

Chapter One

Introduction to the cyclical implementation of design-based research for the improvement of teaching-learning in an Industrial Engineering course

1.1 Introduction

“For South Africa as a country, one of our biggest priorities is to develop qualified artisans to support our economy, particularly when one considers the fact that to successfully deliver on the strategic infrastructure projects (SIP’s), we need artisans” (Department of Higher Education and Training, 2013). With the growth in the mining industry, Further Education and Training (FET) colleges should provide competent students to fill the gap created by the shortage of artisans in South Africa. Severe shortages of artisan labour in key technical fields in the South African labour market seriously hamper development (Mukora, 2008). Public FET Colleges in South Africa are presently under serious pressure in that they face numerous challenges varying from providing of out dated curriculums, lack of lecturer education, inadequate infrastructure, lack of resources, etc. Though, at the centre of these difficulties is the continuation of old procedures like delivery of sub-standard quality education in some cases as well as uneven dispersal of resources amid students coming from diverse and different communities (Pule, 2011).

The biggest and growing demand for artisan labour is for metal, machinery and related trades in the Mining and Manufacturing sectors. To keep up with the demand FET colleges should provide competent students. With the use of technology-enhanced learning (TEL), like the use of screencasting, colleges could contribute towards students’ experiences of quality education that will contribute towards teaching and learning relevant to the needs of the student. In addition to understanding of subject content and information, students should acquire 21st century learning skills in order for them to become life-long learners. Within the South African context, many students attended dysfunctional schools and it is vital to improve and enhance these students’ knowledge and skills for them to become 21st century artisans to be part of a progressively interconnected world in which they work and live in (Sapa, 2012).

Variances in terms of types of students entering further education and learning remain challenging in South Africa. These variances encompass the multiplicity of students in terms of age, gender, language, culture, inadequate Internet access and living conditions, especially in remote and rural areas. Engineering students enrolled for blended education courses need support and scaffolding to obtain skills and abilities often far removed from their daily realities and surroundings. TEL offers the benefit of allowing students the freedom of choosing when, where, and how they want to study. Systematic combination of pedagogy with TEL may contribute to addressing learning differences (Auerbach & Ferri, 2010; Mukora, 2008).

This dissertation discusses how design-based research (DBR) could be used to design, develop and implement educational tools like screencasts on DVDs in order to work out misconceptions regarding direct current (DC) resistive theory in an engineering course for N2 students at a Northern Cape FET college.

1.2 Review of relevant literature

1.2.1 Misconceptions in Electronics

The presence of student misconceptions is a well-known fact at college level in electrical circuits. As an illustration of problems students could have, consider the misconception that potential difference is initiated by current flow (while in fact, the opposite is true). The discrepancy of the initial conceptual framework triggers misunderstanding in future parts of the students' education. The term misconception refers to the concepts that students should know about any singularities that are conflicting with technical theories. The objective of successful electronics teaching is to inspire the student to build understanding that is in general coherent with acknowledged electronics theory. It is known that students use pre-existing ideas formed from preceding encounters to argue their skewed electronics concepts (Bull, Jackson, & Lancaster, 2012; Sencar, Yilmaz, & Eryilmaz, 2001).

Since electronics comprises numerous abstract theories, students may acquire them in various ways of which some are misconceptions of facts. For students to develop conceptual understanding of electronic theory, they have to comprehend not only the functioning of components, but also the use of the component. In particular the procedure of learning and the application of information develops better when students are permitted to learn fundamental concepts rather than remembering repetitive tasks and factual data (Wiig & Wiig, 1999).

1.2.2 Screencasts

Students' circumstances as well as their rational characters are extensively varied. Educational technologies can be employed to improve students' strengths and recompense for limitations. Screencasts can be used to complement learning materials to aid students in all theoretical fields. Presently the methods to learn electronics are evolving, improving and adjusting in order for lecturers to use new learning technologies (Jesus & Moreira, 2009; Periago & Bohigas, 2005)

A screencast is a recording of actions on a screen accompanied by audio explanations to enhance the interactive process of teaching and learning. Screencasts can be used to employ two senses; seeing and hearing. Screencasting can be used to explain, improve and clarify concepts which students may have problems with (Pinder-Grover, Millunchick, & Bierwert, 2008). A benefit of screencasting is that it offers students the freedom to choose when, what, where and how they study, which makes it a good

educational tool (Nichols, 2007; Oud, 2009; Periago & Bohigas, 2005). Screencasts in the engineering field have extensive applications:

- Lecturers produce theoretical work on a screencast and students can use the screencasts to learn about the theory.
- Screencasts can be used to provide an extensive part of the theoretical material of a course, thus freeing lecturers' time for individual teaching, discussion sessions, and practical teaching (Nichols, 2007). Online screencasts can support many students, who spend an increasing amount of time on the Internet (Oud, 2009). Combining sound and images in a screencast enhances learning experiences (Oud, 2009).
- Screencasts can be used not only as a lecturing instrument, but as personalized feedback to students, or during students' review of one another's work. A large number of students have access to computers, the Internet, or smartphones. Therefore screencasts can provide a simple means to enrich course content to students.
- Screencasts promote an easy and cheap way of producing multimedia instructional material that could be used in various educational settings. Short explanations of core content can be given to students as reference material via screencasts.
- Screencasting can be used to provide students with the means to revise and repeat the learning material for deep understanding of complex concepts. By using web-based media, presentation of material is independent of place, time and written text. Individuals can learn or revise their work according to their own needs (Periago & Bohigas, 2005).
- Communication can also be established between lecturers and students by means of screencasts. Students respond positively to the use of screencasts in their online classes for a more personalized approach to a course (Mangieri, 2009).

From the above it becomes evident that screencasts could be used as cognitive learning tools to augment students' conceptions of DC resistive circuits.

1.3 Purpose of the research and research questions

From the above it becomes evident that there is a need to determine the specific misconceptions of the N2 Industrial Electronics students at the specific research context, to design and develop screencasts suitable for a subject area, determine students' perceptions relating to their use of the screencasts, and compile guidelines for the design, development, implementation and evaluation of screencasts for Industrial Electronics.

The research questions to be answered during this study:

- Determine the nature of misconceptions in the prior knowledge of students registered for Industrial Electronics.

- Explore students' perceptions regarding the usefulness of screencasts as cognitive learning tools.
- Compile guidelines for screencasts of DC resistive circuits to enhance students' conceptual knowledge.

1.4 Research design and methodology

1.4.1 Research design

Herrington warns that e-learning and blended learning often focus on strategies to disseminate information, rather than adopting the use of TEL as cognitive tools to inspire thinking and understanding (Auerbach & Ferri, 2010). Colleges regularly use ICTs to distribute information “where students learn *from* the technologies rather than *with* them as cognitive tools” (Auerbach & Ferri, 2010, p. 1). DBR combines empirical research with the design of education surroundings implanted in theory and presents the opportunity to advance teaching and learning (Auerbach & Ferri, 2010; Wang & Hannafin, 2005). DBR offers a comprehensive approach to explore the usefulness of authentic learning designs (Auerbach & Ferri, 2010; Herrington & Kervin, 2007; Herrington & Reeves, 2011).

Wang and Hannafin (2005) define DBR as a methodical, yet an adaptable methodology intended to improve educational practices through iterative analysis, design, development, and implementation, based on a partnership among researchers and practitioners in real-world settings, and leading to contextually susceptible design principles and theories. The foundation behind DBR is to shape an improved association amongst educational research and real-world problems (Amiel & Reeves, 2008). Amiel and Reeves (2008) point out the dissimilarity between DBR and customary pragmatic prognostic research. With DBR the importance is placed on an iterative research method that does not just assess a ground-breaking creation or intervention, but systematically improves the invention while also generating design principles that can guide similar research and development endeavours. This results in a cycle of research that is markedly different from what is currently pursued by many researchers in the field (Amiel & Reeves, 2008).

Drawing on the work of Herrington and colleagues, the design and development of the screencasts will focus on employing educational technologies in order to create dependable learning tasks (Auerbach & Ferri, 2010; Bamberger & Schultz-Ferrell, 2010b; Herrington & Kervin, 2007; Herrington & Oliver, 2000; Herrington & Standon, 2000). The study will describe three cycles of interviewing and analysis based on quantitative and qualitative research.

1.5 Preliminary structure and chapter division

The dissertation is presented according to the following chapters:

Chapter 1	Introduction to the cyclical implementation of design-based research for the improvement of teaching-learning in an Industrial Engineering course
Chapter 2	Reviewing of literature relating to the conceptual theoretical framework
Chapter 3	Design-based research design and methodology
Chapter 4	Analyses and presentation of the integrated data of Phase I design-based research
Chapter 5	Development, implementation and evaluation of a screencasts according to phase 1 design principles for an Industrial Engineering course
Chapter 6	Synthesis, conclusion and reflections on the use of design-based research for developing a TEL tool for N2 Industrial Electronics.