slides show what is happening and I can see the output. Student: The demonstrations are very useful because it you cannot see these things happen in the computer and go back if you did not understand Student: Why didn't you give us these from the beginning of the year? It gives you all the steps and helps us to understand.
SUR11	Student: It was difficult to find the answers on Google Student: Many students do not like this method because they are lazy. I think it is a good system because it makes you think very hard if you want to get the program right Student: I had many problems solving these tasks

9.7 APPENDIX 7: Observation schedule (OS)

	Extended - Back	Soni SI: 21202239 - Siyanda					Koti N: 21101176 - Nophalo				
1	Does the student arrive on time?	Y	N				Y	N			
2	If late, how late was the student?	5min	10min	> 10min	Not Attend		5min	10min	> 10min	Not Attend	
3	Does the student settle down to work quick	Y	N				Y	N			
4	Can the student start with work without any supervision?	Y	N				Y	N			
5	Is the student attempting their tasks?	Y	N				Y	N			
7	Does the student use the *e-learning environment* ?	Y	N				Y	N			
8	What e-learning tools did the student use?	Tut orials	Dem os	Theo ry Test	Prac Test	For um	Tut orials	Dem os	Theo ry Test	Prac Test	For um
9	Comment on how the student interacts with the e-learning environment?										
10	Did the student use any *other tools* like Google etc.	Y	N				Y	N			
11	If Yes, what tools did they use?										
12	Comments on how the student interacts with the tools.										
13	Comments on independent learning?										
14	Does the student *collaborate* in solving problems?	Y	N				Y	N			
15	If Yes, how does the student collaborate when solving a problem?										
16	Comments on the collaboration.										
17	Did the student need to speak to the *tutor* ?	Y	N				Y	N			
18	Is the students less reliant on the tutors?	Y	N				Y	N			
19	Comments on students requesting help from tutors.										
20	Does the student solve all the tasks assigned to them?	Y	N				Y	N			
21	What were the Specific problems experiences?										
22	What were the common mistakes made amongst all the students?										
23	Any comments on how they solved the problems.										
24	What did they use to solve the problem?	Collab oratio	Tutor	e-Learn ing	Other		Collab oratio	Tutor	e-Learn ing	Other	

9.8 APPENDIX 8: Online tests (OT)

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 3. ____ describes the feature of languages that allows the same word to be interpreted correctly in different situations based on the context.

a. Polymorphism
b. Architecturally neutral
c. Source code
d. Insulation

____ 4. Programs that are embedded in a Web page are called Java ____.

a. consoles
b. applets
c. applications
d. windowed applications

____ 5. It is a tradition among programmers that the first program you write in any language produces "____" as its output.

a. Hi, your name!
b. Hello, world!
c. My first program!
d. Hello, your name!

9.9 APPENDIX 9: Statistics

Pass rate in the subject Technical Programming 1 (PR1)

Year	**Percentage pass rate (%)**
2010	38
2011	44
2012	46

Staff Usage (BB1)

Year	**Percentage (%)**
2010	17
2011	17
2012	20

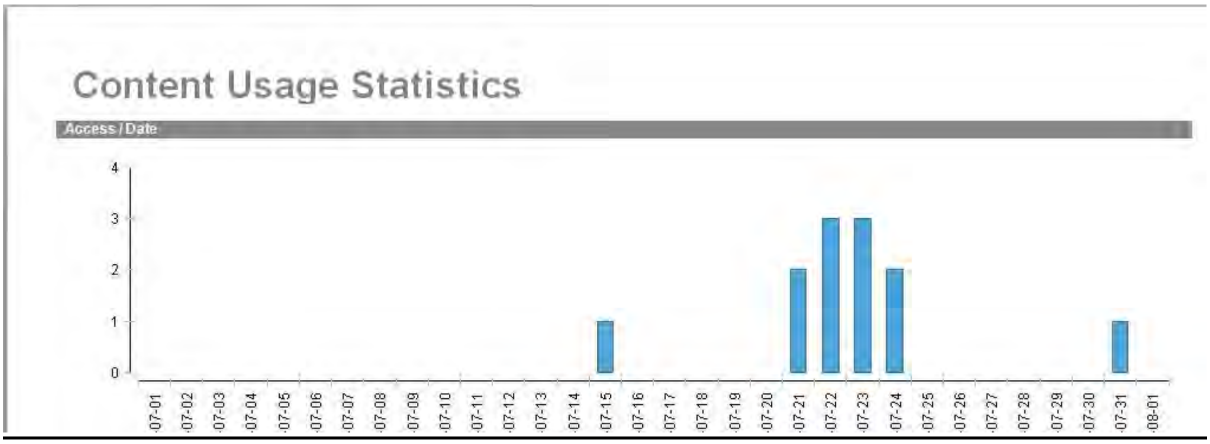
Students Usage of Supplementary Notes (BB2)

Code	**Section**	**Date**	**No of students that accessed**
BB1	Supplementary Notes		First set of notes: 80 Second set of notes: 50 Third set of notes: 20
BB2	Supplementary Notes		Revised supplementary notes Access by 45 students

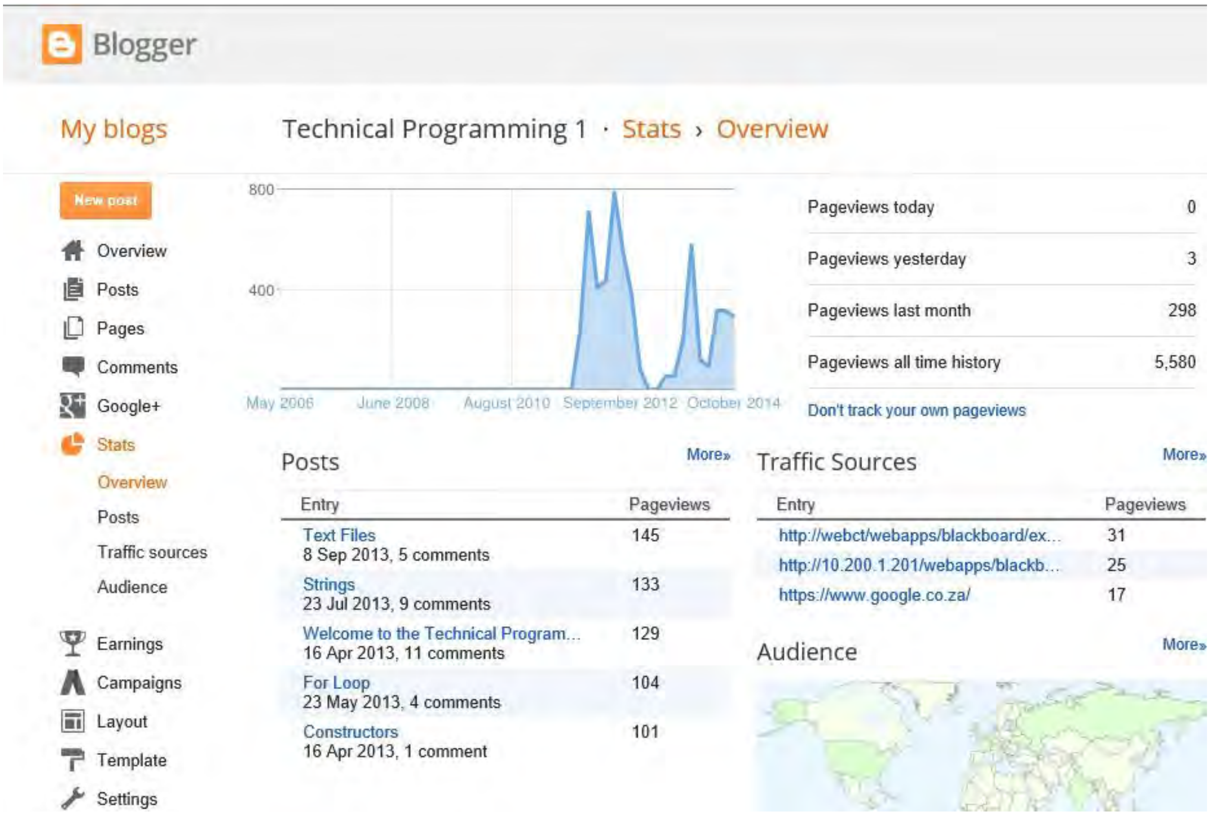
Student Online Test Usage (BB3)

Test Number	**Number of students that attempted and passed the test**
1	60
2	60
3	55
4	40
5	31
6	15
7	15
8	15
9	15
10	15

Blackboard Report (BB4)



Blog Dashboard (BD)



Blog (BG)

Code	Comment
BG01	85 % visited the blog. Only two question were asked
BG02	About 15 students (10%) only accessed the notes on the blog prior to the lesson

Departmental Statistics (DS) – obtained from a survey of students conducted in 2013

Students selection choice for IT	**Percentage (%)**
First choice IT	8
Second choice IT	31
Lower choice IT	61

Access to a computer outside of the institution (AC)

Access to computer outside of institution	**Percentage (%)**
Yes	30
No	65
Not sure	5

9.10 APPENDIX 10: Reports

Customised Software Report: Dr.Q Classroom Report (CSR1)

CLASSROOM REPORT				
Questions	Y	N	NS	COMMEN
1. Did the lecturer attend the lesson in NW4 today?	32	0		
2. Was the lecturer on time for class?	29	2	1	
3. Were you able to hear the lecturer clearly?	31	1		
4. Did the lecturer answer all questions properly, that were asked by students?	32	0		
5. Did you understand what was taught in this lesson?	21	1	10	
6. Did you ask any questions during the lesson?	6	26		
7. Did the lecturer teach at a good pace?	28	1	3	
8. Were you able to complete all the tasks given in this lesson?	23	9		
9. Do you plan to do any work in this subject outside of your lessons?	28	1	3	
10. Was the venue clean and tidy?	31	1		
11. Did you feel comfortable during the lesson?	31	1		
12. Did you feel motivated to learn in the lesson?	26	1	5	
13. Did you enjoy the lesson?	22	2	8	
14. Did you find the lesson useful?	32	0	0	
15. How can the classroom environment be improved?				16
16. Do you have group discussions with friends or peers on computer programming outside of your lesson?	19	13		
17. Were you afraid to ask questions in the lesson today?	14	18		
18. Please think about today's lessons.				14

Customised Software Report: Dr.Q Laboratory Report (CSR2)

LABORATORY REPORT										
Questions	Y	N	NS	COMM	NONE	NO	1-3 QUES	>QUES	TUT	VIDOES
1. Did you attend the theory lecture this week?	15	1								
2. Did you miss any practicals this week?	4	12								
3. Were you able to complete all the tasks given in this lesson?	4	12								
4. Did you understand the work carried out in this lesson?	4	4	8							
5. Do you plan to do any work in this subject outside of your lessons?	16	0	0							
6. Did you ask the tutor any questions?	9	7								
7. If yes, did you ask: 1-3 questions, >3 questions							6	2		
8. Did you get any help in the lesson today:						6				
No, Friend, Tutor, E-learning tools, Other										
9. Which of the following did you make use of in the lesson today:					7				7	1
None, Tutorials, Vidoes, theory tests, Other										
10. Did you use the e-learning environment today	9	7								
11. If Yes,										
a. Were the e-learning tools easy to use?	8	1								
b. Did you feel comfortable using the e-learning environment?	8	0								
c. Did you feel motivated using the e-learning environment?	8	0								
d. Did you enjoy using the e-learning environment?	8	1								
e. Did you find the e-learning environment useful?	7	1								
12. Did the tutors provide sufficient assistance during the lesson?	12	4								
13. Do you have access to a computer outside of campus?	10	6								
14. Do you have access to internet outside of campus?	9	7								
15. How can the e-learning environment be improved?			9							
16. Do you have group discussions with friends or peers on computer programming outside of your lessons?	12	4								
17. Were you afraid to ask questions in the lesson today?	6	10								
18. Please think about today's lessons. How can the lesson or environment be improved?			7							

Customised Software Report: Dr.Q Classroom Summary Report (CSR3)

Classroom Report
Monday, May 13, 2013

Question 15
----

1) we need more theory classes

2) Nothing needs to be improved it fine as it is.

3) none

4) must have more classes

5) less light when the projector is used

6) every thing is clear for now

7) as far as im concerned it is good so far

8) no improvement can be done because for me its fine

9) having more examples

16) teamwork with discussions in the lab

Question 18
----

1) we need more theory classes

2) Nothing as of yet I can think of,but I think it is perfect as it is.

3) give us more homeworks

4) always teach at right pace

5) it is good

Customised Software Report: Dr.Q Classroom Summary Report (CSR4)

Classroom Report

Monday, May 13, 2013

Questions	Yes	No
Question1	32	0

Questions	Yes	No	Not Sure
Question 2	29	2	1

Questions	Yes	No
Question3	31	1

Questions	Yes	No	Not Sure
Question 4	32	0	0
Question 5	21	1	10

Questions	Yes	No
Question 6	6	26

Questions	Yes	No	Not Sure
Question 7	28	1	3

Questions	Yes	No
Question 8	23	9

Questions	Yes	No	Not Sure
Question 9	28	1	3

Customised Software Report: Dr.Q Diary Report (CSR5)

CATEGORY: NOTES

START DATE: 24/04/2013 END DATE: 30/04/2013

Supplementary Notes

None of the students used the supplementary notes during this lesson

Students that attended the lesson are using the notes to reinforce concepts taught in class

Students that missed the theory lesson are having difficulties understanding the notes