

Experiences of Physical Sciences teachers when introduced to an electronic expert system

by

Neo Jack Mothobi

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Supervisor: Professor Dr J.G. Knoetze

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Terminology list

Term	Definition
Customer Satisfaction	The degree to which the sold objects of a company meet the customer's expectations (Wikipedia, 2010).
Customer Satisfaction Index	“The overall satisfaction level of the customer as a single number, usually as a percentage” (Bhave, n.d.).
Data analysis	“A process of inspecting, cleaning, transforming and modelling data with the goal of highlighting useful information” (Wikipedia, 2010).
Data interpretation	The application of statistical procedures to analyse specific observed or assumed facts from a particular study (Wikipedia, 2010).
Frequency	The number of times something happens in the experiment or the study (Wikipedia, 2010).
Parameters	“Arithmetic means, mode, median and other statistical terms that are used to describe the population” (Maree, 2003).
Participant	Someone who participates in the experiment or research study (Oxford Popular School Dictionary, 2008).
Performance Matrix	It is a graphical representation that outlines the key performance measurements of the parameters (Bhave, n.d.).
Raw scores	Data collected from the participants in the research study which has not been processed or manipulated (Wikipedia, 2010).
Sample	A group of participants selected from a population to be part of the experiment or the study (Wikipedia, 2010).
Score	The original tally a participant obtained of a test that is not manipulated (Online Dictionary, 2010).

Summary

Keywords

Electronic Performance Support System, Decision Support System, Electronic Expert System, Customer Satisfaction Index Questionnaire, Retrospective Opinionnaire, Flowchart, Algorithm, Performance Matrix, Wilcoxon Signed Ranked Test, Statistical Package for the Social Sciences.

This study outlines the strategies that were employed during the training of Grade 11 Physical Sciences teachers in the use and development of an Electronic Performance Support System (EPSS). The EPSS process involves extended individualised support for teachers through face-to-face training.

A purposive sample was utilised and 22 Grade 11 Physical Sciences teachers participated in the study. Teachers' skills and knowledge before and after the EPSS training process were measured on three measures of satisfaction (course material, the EPSS training process and the trainer's competencies) and three measures regarding the EPSS (using an EPSS, creating a flowchart and designing an EPSS).

A customer satisfaction index questionnaire and retrospective opinionnaire were used to collect data from the participants. Microsoft Excel was used to analyse data collected using the customer satisfaction index questionnaire. Furthermore a Statistical Package for the Social Sciences (SPSS) program was used to analyse data collected using a retrospective opinionnaire.

Significant effects were found on all six measures when comparing the skills of teachers before and after attending the EPSS training programme. The results reveal that teachers who participated in the research are satisfied with the use, design and development of an EPSS in education.

Chapter 1: Purpose and rationale of the study

1.1 Introduction

In a technological age like the 21st century teachers search for new instructional methods and resources that can provide learners with authentic learning experiences. Technological advancement in education will enable learners to develop 21st century skills such as problem-solving, critical thinking and digital literacy. The challenge for teachers is to provide effective 21st century support systems to expand learners' knowledge and skill repertoires.

Teachers, however, may continue to question whether digital media can influence learning but a universal perspective is that a combination of proper digital media can enhance abstract conceptual change. It would appear that technological developments have proceeded at a pace beyond that of pedagogy and its implementation. For example, in a subject such as Physical Science the concept *linear motion* is usually difficult to explain orally or by using still pictures, but a computer simulation with animation and sound can make the process much clearer and easier to understand.

The plethora of technology, “digital tools and resources for learning, have acquired noticeable interest among teachers in the use of technology as an integral and mainstream component of curriculum delivery” (Oliver, 2006, p. 259). Furthermore, contemporary practice has proved that teachers look for guidance in the design and development of effective support systems and learning strategies.

According to Angeli (2005) as cited by Oliver (2006, p. 259) for “many [teachers] the choices are overwhelming; thus many find it confusing to know what to choose and how to best implement new ideas in their classroom teaching”.

Furthermore, the need for meaningful learning in schools has necessitated that teachers should be trained in the design, development and the implementation of an Electronic Performance Support System (EPSS) in education. Teachers should further take notice that scientific and technological expertise form part of the learners' prosperity.

Teachers are required to assist learners in understanding the abstract concepts in Physical Sciences. In order to find the most effective solution to performance problems, teachers are required to identify the cause of the observed performance gaps. It is therefore not only important to understand contemporary learning theory but to identify those application technologies that can contribute to the optimisation of instruction and learning in new learning environments.

1.2 The study title issues defined

This section explains the phrase segments of the study title in order to clarify the title of the study.

Experiences ...

The concept *experience* in educational research is usually associated with qualitative research. This implies that the experiences of people are determined through qualitative methods of data collection, e.g. observation and interviews. In medical sciences experiences of patients are determined by means of structured questionnaires or an opinionnaire. In this study the experiences of physical science teachers are determined using an opinionnaire and a questionnaire.

... Physical Science Teachers ...

The phrase *Physical Science teachers* refers to teachers in secondary schools involved in the teaching of Physics and Chemistry to Grade 10 to 12 learners.

... Electronic Expert System

The phrase *electronic performance support system* refers to a category of electronic tools known as electronic expert systems.

Gery (1991) as cited by Singhal and Prasanna (n.d.) defines an Electronic Performance Support System (EPSS) as the “use of technology to provide on-demand access to integrated information, guidance, advice, assistance, training and tools to enable high-level job performance with a minimum of support from other people”.

Various authors concur with Singhal and Prasanna (n.d.) that an EPSS is an advisory system that permits users to perform tasks successfully without major intervention (Singhal & Prasanna, n.d.; Shepherd, 2001; Banerji, 1999; Gal & Nachmias, 2011; Wild & Kirkpatrick, n.d.). Mao (2004) argues that “from a technological perspective an EPSS is about enhanced access to training materials in the context of work in a convenient manner”.

1.3 The use of Electronic Performance Support Systems (EPSSs)

The proliferation of technology has necessitated employees within organisations to acquire new skills and knowledge required to fulfil job activities (Ingraham, n.d.; Bayram, 2004). This has created the development and implementation of an interactive multimedia computer-based system, an electronic performance support system (Singhal & Prasanna, n.d.; Barker, Richards & Banerji, 1994; Banerji, 1999).

Mao (2004) advocates the view that an EPSS is designed on the integration of multimedia “technologies such as hypertext, hypermedia, simulation, video, voice, expert system and intelligent agents”. Ingraham (n.d.) advocates a position that an EPSS is a vital technique for supporting skills improvement, knowledge acquisition and effective problem-solving. It is evident that most of the literature available attests to the fact that an EPSS is used primarily in organisations to improve job performance.

Bannan-Ritland, Egerton, Page and Behrmann (2000) assert in their study that the “use of performance technology for specific initiatives in education” is a new undertaking. Several researchers confirm that this new innovation can be used in primary, secondary and higher education where the purpose is to teach learners, teachers and students decision-making skills (Hixon & So, 2009; Liu, 2004; Stoyanov & Bastiaens, 2005; Stoyanov, Kommers, Bastiaens & Mediano, 2007).

Jonassen (2006) supports the notion that applying an EPSS in education will enhance meaningful learning. Furthermore, Jonassen (2006) indicates that learning should be supported by mindtools of which an EPSS is an example.

Liu (2004) suggests that an electronic expert system can enable novice teachers to view a pre-recorded lesson, visualise how a lesson is presented and have access to well-developed lesson plans on a specific topic. Furthermore, Liu (2004) points out that using online communication an expert teacher can provide the novice teacher with “guidance, feedback and suggestions” on a specific topic.

According to Liu (2005) the following electronic expert systems have been developed to be used in education with the aim of helping teachers in instructional planning processes:

- “Electronic Performance Support System (EPSS)”
- “Support for Teacher Enhancing Performance in schools (STEPS)” and
- “Instructional Planning Assisting System (IPASS)”

Liu (2004) regards the use of an EPSS as critical component to educate high quality and well prepared teachers. Based on the literature available it can be concluded that an EPSS can be used in education to expose teachers to various teaching environments and enable them to share teaching experiences.

According to Gustafson (2000) as cited by Mitchem, Kight, Fitzgerald, Koury and Boonseng (n.d.) an EPSS may “offer an effective way to provide training and assistance to students with emotional and behavioural disorder (EBD) in acquiring and using self-regulated skills”.

Furthermore Mitchem, Kight, Fitzgerald, Koury and Boonseng (n.d.) suggest that an EPSS may serve as an assistive tool in enabling students “to acquire and practise the self management and self-regulation skills that they need to participate successfully in general education”. They emphasise that an EPSS supports skills required for success in high school and in future for all students.

In a study conducted by Alparslan, Cagiltay, Ozen, and Aydin, (n.d.) it is said that an “EPSS is a powerful tool which can be developed to support students’ learning”. Stoyanov and Bastiaens (2005) point out that “empirical studies brought some empirical evidence that performance support systems could be useful for university teaching”.

An EPSS is regarded as being complementary to traditional training methods in many ways. “Learning everything in advance has become impossible and it is difficult to be proficient with many applications” (Mao, 2004). Alparslan et al. (n.d.) believe that in educational settings there are several avenues where an EPSS approach would be appropriate, thus presenting alternative options for the learners to study on their own.

Bannan-Ritland, Egerton, Page and Behrmann (2000) indicate that in “post reading activities, the facilitator can use performance support to provide the child with tutorial-like reading activities targeted to improve specific skills”. They argue that an “EPSS can present an elegant solution to providing guidance and support for those committed to improving the reading skills of children”. Maughan (n.d.) points out that an EPSS may serve as a repository of highly relevant information that a learner requires when performing a given task.

1.4 The purpose of and the rationale for the study

The purpose of the study for the researcher is to determine the following:

- (a) The level of satisfaction of Physical Science teachers regarding the course material, training process and the trainer’s competencies relating to the training to design and develop an EPSS.
- (b) The perceived change in knowledge and skills of Physical Science teachers after training in using an EPSS.

The rationale for the study is to determine whether:

- (a) it is possible to train Physical Science teachers in the use and development of an electronic expert system on the terrain of kinematics.
- (b) Physical Science teachers’ perceived knowledge and skills will change as a result of training.

1.5 Problem identification and background of the study

Despite the recent developments on the use and development of an EPSS in education there is a growing body of evidence indicating that the uptake of EPSS by teachers is still in its infancy. Juang, Liu and Chan (2005) indicate that is necessary to develop an EPSS in an educational context. According to Carlson and Gadio (n.d.) “most teachers want to learn to use

educational technology effectively, but they lack the conceptual framework, time, computer access and support necessary to do so”. Carlson and Gadio (n.d.) further point out that providing teachers with training on how to develop an EPSS “implies a shift in the teacher role from being the sole source of knowledge and instruction to being a facilitator of student learning”.

Wang and Sung (2011) conducted a study to introduce teachers to an EPSS and the participants indicated that “they have never heard of an EPSS”. Wang and Sung (2011) add that “after it was explained what an EPSS was, they all said they would accept it if it were offered to them”. It is imperative to find ways that successfully make use of this technology to provide the necessary professional development to train teachers.

Strategies for training Physical Science teachers regarding the design, development and implementation of an EPSS must be explored and realised. Given the evidence of a marked lack of training, skills and knowledge, Physical Science teachers are in need of a system that is accessible, easy to use and that provides a consistent approach to help improve their teaching strategies. Therefore the problem identified in this research is that Grade 11 Physical Sciences teachers are not familiar with the design, development and the implementation of an EPSS in education.

The problem identification has generated a number of research questions. These questions are the following :

Research question 1: What is the teachers’ level of satisfaction regarding the course material, training process and the trainer’s competencies relating to the training to design and develop an EPSS?

Research question 2: Is there a change in knowledge and skills of the teachers after the training in using an EPSS?

1.6 Significance of the study

The study can provide valuable information and findings towards suggesting an alternative or improved approach to education in this technological world.

Documented information and findings regarding the use of an EPSS in education are not widely available. This research is important because it can provide information on how an EPSS can be used in education for the betterment of instruction and learning.

1.7 Delimitation

The study is limited to Grade 11 Physical Science teachers in the Tshwane North District; therefore it cannot be considered as representative of all Physical Science teachers in the Gauteng Education Department. Furthermore, the results of the study cannot be generalised because of its limitation of a small group of Physical Science teachers.

1.8 Limitations

Although the research was carefully prepared it has some limitations and shortcomings. Due to the time limit the research was conducted in a small group of only 22 Grade 11 Physical Science teachers and may not represent the majority of teachers in the Tshwane North District. The study is also limited by the validity of the usefulness of the results to important stakeholders. The researcher assumes that the methodology is appropriate to the problem being addressed and the purpose of the study.

1.9 Assumptions

The Customer Satisfaction Index and Wilcoxon signed rank test are used in this study to accept or nullify the hypotheses. Categorical data was collected and analysed quantitatively. Crichton (1998) states that the Wilcoxon signed rank test can be used in a non-parametric test. He further attests to the fact that the Wilcoxon signed rank test “does not require the assumption that the population is normally distributed”. The Customer Satisfaction Index was used to measure the perceived change in knowledge and skills of Grade 11 Physical Science teachers after training in using and designing an EPSS.

It was envisaged that Grade 11 Physical Science teachers would show a:

- high level of satisfaction regarding the course material, training process and the trainer’s competencies.
- change in knowledge and skills on how to design a flowchart, hyperlinked slide show, algorithm and the EPSS.

Chapter 2: Literature review

2.1 Introduction

This chapter reports on the literature study conducted investigating issues pertinent to the design and development of an EPSS in education.

2.2 Electronic Performance Support System

2.2.1 Introduction to an EPSS

Gustafson (2000, p. 42) indicates that “there is very little literature that describes how people have actually designed and developed EPSSs” (cited by Campbell, 2008). He further states that “EPSS design is an immature technology about which there is much more to be learnt” (ibid). In the area of prototype development he sees rapid prototyping as being important, because of the iterative process it has to undergo before the final prototype is acceptable (ibid).

The performance of a task assessment process could be improved through intervention strategies. This could be implemented through an electronic performance support system (EPSS) (ibid). However, the improvement and achievement of efficient task performance in any area of assessment is vital and desirable for the successful deployment of the EPSS (ibid).

Gustafson as cited by Campbell (2008) indicates that the reason that underpins the use of the prototype method of development is articulated in Pareto’s Law, 80/20 rule. The law states that only a small amount of effort is required to produce a product that has most of the desired features and performance. Thus it can be concluded that a large amount of effort and input is required to bring the product to completion (80 percent of input is required to yield an output of 20 percent).

2.2.2 Definition of an EPSS

Gery (1991) as cited by (Singhal and Prasanna, n.d.) defines an electronic performance support system as

an integrated electronic environment that is available to and easily accessible by each employee and is structured to provide immediate, individualized on-line access to a full range of information, software, guidance, advice and assistance,

data, images, tools and assessment and monitoring systems to permit job performance with minimal support and intervention by others.

Raybould (1990) as cited by Wild and Kirkpatrick (n.d., p. 2) defines a “performance support system as a computer-based system that improves worker productivity by providing on-the-job access to integrate information, advice and learning experiences”. He further indicates that the performance support system is aimed at providing training and support to novice as well as advanced users in the performance of tasks.

Additionally Gery (1991), as cited by Laffey (1995, p. 31) defines an EPSS as the “use of technology to provide on-demand access to integrated information, guidance, advice, assistance, training and tools to enable high-level job performance with a minimum of support from other people”. Furthermore, Gery (1995) as cited by Maughan (n.d., p. 49) indicates that an EPSS is the “configuration of hardware and software, and content accessible by employees or students and structured to provide users with information to permit them to do their jobs or perform tasks with minimal intervention by others”.

Most importantly, Shepherd (2001, p. 2) refers to an EPSS as an “electronic infrastructure that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable an individual to achieve a required level of performance in the fastest possible time and with the minimum support from other people”. Lastly he indicates that an EPSS is company specific rather than generic, thus encompassing specific policies and procedures of an organisation.

From the above deliberation an EPSS can be defined as an online system that:

- is delivered to the desktop;
- encompasses all software needed to support the work of individuals;
- integrates knowledge assets into the interface of the software tools;
- is aimed at helping the users with what actions to take;
- simplifies the steps required to perform a task;
- delivers information on a just-in-time basis; and
- delivers a body of procedural knowledge.

2.2.3 The goal of an EPSS

Laffey (1995, p. 31) indicates that the goal of an EPSS is “to provide whatever is necessary to ensure performance and learning at the moment of need.” Maughan (n.d.) further attests to the fact that an EPSS provides “prescriptive information to enable a user to accomplish a task”. Furthermore, Grey (1995) as cited by Maughan (n.d., p. 49) indicates that an electronic performance support system “is employed to support skills and knowledge growth in real-time and at the work situation”.

Moreover, Singhal et al. (n.d.) suggests that an EPSS is aimed at helping users with “how to perform a task”, at having “access to knowledge bases” and access to “various forms of knowledge representation (e.g. videos, audio, text, image and data)”. Rupel (n.d.) states that the goal of an EPSS is to improve users’ performance on the system. Once this has been understood, then users will be able to understand the Performance Support Continuum (PSC) (ibid).

Banerji (1999) views an EPSS as the human activity system consisting of people and resources organised to accomplish a task. This author indicates that one of the functions of an EPSS is aimed at reducing the permeability of the interface, thus minimising the overall time taken to perform a task. In order for the researcher to fulfil this requirement it is necessary for him to identify which factors have the largest effect in limiting performance, or what the performance impediments are. It is important to understand the nature of the basic factors that influence the time it takes for a person to perform a task within a given application domain. “The total time taken to perform a task depends on two factors time, namely to find a method and the time for the actual execution of the task” (ibid, p. 7).

It can be concluded that an EPSS provides timely information, useful advice and relevant training to the workplace. Laffey (1995, p. 33) suggests that an EPSS should not be “seen as a vehicle for delivering information [but as a] reconceptualisation of the work environment”. He proposes that the EPSS be regarded as technologies that are aimed at transforming the way in which people work and learn. Finally, an EPSS is designed to improve the performance of the users in a work environment.

2.2.4 Components of an EPSS

Singhal et al. (n.d.) indicate that an EPSS consists of:

- an “*advisory component*” as it entails task identification and thus develops the job aid;
- an “*information component*” since it encompasses databases, hypertexts and an online help system;
- a “*training component*” through its ability to provide relevant training to the users when required; and
- a “*user interface component*” through which the user is allowed to access the required information when performing a task easily.

In addition Carr (1992) as cited by Marion (1998) indicates that an EPSS be regarded as:

- an “*advisor*” because it provides advice via expert systems and knowledge-based systems;
- an “*assistant*” since it provides tools and online help for users;
- a “*librarian*” for the reason that it provides relevant reference materials and information databases; and
- a “*teacher*” through its ability to provide users with Computer-Based Training (CBT).

Zubak (1997) as cited by Marion (1998) categorises an EPSS as:

- a “*stationery embedded help*” where an interface is developed as part of the support interface;
- a “*process embedded help*” which is a step-by-step task-driven support system that enables the user to accomplish a work-related task;
- an “*instructional embedded help*” whereby users are provided with detailed information related to the task given; and
- “*context embedded help*” because the system can interpret the users’ action and provides relevant assistance.

Rupel (n.d.) further concurs with Banerji (1999) that an EPSS has three different performance support spectra:

- “*intrinsic support*” – information is embedded within the interface and support is provided to the users as he is engaged in the process of completing that task;

- “*extrinsic support*” – information is embedded in the system and support is provided to the users outside the process of task completion; and
- “*external support*” – information is accessed as text or through a help desk.

Additionally Abraham (2005) also identified the following components as being critical in the development of an EPSS, namely “knowledge base, knowledge base acquisition facility, inference engine”, user interface, users, expert knowledge and explanation facility.

2.2.5 Content features of an EPSS

According to Singhal et al (n.d., p. 5) the content features of an EPSS encompasses:

- “the step-by-step instructions on performing a task”;
- “demonstration on how to conduct selected transactions”;
- “process maps, flow charts and process review”;
- “glossaries and keyword search function”;
- “checklist, frequently asked questions, exercise and job refreshers in text or graphic format”; and
- “computer-based training (CBT)”.

2.2.6 Various types of an EPSS

Banerji (1999, p. 7) has identified three different types of EPSS:

- A *software-integrated* system where “tasks are performed with computer and software tools such as word processors and spreadsheets” (ibid);
- A *job-integrated* system where “computer-based tools mediate the organisational tasks and practices” (ibid); and
- An *operation job-integrated* system where “computer-based systems mediate and facilitate the various operations and job roles, such as knowledge-based tasks and repair and maintenance jobs” (ibid).

Furthermore, Abraham (2005, p. 910) points out that there are two types of expert systems, namely a “frame-based expert system” and the “rule-based expert system”. These systems can be explained as a set of “if-then” statements or frames:

- *Frame-based expert system*: This is the type of an expert system that uses frames to store knowledge.
- *Rule-based expert system*: This is an expert system that consists of if-then-else rules. As indicated by Abraham (2005, p. 911) the rules of the system can be developed as follows:
 - “Rule 1: *If A and C then Y*”;
 - “Rule 2: *If A and X then Z*”;
 - “Rule 3: *If B then X*”; and
 - “Rule 4: *If Z then D*”.

Maughan (n.d.) also indicates that an EPSS occurs in two distinct categories, namely a stand-alone system and embedded systems. An *embedded system* incorporates devices that provide suggestions and relevant information required to during the performance of a task.

Furthermore as a *stand-alone system* that is made available to the user while the work is on-going but the user is required to seek or pull information using queries.

According to Chrysler (2005) an expert system could be developed using decision tree analysis. The decision tree analysis is described as the process of examining a decision point and posing the following question, “What are the possible outcomes or options?” (ibid, p. 2). He further indicates that the decision tree allows the designer “to break the decision-making process into discrete steps that can be considered separately and sequentially” (ibid). The outcome of the decision tree analysis is a flowchart that the researcher would follow in his quest to design an expert system.

2.2.7 Design of an EPSS system

Marion (1998) outlines the following three dimensions that designers should consider when designing an EPSS:

- “*Performance-Centered Design*” focuses on the user interface and its functionality;
- “*Performance Support*” is scaffolded on top of the base user interface that helps workers use the software; and
- “*Knowledge Support*” deals with assistance in performing knowledge-based work. It incorporates domain knowledge.

Maughan (n.d.) indicates that the “level of intelligence built into the EPSS determines how adaptable the interface can be and how the system can acquire new knowledge”.

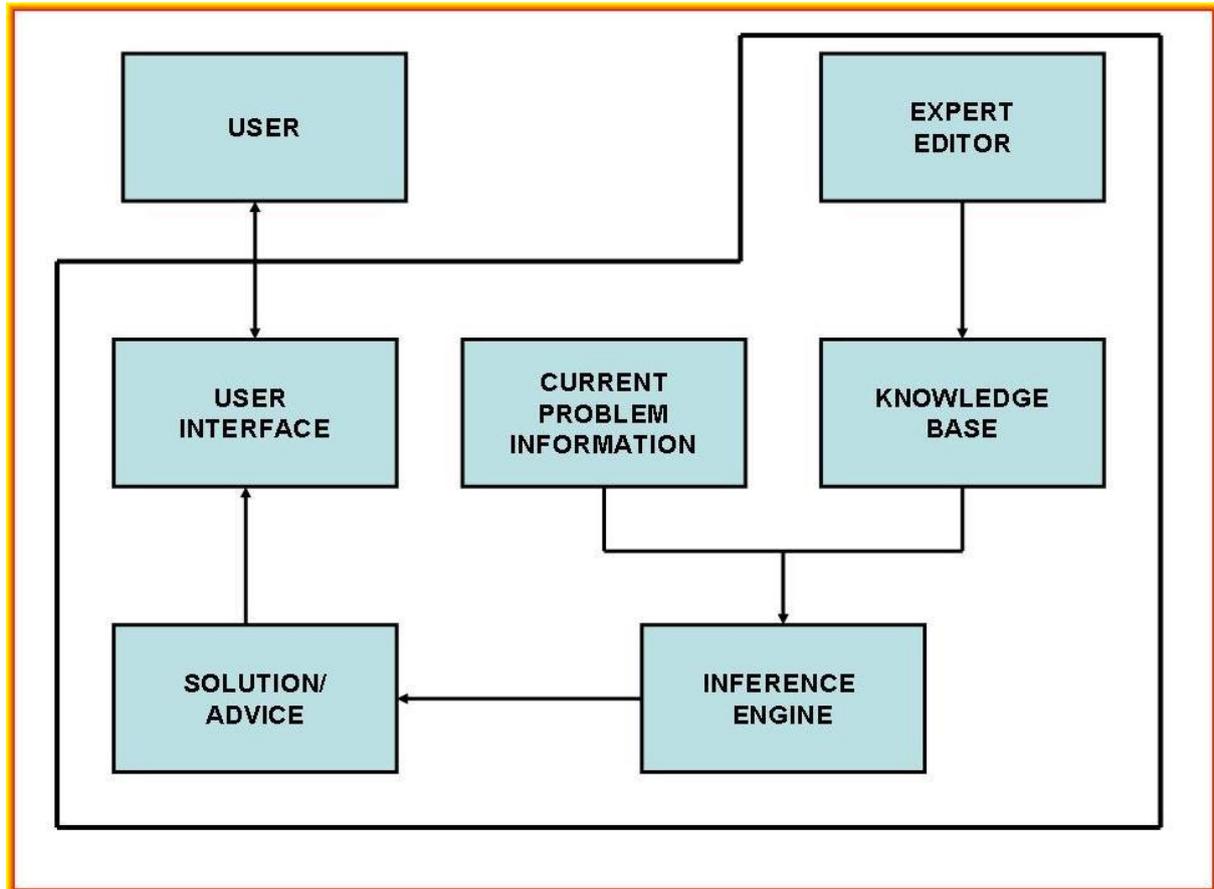
According to Abraham (2005, p. 911) the steps in developing an EPSS encompass determining the “actual requirements, knowledge acquisition, constructing expert system components, implementing results and formulating a procedure for maintenance and review”.

Furthermore Banerji (1999) states that “an EPSS Framework is being adopted to model complex rules and regulations documents”. An EPSS system should therefore involve the following aspects of an EPSS model; “reference materials, regulations, procedure guidance and advice” (Banerji, 1999).

Figure 2.1 represents seven essential components that should be taken into consideration when developing an EPSS as outlined by Jonassen (2006):

- *user* encompasses people who will be using the expert system to solve a particular problem;
- *current problem information* includes questions based on the current situation so that the user will be guided to a solution regarding the task;
- *user interface* provides the “expert system’s communication with the user” (Jonassen, 2006, p. 136). Furthermore, its purpose is to look for information “from the knowledge base to provide answers and suggestions” in such a way that a user will be able to accomplish an activity;
- *knowledge base* is where all the relevant information is stored (data and rules);
- *expert editor* allows information to be added or discarded based on the user requirements;
- *inference engine* includes:
 - the “backward chaining” which encompasses the process solving a task by starting with the desired conclusions(s) and working backwards to find supporting facts;
 - “forward chaining” which encompasses the process of solving a task by starting from the facts and applying rules to find supporting facts.
- *solution or advice* provides the user with the solution based on the data entered.

Figure 2.1: Components of an Expert System (Jonassen, 2006, p. 135)



An instructional system design (ISD) model is used to develop an electronic performance support system. Table 2.1 indicates the main tasks of developing the EPSS as pointed out by Juang, Liu and Chan (2005).

Table 2.1: Main tasks of developing an EPSS

	Phase	Description
1.	Analysis	The “analysis of the curriculum framework, objectives and instructional plans” (ibid).
2.	Design	“The design of the instructional plans concerning the teaching objectives, material selection, instructional steps, exercises and assessment according to the overall curriculum structure and objectives” (ibid).
3.	Development	“Learning materials and instructional instruments are created based on the design phase” (ibid).
4.	Implementation	The “implementation of the design curriculum by appropriate teachers to prove it is feasible and conforms to the stated objectives” (ibid).
5.	Evaluation	Consists of two phases, namely “formative and summative evaluation” (ibid).

From Table 2.1 it can be deduced that the EPSS could be developed using a prototyping approach for iterative processes and implementation. It can be concluded that the design and development of an electronic performance support system is a complex and an abstract activity.

From the above deliberations it can be deduced that the value of an EPSS is measured by the increased worker productivity with minimal assistance and interruption. Furthermore, the development of an EPSS should be evaluated and the actual improvement determined.

2.2.8 Knowledge types and their representation on an EPSS

Rupel (n.d.) indicates that when designing and EPSS it is important to consider how knowledge is presented to the users. Wild et al. (n.d., p. 4) concur with Rupel (n.d.) that the expert performance embedded in the performance support function includes “information structures and declarative knowledge that are required for performance and the cognitive strategies and procedural knowledge that are required by the task”. Rupel (n.d., p. 330) indicates that knowledge is broken down into information types as indicated in Table 2.2.

Table 2.2: Knowledge Types

	Types	Description
1.	Concepts	“A group of items which share a unique combination of critical attributes and can be referred” (ibid).
2.	Facts	“A statement that can be supported without supporting evidence” (ibid).
3.	Principle	“A statement which tells the reader what should or should not be done or what seems to be true in light of the evidence” (ibid).
4.	Structure	“A physical object which can be divided into parts and has boundaries” (ibid).
5.	Procedure	“A set of steps performed by one person to obtain a specific outcome” (ibid).
6.	Classification	“A sorting of items into categories based on a sorting attribute” (ibid).
7.	Process	“A series of events or phases which take place over time and have an identifiable purpose or result” (ibid).

Abraham (2005) indicates that “knowledge acquisition is an important aspect in the development of an expert system”. According to Rupel (n.d., p. 330) knowledge representation is crucial in the development of an EPSS and Table 2.3 indicates how each information type should be presented to the user when required.

Table 2.3: Representation of knowledge in an EPSS

	Types	Description
1.	Concepts	“pop-up window or hypertext link to concept” (ibid).
2.	Facts	“pop-up window containing text” (ibid).
3.	Principles	“pop-up window of principle with application to task” (ibid).
4.	Structure	“graphic diagram with hypertext to additional information” (ibid).
5.	Procedure	“interactive procedure in text, video or graphic format” (ibid).
6.	Classification	“pop-up window of comparison or advisor for recommended path” (ibid)
7.	Process	“interactive or static representation of process in text, video or graphic format” (ibid).

2.2.9 Advantages of an EPSS

According to Singhal et al. (n.d.) the advantages of an EPSS surpass its shortcomings. Their beliefs are based on the assumptions that an EPSS:

- uses a wide range of technologies in its components;
- incorporates jobs aids;
- incorporates Computer Based Teaching lessons (CBT);
- provides the user with a seamless interface to move between the CBT lessons; and
- reduces the cognitive overhead of manipulating more than one system.

In addition, Abraham (2005) indicates that the vital benefits of an EPSS are its ability to:

- “capture and preserve irreplaceable human experience” (ibid);
- “develop a system more consistent that human experts” (ibid);
- “minimise human expertise needed at a number of locations at the same time” (ibid); and
- “deploy solutions faster that human experts” (ibid).

2.2.10 Role of an EPSS in education

Fitzgerald, Semrau, Watson and Lynch (1998) indicate that initiatives are underway that attempt to extend the real-world through developing a series of EPSS software programs for children to use in classroom settings. They point out that these software programs for children are compatible with the cognitive-behavioural strategies in the instructional materials for teachers. In conclusion they regard computer-based training as “an innovative approach for helping students gain control over personal behaviours”.

Juang Liu and Chan (2005) indicate that it is necessary to develop an EPSS in an educational context. They support the idea that an EPSS has the potential to “enhance teachers’ or learners’ knowledge acquisition and performance improvement”. Furthermore, an “EPSS can provide learning opportunities to supplement traditional classroom or training strategies” (ibid).

Maughan (n.d., p. 53) points out that “educators are encouraged to think about the comprehensive nature of an EPSS development and select those features and systems that can be created and used in settings that do not have the resources or infrastructure to a fully developed system”. It can be concluded that the development and the use of an EPSS in education is still in its infancy. Proper training should be put in place to train teachers in the design and development of an EPSS.

2.2.11 EPSS as a reflective tool in the classroom

Jonassen (2006, p. 140) further indicates that “expert system rule bases are reflective tools that can be used in a variety of classroom situations”. He suggests that students can use the rule-based system to reflect the decisions that they have made regarding the goal that has been completed. He outlines the following activities as pertinent to the development of an expert system by learners:

- *Step 1:* The development of a plan on how to design an expert system.
- *Step 2:* Students identify the purpose and the problem domain of building an expert system.
- *Step 3:* The identification of problem solution or decisions that prompt the development of an expert system.
- *Step 4:* Isolation of problem features, factors or variables regarding the development of an expert system.
- *Step 5:* Rules and examples are generated regarding the problem at hand.
- *Step 6:* Refinement and efficiency of decisions.
- *Step 7:* Testing of the system as to whether it conforms to the user’s expectations.
- *Step 8:* Reflection on the activities based on the solutions provided.

In conclusion Jonassen (2006, p. 147) states that when learners are involved in the design of an expert system they are “engaged in reflective thinking”. He regards the process of building an expert system as an intellectually engaging and challenging endeavour.

Chapter 3: Research design and methods

3.1 Research design

Based on the research questions under investigation, the researcher implemented a quantitative research design. According to Cohen and Marion (1980) quantitative research “is defined as social research that employs empirical methods and empirical statements”. Typically empirical statements are expressed in numerical terms. Another factor in quantitative research is that empirical evaluations are applied. Empirical evaluations are defined as “a form that seeks to determine the degree to which a specific program fulfils or does not fulfil a particular standard” (Cohen & Marion, 1980). Creswell (1994) gives a very concise definition of quantitative research as a type of research that is “explaining phenomena by collecting numerical data that are analyzed using mathematically based methods”.

Various authors (Critchton, 1998; Page-Bucci, 2003) agree that non-numerical data (beliefs or opinions) can be converted “into quantitative data by measuring them numerically using a Likert-scale”. Therefore the study plan involves the gathering of non-numerical data to determine the following:

- The satisfaction levels of Grade 11 Physical Science teachers regarding the course material, training process and trainer’s competencies.
- The change in knowledge and skills of Grade 11 Physical Science teachers regarding how to design a flowchart, hyperlinked slide show, algorithm and an EPSS.

3.2 Sampling procedure

Permission was requested from the Gauteng Department of Education, Tshwane North District Office and the principals of the eight identified schools to conduct the research.

Written approval to conduct the research was obtained from the Gauteng Department of Education, Tshwane North District and the participating schools. All Grade 11 Physical Science teachers in the eight schools selected by means of purposive sampling agreed to participate in the research.

The sample consisted of twenty-two Grade 11 Physical Sciences teachers (six females and 16 males) from eight schools.

3.3 Data gathering instruments

A Customer Satisfaction Index Questionnaire (CSIQ) and a Retrospective Opinionnaire (RO) were developed and used to gather data from the participants.

3.3.1 Structure of the data gathering instruments

Table 3.1 indicates the structure of the CSIQ.

Table 3.1: Structure of the Customer Satisfaction Index Questionnaire

Categories	Number of Questions	Focus of the questions in each section	Variables
Section A - Course material	4 couplets of questions (i.e. 8 questions)	The questions focused on <i>how important</i> and <i>how satisfied</i> the participants were pertaining to the course material used during the EPSS training process.	P 1. Useful and easy to apply P 2. Related to your learning area P 3. Useful resource in your learning area P 4. Appropriate learning material
Section B - EPSS training process	5 couplets of questions (i.e. 10 questions)	The questions focused on <i>how important</i> and <i>how satisfied</i> the participants were pertaining to the EPSS training process.	P 5. Met the defined objectives P 6. Relevant to your learning area P 7. Practical and useful P 8. Satisfactory training process P 9. Clearly defined objectives
Section C - Trainer's competencies	5 couplets of questions (i.e. 10 questions)	The questions focused on <i>how important</i> and <i>how satisfied</i> the participants were pertaining to the trainer's competencies during the EPSS training process.	P 10. Logical manner P 11. Encouraged participation P 12. Knowledge of subject content P 13. Provided assistance P 14. Prompt feedback

Consult the Customer Satisfaction Index Questionnaire in Addendum A.

Table 3.2 indicates the structure of the RO.

Table 3.2: Structure of the Retrospective Opinionnaire

Categories	Number of Statements	Focus of the statements in each section	Variables
Section A - Design a flowchart	3 statements	The statements focused on <i>how to develop a flowchart</i> .	S.1 Acquired necessary skills to design a flowchart S.2 Acquired knowledge about the symbols used to create a flowchart S.3 Acquired knowledge on how to divide a flowchart into slides.

Table 3.2: Structure of the Retrospective Opinionnaire (continued)

Categories	Number of Statements	Focus of the statements in each section	Variables
Section B - Create a hyperlinked slide show	3 statements	The statements focused on <i>how to create Microsoft PowerPoint slides.</i>	S.4 Acquired necessary skills to design a hyperlinked slide show. S.5 Acquired necessary skills to create textboxes. S.6 Acquired necessary skills to create hyperlinks using textboxes.
Section C - Design an algorithm and the EPSS	7 statements	The statements focused on <i>how to design an EPSS in education.</i>	S.7 Possess knowledge pertaining to the functions of an EPSS. S.8 Possess knowledge pertaining to the components of an EPSS. S.9 Acquired necessary knowledge to integrate an EPSS in my learning area. S.10 Acquired necessary skills to integrate an EPSS in my learning area. S.11 Acquired necessary skills to create an algorithm. S.12 Acquired knowledge on how to design an EPSS in education. S.13 Acquired knowledge on how to develop an EPSS in education.

Consult the Respective Opinionnaire in Addendum B.

3.4 Data collection

Two instruments were employed to collect data regarding twenty-seven variables.

Three training sessions (in one day) were conducted in each selected school with the Grade 11 Physical Science teachers (see Table 4.1). The Grade 11 Physical Science teachers were provided with the data gathering instruments after the third training session. The researcher demonstrated to the participants how the data gathering instruments should be filled-in (Consult Addendum F).

3.5 Ethical considerations

Written approval to conduct the research was obtained from the Gauteng Department of Education, Tshwane North District Office and the participating schools. Furthermore, the Ethics Committee of the University of Pretoria approved the research project.

The dignity of the participants was respected as one of the main ethical considerations. The choice of the participants was safeguarded by the researcher because only Grade 11 Physical

Science teachers who agreed to participate in this research were selected. The participants were under no obligation to complete the CSIQ or the RO.

A covering letter was included with the CSIQ and the RO informing the participants that their anonymity would be maintained and respected. It was further indicated on the consent form that participants were free to withdraw from and discontinue the research any time without any prejudice. Furthermore the letter stated that the names of the schools would not be divulged as part of the findings and conclusions.

3.6 Data preparation

The data gathered with the CSIQ and RO were tabulated in MS Excel Worksheets (Consult Addendum G and Addendum H).

During data preparation the incomplete data regarding the CSIQ were identified (Table 3.3). The incomplete data were removed from the data (Consult Addendum G). Only 21 participants were recorded for parameter 2 and parameter 6.

Table 3.3: Incomplete data

Participants	Parameters		Comments
Participant 4	Parameter 2	P 2.1 – selected	Data for this parameter were not used in this research.
		P 2.2 – not selected	
Participant 12	Parameter 6	P 6.1 – selected	Data for this parameter were not used in this research.
		P 6.2 – not selected	

3.7 Research variables

Table 3.4 indicates the variables that were covered in the Retrospective Opinionnaire.

S1 to S13 refer to the statements in the opinionnaire (Consult Addendum H).

Table 3.4: Variables – Retrospective Opinionnaire

Categories	Variables
Section A - Design of a flowchart	S.1 Acquired necessary skills to design a flowchart
	S.2 Acquired knowledge about the symbols used to create a flowchart
	S.3 Acquired knowledge on how to divide a flowchart into slides
Section B - Create a hyperlinked slide show	S.4 Acquired necessary skills to design a hyperlinked slide show
	S.5 Acquired necessary skills to create textboxes
	S.6 Acquired necessary skills to create hyperlinks using textboxes
Section C - Design an algorithm and the EPSS	S.7 Possess knowledge pertaining to the functions of an EPSS
	S.8 Possess knowledge pertaining to the components of an EPSS
	S.9 Acquired necessary knowledge to integrate an EPSS in my learning area
	S.10 Acquired necessary skills to integrate an EPSS in my learning area
	S.11 Acquired necessary skills to create an algorithm
	S.12 Acquired knowledge on how to design an EPSS in education
	S.13 Acquired knowledge on how to develop an EPSS in education

Table 3.5 indicates the variables that were covered in the Customer Satisfaction Index Questionnaire. P1 to P14 refer to the parameters in the questionnaire (Consult Addendum G).

Table 3.5: Variables – Customer Satisfaction Index Questionnaire

Categories	Variables
Section A – Course material	P 1. Useful and easy to apply P 2. Related to your learning area P 3. Useful resource in your learning area P 4. Appropriate learning material
Section B – EPSS training process	P 5. Met the defined objectives P 6. Relevant to your learning area P 7. Practical and useful P 8. Satisfactory training process P 9. Clearly defined objectives
Section C – Trainer’s competencies	P 10. Logical manner P 11. Encouraged participation P 12. Knowledge of subject content P 13. Provided assistance P 14. Prompt feedback

3.8 Research hypotheses

The research hypotheses relevant in this study are the following:

- H₁ Teachers will show a high degree of satisfaction with the course material after attending an EPSS training program in the CSIQ.
- H₂ Teachers will show a high degree of satisfaction with the training process after attending an EPSS training program in the CSIQ.
- H₃ Teachers will show a high degree of satisfaction with the trainer’s competencies after attending an EPSS training program in the CSIQ.

- H₄ Teachers will show a significant increase in skills and knowledge on how to design a flowchart after attending the EPSS training in the RO.
- H₅ Teachers will show a significant increase in skills and knowledge on how to create a hyperlinked slide show attending the EPSS training in the RO.
- H₆ Teachers will show a significant increase in skills and knowledge on how to design and algorithm and an EPSS after attending the EPSS training in the RO.

Chapter 4: Training framework

4.1 Contextual Background

This section outlines the three training sessions that were identified, developed and implemented in this study. The training sessions are as follows, familiarisation on how to solve problems using an EPSS, co-development of a hyperlinked slide show and development of an algorithm and the EPSS.

4.2 Training sessions in the familiarisation, co-development and the development of an algorithm and the EPSS

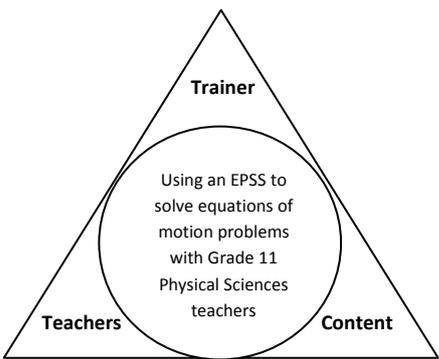
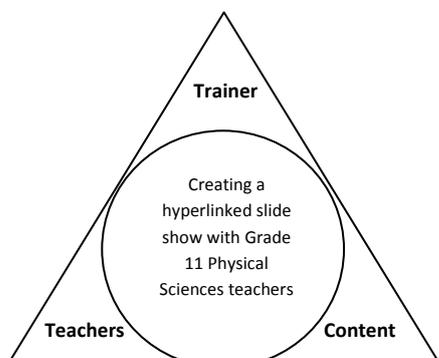
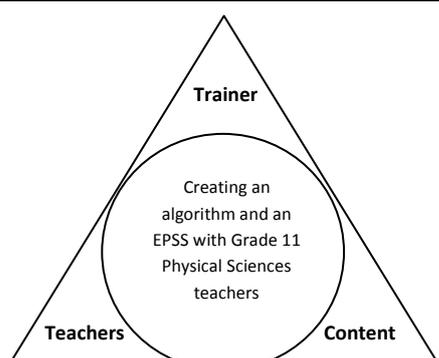
All three training sessions (see Table 4.1) included an initial face-to-face meeting and application of the skills grasped by the participants. In addition these training sessions were used to facilitate the process of solving problems using an EPSS, creating a hyperlinked slide show and designing an algorithm and an EPSS. The training sessions took place in the school's computer laboratory/staffroom are discussed in paragraphs 4.2.1. – 4.2.3.

4.2.1 Session 1: Familiarisation on how to solve problems using an EPSS

The participants were provided with training material on how to solve an equation of motion problems using an EPSS. The material included the researcher's notes, equations of motion questions (worksheet), information sheet and an EPSS CD. The researcher, acting as the trainer, was involved in a process of familiarising teachers (participants) with the functions and components of an EPSS.

Furthermore, the community (researcher and participants) had a set of rules related to an EPSS that they adhered too. In a nutshell, these rules encompassed the facilitation rules and procedures on how to navigate through the system. Thus these rules were used as a guide to create a helpful learning environment so that the exploration process could yield the expected results.

Table 4.1: Contextual framework

Session 1: Familiarisation on how to solve problems using an EPSS		What I need to achieve the set goal	Duration
		Material used <ul style="list-style-type: none"> • Researcher's notes 1 • Worksheet 1: Equations of motion questions • Information sheet 2: Equations of motion formulae • Solutions to the Equation of Motion questions • EPSS CD (Addendum C)	30 minutes
Session 2: Co-development of a hyperlinked slide show		What I need to achieve the set goal	Duration
		Material used <ul style="list-style-type: none"> • Researcher's notes 2 • Worksheet 2: True or False questions • Information Sheet 2: Flowchart • Information sheet 3: Flowchart divided into slides • Solutions to the True or False questions • Ms PowerPoint (Addendum D)	60 minutes
Session 3: Development of an algorithm and the EPSS		What I need to achieve the set goal	Duration
		Materials used <ul style="list-style-type: none"> • Researcher's notes 3 • Worksheet 3: Kinematics Problems • Information sheet 4: Kinematics algorithm • Solutions to the Kinematics Problems • Ms PowerPoint (Addendum E)	70 minutes
Key	Explanation		
Participants	Grade 11 Physical Science teachers participating in the research process		
EPSS	Electronic Performance Support System		
Ms PowerPoint	Microsoft PowerPoint program		

Prior to the familiarisation process the researcher explained the structure of an EPSS in a chronological manner to enable participants to grasp various components of the system. Consequently an EPSS was used as a Training/Trainee Instructional Mediating Tool by the trainer and the participants. The researcher utilised an EPSS that is stored on a Compact Disk (CD) in a blended learning environment.

During the familiarisation process, the researcher provided the necessary answers to questions asked as a means of alleviating participants' fears and enabling them to participate in the training process. The familiarisation process on how to solve problem using an EPSS engaged participants in understanding the components and functions of an EPSS in a blended learning environment. The familiarisation process afforded the participants an opportunity to delve into all the components of the EPSS, including its look and feel.

4.2.2 Session 2: Co-development of a hyperlinked slide show

The familiarisation process progressed to the co-development of a hyperlinked slide show by the researcher and the participants. The co-development session engaged participants in understanding how to create a hyperlinked slide show using *Microsoft PowerPoint* program.

Participants worked together in a heterogeneous group and took advantage of one another's knowledge and experiences. Furthermore, they were supported through activities that require them to integrate their thinking and decision-making to interrelate the process of developing a hyperlinked slide show. Lastly, the co-developed hyperlinked slide show was stored on a Compact Disk (CD) so that it can be used as a guide in similar future endeavours.

4.2.3 Session 3: Development of an algorithm and the EPSS

The familiarisation and co-development sessions progressed to the development of an algorithm and an EPSS by the participants. The development session allowed participants to showcase the skills that they had acquired in the familiarisation and the co-development sessions.

The researcher provided the participants with training material on how to create an algorithm and an EPSS. The material included the researcher's notes, flowchart, kinematics questions

(worksheet), solutions and information sheet. The participants were involved in a process of developing a functional EPSS. They used *Microsoft PowerPoint* software installed on their computers to construct the envisaged EPSS.

Furthermore, the community had a set of rules related to an EPSS that they had to adhere to. These included the rules and procedures on how develop an EPSS. Thus these were used as a guide to create a helpful learning environment so that the development process could yield the expected results.

Participants played an active role in the development of an algorithm and an EPSS while working with the material that they had developed using *Microsoft PowerPoint* program. This entailed developing appropriate templates used in the construction of an algorithm and an EPSS. At this level they passed through developmental cycles as they selected various tools and resources. They followed a planned preformatted programme to plan so that they could achieve the expected outcome.

Moreover, they worked collaboratively in a heterogeneous group and took advantage of one another's knowledge and experiences. They were supported through activities that require them to integrate their thinking and decision-making to interrelate the process of developing an EPSS. Finally, the developed algorithm and an EPSS were stored on a Compact Disk (CD) so that it can be used as a guide in similar future endeavours.

Chapter 5: Research Findings

5.1 Introduction

This chapter provides a detailed overview of the findings from the CSIQ and the RO received from the participants. Figures and tables are used in the presentation of the data collected during the EPSS training programme.

5.2 Data Analysis

5.2.1 Customer Satisfaction Index Questionnaire

A quantitative data analysis software program namely Microsoft Excel was used to analyse data collected using the CSIQ. The researcher used Microsoft Excel to determine the weight, average and customer satisfaction index of the participants.

The Performance Matrix was drawn and consist of the data obtained from the average score (satisfaction) on the x-axis against the average weightings (important) on the y-axis plotted for each parameter. Its purpose is to provide a quick overview of the relationship between variables as well as the areas where there is scope for improvement.

The Customer Satisfaction Index (CSI) was calculated to represent the overall satisfaction level of the teacher as a single number, usually a percentage. The CSI was achieved by calculating the average of all the weights given by the teachers. A table indicating the customer satisfaction index was displayed for each parameter as part of the research report.

5.2.2 Retrospective Opinionnaire

A quantitative data analysis software program named Statistical Package for the Social Sciences (SPSS) was used to analyse data collected using the RO. The researcher used the SPSS program to determine the median, r-value and z-value of the participants.

The Wilcoxon Signed Rank Test was used to determine teachers' perceived change in knowledge and skills on how to design a flow chart, a hyperlinked slide show, an algorithm and the EPSS before and after training was compared to validate or nullify the hypotheses.

5.3 Analysis of the Customer Satisfaction Index Questionnaire data

The analysis of the Customer Satisfaction Index Questionnaire raw data is supplied in Addendum G.

5.3.1 Analysis of the CSI-data pertaining to the course material

5.3.1.1 Summary of data pertaining to the course material

Table 5.1 is a summary of the data pertaining to the course material used during the EPSS training process.

Table 5.1: Summary of data pertaining to the course material

Parameter number	Section A: Questions pertaining to the course material		Frequencies					Total	Number of participants
			Extremely dissatisfied/unimportant	Dissatisfied/unimportant	Neutral	Satisfied/important	Extremely satisfied/important		
			1	2	3	4	5		
P1	1.1	How important is it that the course material should be useful and easy to apply?	0 (0%)	0 (0%)	1 (4,6%)	7 (31,8%)	14 (63,6%)	101	22
	1.2	How satisfied are you that the course material was useful and easy to apply?	0 (0%)	0 (0%)	2 (9,1%)	12 (54,6%)	8 (36,4%)	94	22
P2 [#]	2.1	How important is it that the course material should be related to your learning area?	0 (0%)	0 (0%)	0 (0%)	6 (28,6%)	15 (71,4%)	99	21
	2.2	How satisfied are you that the course material is related to your learning area?	0 (0%)	0 (0%)	0 (0%)	10 (47,6%)	11 (52,4%)	95	21
P3	3.1	How important is it that the course material should be a useful learning resource to your learning area?	0 (0%)	0 (0%)	1 (4,6%)	8 (36,4%)	13 (59,1%)	100	22
	3.2	How satisfied are you that the course material is a useful resource in your learning area?	0 (0%)	0 (0%)	1 (4,6%)	10 (45,5%)	11 (50,0%)	98	22
P4	4.1	How important is it that the material provided during the training programme was appropriate?	0 (0%)	0 (0%)	2 (9,1%)	6 (27,3%)	14 (63,6%)	100	22
	4.2	How satisfied are you that the material provided during the training programme is appropriate?	0 (0%)	0 (0%)	2 (9,1%)	11 (50%)	9 (40,9%)	95	22

See paragraph 3.6

5.3.1.2 Calculation and interpretation of the CSI values pertaining to the course material

Table 5.2 indicates the calculation of the Customer Satisfaction Indices pertaining to the course material.

Table 5.2: Calculation of the CSI values pertaining to the course material

Parameter P	Weighting A	Score B	Weighting (avg. of 1) C	Weighting (avg. of 1) * Score D = B * C
P1: Useful and easy to apply	4,59	4,27	1,00	4,27
P2: Related to your learning area	4,71	4,52	1,02	4,61
P3: Useful resource in your learning area	4,55	4,45	0,98	4,36
P4: Appropriate learning material	4,55	4,32	0,99	4,28
	Average = 4,60			Average CSI = 4,39

It is clear from Table 5.2 that the Customer Satisfaction Indices ranged from 4,27 (P1: Useful and easy to apply) to 4,61 (P2: Related to your learning area). The average CSI of all the parameters pertaining to the course material is 4.39. Therefore the Customer Satisfaction Index Percentage based on the scale (1 - 5) used is 88%. It can be concluded that 88% of the participants were satisfied with all the parameters pertaining to the course material.

5.3.1.3 Graphical representation and the interpretation of the weighting and scores

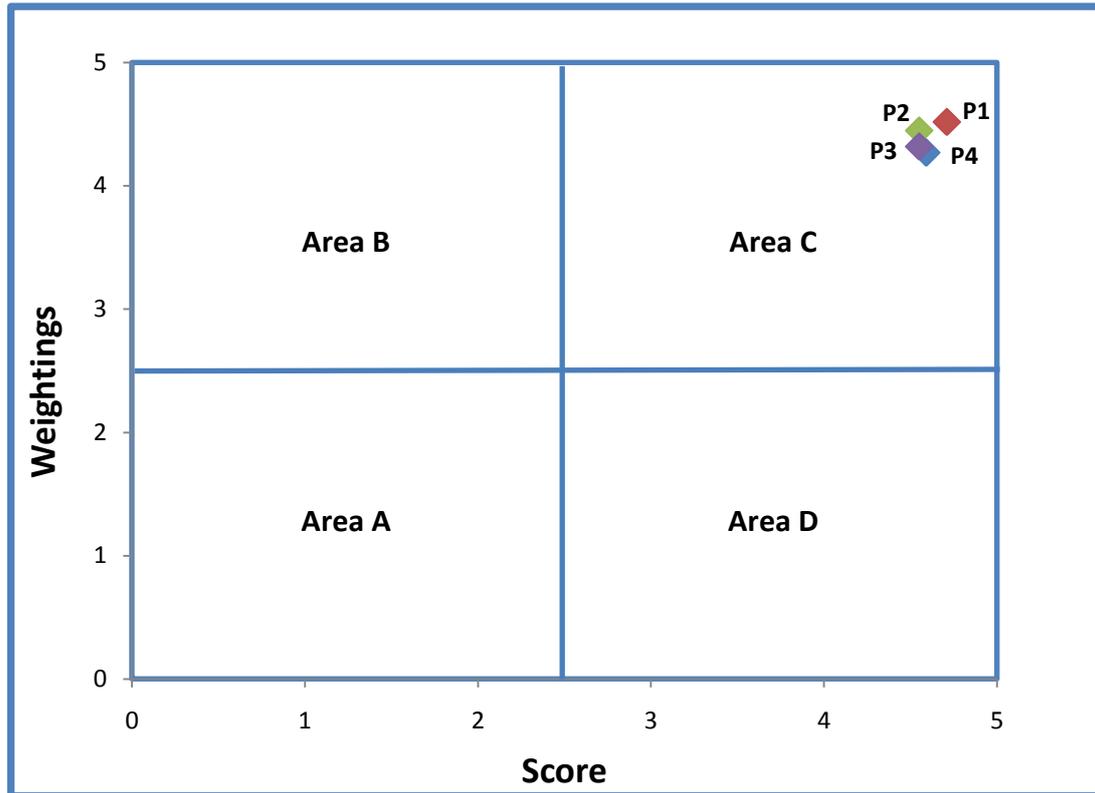
Table 5.3 indicates how to interpret the information in the Performance Matrix (Figure 5.1).

Table 5.3: Interpretation of the Performance Matrix pertaining to the course material

Key	Points on the graphs	Interpretation of the results
Area A	Low score, low weighting	The course material used during the EPSS training process should be discarded.
Area B	Low score, high weighting	The course material used during the EPSS training process should be enhanced so that it could be accepted.
Area C	High score, high weighting	The course material used during the EPSS training process was accepted by the participants.
Area D	High score, low weighting	The course material used during the EPSS training process should be enhanced so that it could be accepted.

Figure 5.3 indicates the graphical representation of the scores on the x-axis and the weighting on the y-axis for each parameter.

Figure 5.1: Performance Matrix pertaining to the course material



It is clear from Figure 5.1 and Table 5.2 that the course material was accepted by the participants from the eight participating schools.

5.3.2 Analysis of the CSI-data pertaining to the EPSS training process

5.3.2.1 Summary of data pertaining to the EPSS training process

Table 5.4 is the summary of data pertaining to the EPSS training process.

Table 5.4: Summary of data pertaining to the EPSS training process

Parameter number	Section B: Questions pertaining to the EPSS training process		Frequencies					Total	Number of participants
			Extremely dissatisfied/ unimportant	Dissatisfied/ unimportant	Neutral	Satisfied/ important	Extremely satisfied/ important		
			1	2	3	4	5		
P5	5.1	How important is it that the course should meet the defined objectives?	0 (0%)	0 (0%)	0 (0%)	12 (54,6%)	10 (45,5%)	98	22
	5.2	How satisfied are you that the course met the defined objectives?	0 (0%)	1 (4,6%)	3 (13,6%)	11 (50,0%)	7 (81,8%)	90	22
P6 [#]	6.1	How important it is that the course should be relevant to your current learning area?	0 (0%)	0 (0%)	0 (0%)	5 (23,8%)	16 (76,2%)	100	21
	6.2	How satisfied are you that the course is relevant to your current learning area?	0 (0%)	0 (0%)	3 (14,3%)	6 (28,6%)	12 (57,1%)	93	21
P7	7.1	How important is it that the content of an EPSS programme should be practical and useful to your learning area?	0 (0%)	0 (0%)	1 (4,6%)	6 (28,6%)	15 (68,2%)	102	22
	7.2	How satisfied are you that the content of an EPSS programme is practical and useful to your learning area?	0 (0%)	0 (0%)	3 (13,6%)	8 (36,4%)	11 (50,0%)	96	22
P8	8.1	How important is it that the overall process of an EPSS programme should be satisfactory?	0 (0%)	0 (0%)	3 (13,6%)	9 (40,9%)	10 (45,5%)	95	22
	8.2	How satisfied are you that the overall training process of an EPSS programme was satisfactory?	0 (0%)	0 (0%)	3 (13,6%)	13 (59,1%)	6 (27,3%)	91	22
P9	9.1	How important is it that the objectives of the course should be clearly defined?	0 (0%)	0 (0%)	1 (4,6%)	9 (40,9%)	12 (54,6%)	99	22
	9.2	How satisfied are you that the objectives of the course are clearly defined?	0 (0%)	1 (4,6%)	2 (9,1%)	11 (50,0%)	8 (36,4%)	92	22

See paragraph 3.6

5.3.2.2 Calculation and interpretation of the CSI values pertaining to the EPSS training process

Table 5.5 supplies the calculations of the Customer Satisfaction Indices pertaining to the EPSS training process.

Table 5.5: Calculation of the CSI values pertaining to the EPSS training process

Parameter P	Weighting A	Score B	Weighting (avg. of 1) C	Weighting (avg. of 1) * Score D = B * C
P5: Met the defined objectives	4,45	4,09	0,98	4,01
P6: Relevant to your learning area	4,76	4,43	1,05	4,65
P7: Practical and useful	4,64	4,36	1,02	4,45
P8: Satisfactory training process	4,32	4,14	0,95	3,93
P9: Clearly defined objectives	4,50	4,18	0,99	4,14
	Average = 4,53			Average CSI = 4,24

It is clear from Table 5.5 that the Customer Satisfaction Indices range from 3,93 (P8: Satisfactory training process) to 4,65 (P6: Relevant to your learning area). The average CSI of all the parameters pertaining to the course material is 4,24. Therefore the Customer Satisfaction Index Percentage based on the scale (1 - 5) used is 84,8%. It can be concluded that 84,8% of the participants were satisfied with all the parameters pertaining to the EPSS training process.

5.3.2.3 Graphical representation and the interpretation of the weightings and score

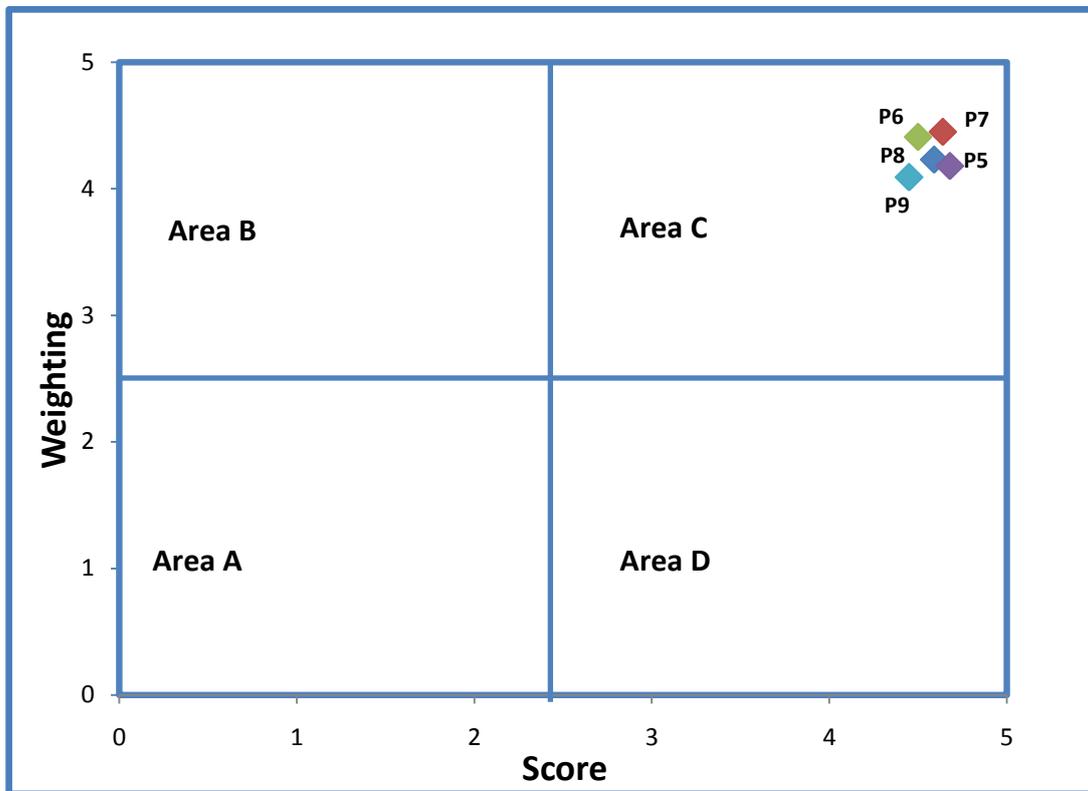
Table 5.6 indicates how to interpret the information in the Performance Matrix (Figure 5.2).

Table 5.6: Interpretation of the Performance Matrix pertaining to the EPSS training process

Key	Points on the graphs	Interpretation of the results
Area A	Low score, low weighting	The EPSS training process should be discarded.
Area B	Low score, high weighting	The EPSS training process should be enhanced so that it could be accepted.
Area C	High score, high weighting	The EPSS training process was accepted by the participants.
Area D	High score, low weighting	The EPSS training process should be enhanced so that it could be accepted.

Figure 5.2 indicates the graphical representation of the score on the x-axis and the weighting on the y-axis for each parameter.

Figure 5.2: Performance Matrix pertaining to the EPSS training process



It is clear from Figure 5.2 and Table 5.5 that the EPSS training process was accepted by the participants of the eight participating schools.

5.3.3 Analysis of the CSI-data pertaining to the trainer's competencies

5.3.3.1 Summary of data pertaining to the trainer's competencies

Table 5.7 is a summary of data pertaining to the trainer's competencies.

Table 5.7: Summary of data pertaining to the trainer's competencies

Section C: Questions pertaining to the trainer's competencies			Frequencies					Total	Number of participants
			Extremely dissatisfied/ unimportant	Dissatisfied/ unimportant	Neutral	Satisfied/ important	Extremely satisfied/ important		
			1	2	3	4	5		
P10	10.1	How important is it that the facilitator should present the course material of an EPSS in a logical manner?	0 (0%)	0 (0%)	2 (9,1%)	5 (22,7%)	15 (68,2%)	101	22
	10.2	How satisfied are you that the facilitator presented the course material of an EPSS in a logical manner?	0 (0%)	1 (9,1%)	3 (13,6%)	8 (36,4%)	10 (45,5%)	93	22
P11	11.1	How important is it that the facilitator should encourage participation among teachers during the training process?	0 (0%)	0 (0%)	1 (4,6%)	6 (27,3%)	15 (68,2%)	102	22
	11.2	How satisfied are you that the facilitator encouraged participation among teachers during the training process?	0 (0%)	0 (0%)	1 (4,6%)	10 (45,5%)	11 (50,0%)	98	22
P12	12.1	How important is it that the facilitator should demonstrate thorough knowledge of the subject content?	0 (0%)	0 (0%)	2 (9,1%)	7 (31,8%)	13 (59,1%)	99	22
	12.2	How satisfied are you that the facilitator demonstrated thorough knowledge of the subject content?	0 (0%)	0 (0%)	1 (4,6%)	11 (50,0%)	10 (45,5%)	97	22
P13	13.1	How important is it that the facilitator should provide assistance on how to explore an EPSS during training?	0 (0%)	0 (0%)	1 (4,6%)	5 (22,7%)	16 (72,7%)	103	22
	13.2	How satisfied are you that the facilitator provided assistance on how to explore an EPSS during training?	0 (0%)	1 (4,6%)	3 (13,6%)	9 (40,9%)	9 (40,9%)	92	22
P14	14.1	How important is it that the facilitator should provide teachers with prompt feedback during the training process?	0 (0%)	0 (0%)	2 (9,1%)	8 (36,4%)	12 (54,6%)	98	22
	14.2	How satisfied are you that the facilitator provided teachers with prompt feedback during the training process?	0 (0%)	0 (0%)	5 (22,7%)	10 (45,5%)	7 (31,8%)	90	22

5.3.3.2 Calculation and interpretation of the CSI values pertaining to the trainer's competencies

Table 5.8 indicates the Customer Satisfaction Indices pertaining to the trainer's competencies.

Table 5.8: Calculation of the CSI values pertaining to the trainer's competencies

Parameter P	Weighting A	Score B	Weighting (avg. of 1) C	Weighting (avg. of 1) * Score D = B * C
P10: Logical manner	4,59	4,23	1,00	4,23
P11: Encouraged participation	4,64	4,45	1,02	4,54
P12: Knowledge of subject content	4,50	4,41	0,98	4,32
P13: Provided assistance	4,68	4,18	1,02	4,26
P14: Prompt feedback	4,45	4,09	0,97	3,97
	Average = 4,57			Average CSI = 4,26

It is clear from Table 5.8 that the Customer Satisfaction Indices range from 3,97 (P14: Prompt feedback) to 4,54 (P11: Encouraged participation). The average CSI of all the parameters pertaining to the course material is 4,26. Therefore the Customer Satisfaction Index Percentage based on the scale (1 to 5) used is 85,2%. It can be concluded that 85,2% of the participants were satisfied with all the parameters pertaining to the trainer's competencies.

5.3.3.3 Graphical representation and the interpretation of the weighting and score

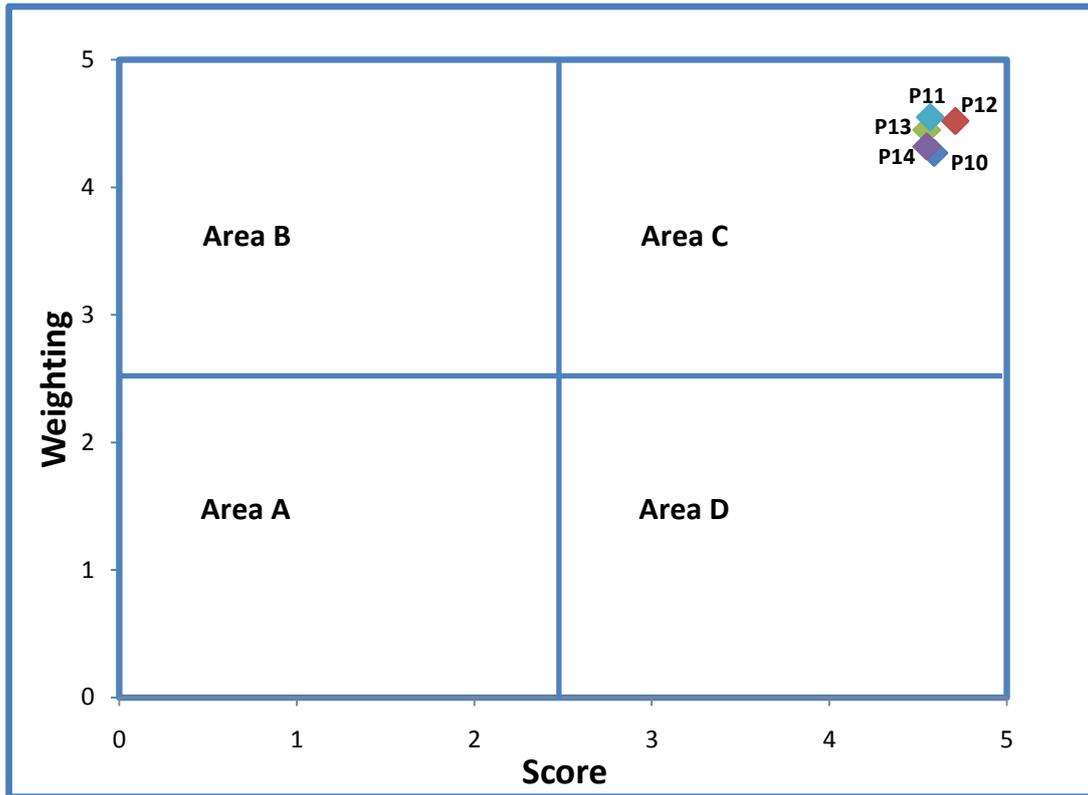
Table 5.9 indicates how to interpret the information in the Performance Matrix (Figure 5.3).

Table 5.9: Interpretation of the Performance Matrix pertaining to the trainer's competencies

Key	Points on the graphs	Interpretation of the results
Area A	Low score, low weighting	The trainer's competencies should be discarded.
Area B	Low score, high weighting	The trainer's competencies should be enhanced so that they could be accepted.
Area C	High score, high weighting	The trainer's competencies were accepted.
Area D	High score, low weighting	The trainer's competencies should be enhanced so that they could be accepted.

Figure 5.3 indicates the graphical representation of the score on the x-axis and the weighting on the y-axis.

Figure 5.3: Performance Matrix pertaining to the trainer’s competencies



It is clear from Figure 5.3 and Table 5.8 that the trainer’s competencies were accepted by the participants of the eight participating schools.

5.4 Analysis of the Retrospective Opinionnaire data

The analysis of the Retrospective Opinionnaire raw data is available in Addendum H.

5.4.1 Analysis pertaining to the design of a flowchart

5.4.1.1 Summary of data pertaining to the design of a flowchart

Table 5.10 and Addendum I indicate the summary of the Wilcoxon signed rank test results pertaining to the design of a flowchart.

Table 5.10: Summary of the Wilcoxon signed rank test results pertaining to the design of a flowchart

Statements	Median		z-value	p-value	r-value	absolute r-value
	Before	After				
S.1 Acquired necessary skills to design a flowchart.	2	4	-3,963	p < 0,05	-0,844	0,844
S.2 Acquired knowledge of the symbols used to create a flowchart.	2	4	-3,858	p < 0,05	-0,823	0,823
S.3 Acquired knowledge on how to divide a flowchart into slides.	1,5	4	-3,832	p < 0,05	-0,817	0,817

5.4.1.2 Interpretation of the results pertaining to the design of a flowchart

Table 5.11 indicates the interpretation of the results pertaining to the design of a flowchart.

Table 5.11: Interpretation of the results pertaining to the design of a flowchart

Statements	Interpretation
S.1 Acquired necessary skills to design a flowchart.	The skills levels of the participants to design a flowchart after training (median = 4) were significantly higher than the skill levels before training (median = 2). (z = -3,963, p < 0,05).
	Furthermore, the absolute value of the effect size (r-value = 0,844) is greater than 0,05 which means that there is a larger chance that the high skills level of the participants to design a flowchart after training than before training was a result the EPSS training attended.
S.2 Acquired knowledge of the symbols used to create a flowchart.	The acquired knowledge levels of the participants of the symbols used to create a flowchart after training (median = 4) were significantly higher than the knowledge levels before training (median = 2). (z = -3,858, p < 0,05).
	In addition, the absolute value of the effect size (r-value = 0.823) is greater than 0,05 which means that there is a larger chance that the high skills level of the participants about the symbols used to create a flowchart after training than before training was a result the EPSS training attended.
S.3 Acquired knowledge on how to divide a flowchart into slides.	The knowledge levels of the participants on how to divide a flowchart into slides after training (median = 4) were significantly higher than the knowledge levels before training (median = 1.5). (z = -3,832, p < 0,05).
	Furthermore, the absolute value of the effect size (r-value = 0,817) is greater than 0,05 which means that there is a larger chance that the high skills level of the participants on how to divide a flowchart into slides after training than before training was a result the EPSS training attended.

5.4.2 Analysis pertaining to the design of a hyperlinked slide show

5.4.2.1 Summary of the Wilcoxon signed rank test results pertaining to the design of a hyperlinked slide show

Table 5.12 indicates the summary of the Wilcoxon signed rank test results pertaining to the hyperlinked slide show.

Table 5.12: Summary of the Wilcoxon signed rank test results pertaining to the design of a hyperlinked slide show

Statements	Median		z-value	p-value	r-value	absolute r-value
	Before	After				
S.4 Acquired necessary skills to design a flowchart.	2	4	-3,963	p < 0,05	-0,844	0,844
S.5 Acquired knowledge of the symbols used to create a flowchart.	2	4	-3,858	p < 0,05	-0,823	0,823
S.6 Acquired knowledge on how to divide a flowchart into slides.	1,5	4	-3,832	p < 0,05	-0,817	0,817

5.4.2.2 Interpretation of the results pertaining to the design of a hyperlinked slide show

Table 5.13 and Addendum J indicate the summary of the Wilcoxon signed rank test results pertaining to the hyperlinked slide show.

Table 5.13: interpretation of the results pertaining to the design of a hyperlinked slide show

Statements	Interpretation
S.4 Acquired necessary skills to design a flowchart.	The skills levels of the participants to create slides using Microsoft PowerPoint program after training (median = 4) were significantly higher than the skill levels before training (median = 2). (z = -3,787, p < 0,05).
	Furthermore, the absolute value of the effect size (r-value = 0,801) is greater than 0,05, which means that there is a larger chance that the high skills level of the participants to create slides using Microsoft PowerPoint program after training than before training was a result of the EPSS training attended.
S.5 Acquired knowledge of the symbols used to create a flowchart.	The skill levels of the participants to create textboxes on the slides after training (median = 4) were significantly higher than the skill levels before training (median = 2). (z = -3.998, p < 0.05).
	In addition, the absolute of the effect size (r-value = 0,852) is greater than 0,05, which means that there is a larger chance that the high skills level of the participants to create textboxes on the slides after training that before training was the result of the EPSS training attended.
S.6 Acquired knowledge on how to divide a flowchart into slides.	The skill levels of the participants to create hyperlinks using textboxes on the slides after training (median = 3,5) were significantly higher than the skill levels before training (median = 1). (z = -3,867, p < 0,05).
	Furthermore, the absolute value of the effect size (r-value = 0,825) is greater than 0,05, which means that there is a larger chance that the high skills level of the participants to create hyperlinks using textboxes on the slides after training than before training was the result of the EPSS training attended.

5.4.3 Analysis pertaining to the design of an algorithm and the EPSS

5.4.3.1 Summary of the Wilcoxon signed rank test results pertaining to the design of an algorithm and the EPSS

Table 5.14 and Addendum K indicate the summary of the Wilcoxon signed rank test results pertaining to the design of an algorithm and the EPSS.

Table 5.14: Summary of the Wilcoxon signed rank test results pertaining to the design of an algorithm and the EPSS

Statements	Median		z-value	p-value	r-value	absolute r-value
	Before	After				
S.7 Possess knowledge pertaining to the functions of an EPSS.	1	4	-4,053	p < 0,05	-0,864	0,864
S.8 Possess knowledge pertaining to the components of an EPSS.	1	3	-3,956	p < 0,05	-0,863	0,863
S.9 Acquired necessary knowledge to integrate an EPSS in my learning area.	1,5	4	-3,872	p < 0,05	-0,826	0,826
S.10 Acquired necessary skills to integrate an EPSS in my learning area.	1	4	-3,767	p < 0,05	-0,803	0,803
S.11 Acquired necessary skills to create an algorithm.	2	3	-3,684	p < 0,05	-0,786	0,786
S.12 Acquired knowledge on how to design an EPSS in education.	1	4	-4,064	p < 0,05	-0,867	0,867
S.13 Possess knowledge on how to develop an EPSS in education.	1	4	-4,083	p < 0,05	-0,870	0,870

5.4.3.2 Interpretation of the results pertaining to the design of an algorithm and the EPSS

Table 5.15 indicates the interpretation of the results pertaining to the design of an algorithm and an EPSS.

Table 5.15: Interpretation of the results pertaining to the design of an algorithm and the EPSS

Statements	Interpretation
S.7 Possess knowledge pertaining to the functions of an EPSS.	<p>The knowledge levels of the participants pertaining to the functions of an EPSS after training (median = 4) were significantly higher than the knowledge levels before training (median = 1). ($z = -4,053$, $p < 0,05$).</p> <p>Furthermore, the absolute value of the effect size (r-value = 0,864) is greater than 0,05. This means that there is a large chance that the high skills levels of the participants pertaining to the functions of an EPSS after training than before training were due to the EPSS training attended.</p>

Table 5.15: Interpretation of the results pertaining to the design of an algorithm and the EPSS (continued)

Statements	Interpretation
S.8 Acquired knowledge pertaining to the components of an EPSS.	The knowledge levels of the participants pertaining to the components of an EPSS after training (median = 3) were significantly higher than the knowledge levels before training (median = 1); $z = -3,956$, $p < 0,05$.
	In addition, the absolute value of the effect size (r-value = 0,863) is greater than 0,05. This means that there is a large chance that the skills levels of the participants pertaining to the components of an EPSS after training is higher that before training were due to the EPSS training attended.
S.9 Acquired necessary knowledge to integrate an EPSS in my learning area.	The knowledge levels of the participants to integrate an EPSS in their learning area after training (median = 4) were significantly higher than the knowledge levels before training (median = 1,5), ($z = -3,872$, $p < 0,05$).
	Furthermore, the absolute value of the effect size (r-value = 0,826) is greater than 0,05. This means that there is a larger chance that the high skills level of the participants to integrate an EPSS in their learning area after training that before training was due to the EPSS training attended.
S.10 Acquired necessary skills to integrate an EPSS in my learning area.	The skill levels of the participants to integrate an EPSS in their learning area after training (median = 4) were significantly higher than the skill levels before training (median = 1). ($z = -3,767$, $p < 0,05$).
	In addition, the absolute value of the effect size (r-value = 0,803) is greater than 0,05. This means that there is a larger chance that the high skills level of the participants to integrate an EPSS in their learning area after training than before training was due to the EPSS training attended.
S.11 Acquired necessary skills to create an algorithm.	The skill levels of the participants to create an algorithm after training (median = 3) were significantly higher than the skill levels before training (median = 2). ($z = -3,684$, $p < 0,05$).
	Furthermore, the absolute value of the effect size (r-value = 0,786) is greater than 0,05. This means that there is a large chance that the high skills levels of the participants to create an algorithm after training than before training were due to the EPSS training attended.
S.12 Acquired knowledge on how to design an EPSS in education.	The knowledge levels of the participants on how to design an EPSS in education after training (median = 4) were significantly higher than the knowledge levels before training (median = 1). ($z = -4,064$, $p < 0,05$).
	In addition, the absolute value of the effect size (r-value = 0,867) is greater than 0,05. This means that there is a large chance that the high knowledge levels of the participants on how to design an EPSS in education after training than before training were due to the EPSS training attended.
S.13 Acquired knowledge on how to develop an EPSS in education.	The knowledge levels of the participants on how to develop an EPSS in education after training (median = 4) were significantly higher than the knowledge levels before training (median = 1). ($z = -4,83$, $p < 0,05$).
	Furthermore, the absolute value of the effect size (r-value = 0,870) is greater than 0,05. This means that there is a large chance that the high skills levels of the participants on how to develop an EPSS in education after training than before training were due to the EPSS training attended.

Chapter 6: Conclusion and recommendations

6.1 Introduction

This chapter provides a detailed overview of the discussions, conclusion and recommendations from the research findings during an EPSS training programme.

6.2 Discussions

The purpose of the study is to determine the following:

- (a) The level of satisfaction of Grade 11 Physical Science teachers regarding the course material, training process and the trainer's competencies relating to the training to design and develop an EPSS.
- (b) The perceived change in knowledge and skills of Grade 11 Physical Science teachers after training in using an EPSS.

The research questions pursued in this study are as the following:

- (a) What are the teachers' levels of satisfaction regarding the course material, training process and the trainer's competencies?
- (b) Is there any change in the knowledge and skills of the teachers after training in using an EPSS?

The research findings indicate that the participants were satisfied with the course material, training process and trainer's competencies during the EPSS training process. The results further indicate that the participants have gained skills and knowledge regarding the design of a flowchart, a hyperlinked slide show, an algorithm and an EPSS during the training process.

6.3 Implications

This study was limited to Grade 11 Physical Science teachers in the Tshwane North District; therefore it cannot be considered as representative of all Physical Science teachers in the Gauteng Education Department. The results of the study cannot be generalised because of its limitation to a smaller group of Physical Science teachers.. The researcher assumed that the methodology used was appropriate to the problem being addressed and to the purpose of the study.

6.4 Conclusion

It is clear from the training sessions conducted during this research that teacher training in the use and development of an electronic expert system in education is a vital option that should be pursued. This study has enlightened the participants that there are some instructional methods that can be used to facilitate teachers' teaching and benefit learners' learning. The literature review (Hixon & So, 2009; Wang & Sung, 2011; Carlson & Gadio, n.d.) also attests to the notion that teachers should be provided with training in how to design an electronic expert system to empower them to become facilitators of learners learning.

6.5 Recommendations

6.5.1 Familiarisation process

The purpose of the familiarisation process is to:

- demonstrate to the Gauteng Education Department (GDE) officials, Subject Specialists and teachers how an EPSS can be used in teaching and learning;
- enable the GDE eLearning officials, Subject Specialists and teachers to accept that there is a need for change management regarding the introduction of an EPSS in teaching and learning.

It is therefore recommended that during a familiarisation process the following strategies be implemented:

- A meeting should be organised with the GDE provincial officials in the Chief Directorate: Information Systems and Knowledge Management, Directorate: eLearning to provide them with feedback regarding the outcome of this study.
- A meeting should be organised with the GDE provincial officials in the Directorate: eLearning at provincial level and Physical Sciences Subject Specialists in the Directorate: Curriculum to showcase the developed Electronic Performance Support System.
- The GDE provincial officials in the Directorate: eLearning should organise a meeting with eLearning officials and Physical Sciences Subject Specialists in various districts to familiarise them with how an EPSS can be used in teaching and learning.

- The GDE eLearning officials in the Directorate: Curriculum and eLearning at district level should organise a meeting with teachers to familiarise them with how an EPSS can be used in teaching and learning.

6.5.2 EPSS training programme

The GDE officials at provincial level in the Chief Directorate: Information Systems and Knowledge Management, Directorate: eLearning should consider how to implement the development of an EPSS in instruction and learning. The envisaged EPSS training programme should form part of the pre-service and in-service training of teacher's professional development initiatives. The processes in paragraphs 6.5.2.1, 6.5.2.2 and 6.5.2.3 are recommended to ensure that the envisaged training process achieves the expected outcomes.

6.5.2.1 Short-term

During this process the GDE officials at provincial level in the Chief Directorate: Information Systems and Knowledge Management, Directorate: eLearning should collaborate with the University of Pretoria, Faculty of Education and the Department of Science, Mathematics and Technology to train eLearning officials on how to develop an EPSS.. The following eLearning officials should be trained: Chief Education Specialist, Deputy Chief Education Specialist in the Directorate: eLearning at provincial level, Deputy Chief Education Specialist, First education Specialist and Education Specialist in the Directorate: Curriculum and eLearning at district level. These officials should constitute the core team of master trainers at provincial and district level.

6.5.2.2 Medium-term

During this process the GDE officials in the Chief Directorate: Information Systems and Knowledge Management, Directorate: eLearning in collaboration with the University of Pretoria: Faculty of Education and the Department of Science, Mathematics and Technology should train eLearning officials at district level in the Directorate: Curriculum and eLearning and teachers at various schools on how to develop an EPSS in education. These officials should form part of the master trainers who train other teachers on how to design and develop EPSSs in various learning areas.

6.5.2.3 Long-term

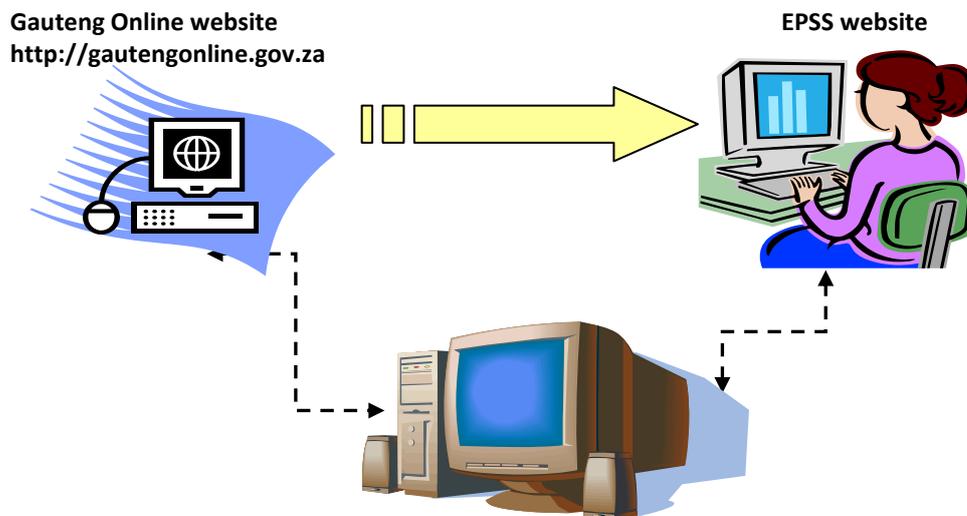
During this term the GDE eLearning officials at provincial level in the Directorate: eLearning should develop a comprehensive training programme on how to develop an EPSS in education. The plan should indicate the budget implications and the timeframes. Furthermore, it should outline the roles and responsibilities of various stakeholders (master trainers, GDE eLearning officials, University of Pretoria and teachers) so that the envisaged training programme could yield the expected outcomes. The GDE officials and other stakeholders should ensure that the timeframes set for training are being implemented in order to meet the identified needs.

6.5.3 Development of an EPSS website

The GDE officials at provincial level in the Directorate: eLearning should develop an online and an offline repository to enable teachers to upload, save and share their developed EPSSs. It is recommended that the GDE design and develop an EPSS website. The envisaged EPSS website will afford teachers the opportunity to receive feedback from their colleagues regarding their developed EPSSs.

In conclusion it should be mentioned that the Gauteng Provincial Government (GPG) has a corporate website, Gauteng Online, for its provincial departments. Therefore it is vital that the envisaged EPSS website should be incorporated into the Gauteng Online, GDE website or a link should be created as illustrated in Figure 6.1.

Figure 6.1: The proposed location of an EPSS website



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Addendum A: Customer Satisfaction Index Questionnaire

The purpose of this questionnaire is to determine the respondent's satisfaction with the course material, training process and trainer's competencies regarding an Electronic Performance Support System.

Please tick (x) the following questions using the scale from 1 to 5, where:

Satisfied	Important
1. Extremely dissatisfied	2. Extremely unimportant
3. Dissatisfied	2. Unimportant
3. Neutral	3. Neutral
4. Satisfied	4. Important
5. Extremely satisfied	5. Extremely important

Section A: Reflection on the course material used during the training programme on how to use and design an EPSS

Questions	1	2	3	4	5
1.1 How important is it that the course material should be useful and easy to apply?	1	2	3	4	5
1.2 How satisfied are you that the course material was useful and easy to apply?	1	2	3	4	5
2.1 How important is it that the course material should be related to your learning area?	1	2	3	4	5
2.2 How satisfied are you that the course material was related to your learning area?	1	2	3	4	5
3.1 How important is it that the course material should be a useful learning resource to your learning area?	1	2	3	4	5
3.2 How satisfied are you that the course material is a useful resource to your learning area?	1	2	3	4	5
4.1 How important is it that the material provided during the training programme was appropriate?	1	2	3	4	5
4.2 How satisfied are you that the material provided during the training programme was appropriate?	1	2	3	4	5

Section B: Reflection on an EPSS training process

Questions	1	2	3	4	5
5.1. How important is it that the course should meet the defined objectives?	1	2	3	4	5
5.2. How satisfied are you that the course met the defined objectives?	1	2	3	4	5
6.1. How important is it that the course should be relevant to your current learning area?	1	2	3	4	5
6.2. How satisfied are you that the course was relevant to your current learning area?	1	2	3	4	5
7.1. How important is it that content of an EPSS programme should be practical and useful to your learning area?	1	2	3	4	5
7.2. How satisfied are you that content of an EPSS programme was practical and useful to your learning area?	1	2	3	4	5
8.1. How important is it that the overall process of an EPSS programme should be satisfactory?	1	2	3	4	5
8.2. How satisfied are you that the overall training process of an EPSS programme was satisfactory?	1	2	3	4	5
9.1. How important is it that the objectives of the course should be clearly defined?	1	2	3	4	5
9.2. How satisfied are you that the objectives of the course were clearly defined?	1	2	3	4	5

Section C: Reflection on the Trainer's competencies during the training process

Questions	1	2	3	4	5
10.1. How important is it that the facilitator should present the course material of an EPSS in a logical manner?	1	2	3	4	5
10.2. How satisfied are you that the facilitator presented the course material of an EPSS in a logical manner?	1	2	3	4	5
11.1. How important is it that the facilitator should encourage participation among teachers during the training process?	1	2	3	4	5
11.2. How satisfied are you that the facilitator encouraged participation among teachers during the training process?	1	2	3	4	5
12.1. How important is it that the facilitator should demonstrate thorough knowledge of the subject content?	1	2	3	4	5
12.2. How satisfied are you that the facilitator demonstrated thorough knowledge of the subject content?	1	2	3	4	5
13.1. How important is it that the facilitator should provide assistance on how to explore an EPSS during training?	1	2	3	4	5
13.2. How satisfied are you that the facilitator provided assistance on how to explore an EPSS during training?	1	2	3	4	5
14.1. How important is it that the facilitator should provide teachers with prompt feedback during the training process?	1	2	3	4	5
14.2. How satisfied are you that the facilitator provided teachers with prompt feedback during the training process?	1	2	3	4	5

Addendum B: Retrospective Opinionnaire

For each statement select the correct box that best describes your behaviour before and after training in an Electronic Performance Support System (EPSS). Please indicate with an (x) how your behaviour has changed by using the following rating scale keys:

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

Section A: How to design a Flow chart

Statements	Before training					After training				
	1	2	3	4	5	1	2	3	4	5
1. I have the necessary skills to design a Flowchart.	1	2	3	4	5	1	2	3	4	5
2. I have acquired knowledge about the symbols used to create a Flowchart.	1	2	3	4	5	1	2	3	4	5
3. I have acquired knowledge on how to divide a Flowchart into slides.	1	2	3	4	5	1	2	3	4	5

Section B: How to create a hyperlinked slide show

4. I have the necessary skills to create slides using Microsoft PowerPoint program.	1	2	3	4	5	1	2	3	4	5
5. I have the necessary skills to create text boxes on the slides.	1	2	3	4	5	1	2	3	4	5
6. I have the necessary skills to create hyperlinks using textboxes on the slides.	1	2	3	4	5	1	2	3	4	5

Section C: How to design an algorithm and the EPSS

7. I possess knowledge pertaining to the functions of an EPSS.	1	2	3	4	5	1	2	3	4	5
8. I possess knowledge pertaining to the components of an EPSS.	1	2	3	4	5	1	2	3	4	5
9. I have the necessary knowledge to integrate an EPSS in my learning area.	1	2	3	4	5	1	2	3	4	5
10. I have necessary skills to integrate an EPSS in my learning area.	1	2	3	4	5	1	2	3	4	5
11. I have the necessary skills to create an Algorithm.	1	2	3	4	5	1	2	3	4	5
12. I have acquired knowledge on how to design an EPSS in education.	1	2	3	4	5	1	2	3	4	5
13. I have knowledge on how to develop an EPSS in education.	1	2	3	4	5	1	2	3	4	5

Addendum C: Familiarisation on how to solve problems using an EPSS

Researcher's notes 1

No	Actions	Resources
The researcher		
1	Provided the participants with three Physical Science problems about the equations of motion.	Worksheet 1: Equations of motion questions
2	Indicated to the participants that we were going to use a special tool to solve the given problems.	EPSS
3	Demonstrated to the participants how to use the tool by solving one problem from the Worksheet 1.	<ul style="list-style-type: none"> • EPSS • Computer • Worksheet 1 • Information sheet 1: Equations of Motion:
4	Asked the participants the following question, "What is the name of this tool?"	
5	Provided each participant with an Electronic Performance Support System.	EPSS CD
6	Explained to the participants that they would use an Electronic Performance Support System to solve the remaining problems given on the Worksheet 1.	<ul style="list-style-type: none"> • EPSS • Worksheet 1: Equations of motion questions
7	Demonstrated to the participants how to use and navigate through an Electronic Performance Support System.	<ul style="list-style-type: none"> • Computer • EPSS
8	Explained to the participants that they had to solve the next two problems using the same tool.	<ul style="list-style-type: none"> • EPSS • Information sheet 1: Equations of Motion
9	Provided assistance and feedback to the participants when they were engaged in the process of solving the two remaining problems using an Electronic Performance Support System.	<ul style="list-style-type: none"> • Worksheet 1 • Information sheet 1: Equations of Motion

Worksheet 1: Equations of Motion Questions

1. What is the final velocity of a car that accelerates 10 m/s^2 from rest and travels 180 m ?

Equations used to calculate the final velocity of an object.					
$v = u + at$		$a =$	$u =$	$t =$	
$v^2 = u^2 + 2as$		$a =$	$u =$		$s =$

2. What is the displacement of a car whose initial velocity is 5 m/s and then accelerates at 2 m/s^2 for 10 seconds ?

Equations used to calculate the displacement of an object.					
$v^2 = u^2 + 2as$		$v =$	$u =$		$a =$
$s = ut + \frac{1}{2} at^2$			$u =$	$t =$	$a =$

3. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m . Determine the acceleration of the car.

Equations used to calculate the acceleration of an object.					
$v = u + at$		$v =$	$u =$	$t =$	
$v^2 = u^2 + 2as$		$v =$	$u =$		$s =$
$s = ut + \frac{1}{2} at^2$			$u =$	$t =$	$a =$

Session 1: Solutions to the Equations of Motion questions

1 $v^2 = u^2 + 2as$

$$v^2 = (0)^2 + 2 (10\text{m/s}^2) (180\text{m})$$

$$v^2 = 3600 \text{ m}^2/\text{s}^2$$

$$v = \sqrt{3600 \text{ m}^2/\text{s}^2}$$

$$V = 60 \text{ m/s}$$

2 $s = ut + \frac{1}{2} at^2$

$$s = (10 \text{ m/s} \times 5 \text{ s}) + \frac{1}{2} (2\text{m/s}^2) (10\text{s})^2$$

$$s = 50 \text{ m} + \frac{1}{2} (2\text{m/s}^2) \times 100\text{s}^2$$

$$s = 50 \text{ m} + \frac{1}{2} (200 \text{ m})$$

$$s = 150 \text{ m}$$

3 $s = ut + \frac{1}{2} at^2$

$$110 \text{ m} = (0 \times 5.21\text{s}) + \frac{1}{2} a(5.21\text{s})^2$$

$$110 \text{ m} = \frac{1}{2} a (27.14 \text{ s}^2)$$

$$220 \text{ m} = (27.14 \text{ s}^2) a$$

$$a = (220 \text{ m})/(27.14 \text{ s}^2)$$

$$a = 8.11 \text{ m/s}^2$$

Information Sheet 1: Equations of Motion Formulae

$s = ut + \frac{1}{2} at^2$		
Description	Symbols used	Units
Displacement	s	m
Start velocity	u	m/s
Time-taken	t	s
Acceleration	a	m/s^2

$v^2 = u^2 + 2as$		
Description	Symbols used	Units
End velocity	v	m/s
Start velocity	u	m/s
Acceleration	a	m/s^2
Displacement	s	m

$v = u + at$		
Symbols used	Symbols used	Units
End velocity	v	m/s
Start velocity	u	m/s
Acceleration	a	m/s^2
Time-taken	t	s

Addendum D: Co-development of a hyperlinked slide show

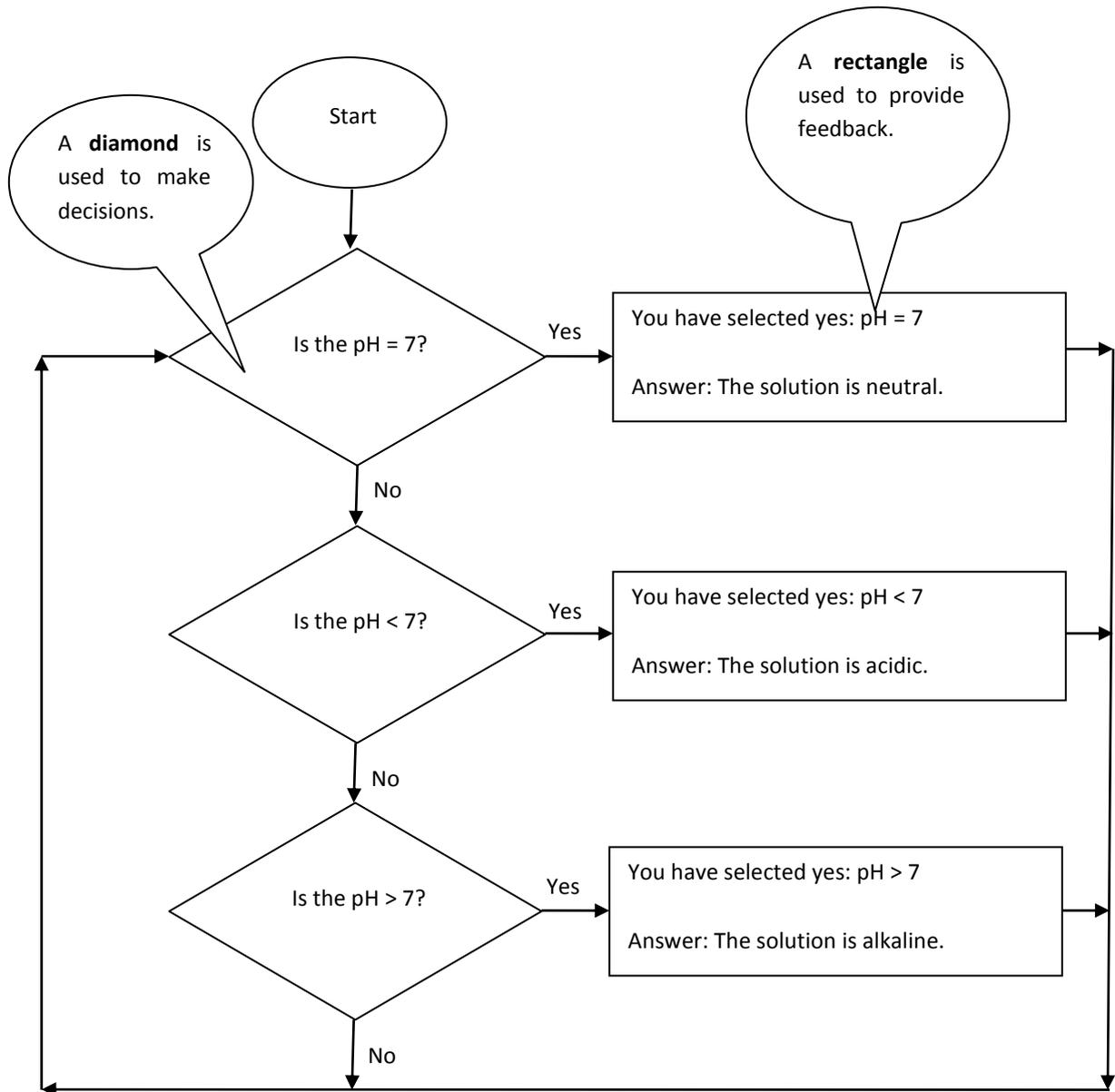
Researcher's notes 2

No	Actions	Resources
The researcher		
1	Provided teachers with three True or False questions in Physical Sciences based on the following topics (1 question per topic) <ul style="list-style-type: none"> • Kinetic energy • Sound • Waves 	Worksheet 2: True or False questions
2	Explained to the teachers that we were going to create a computer-based version of the test that consists of three True or False questions.	Worksheet 2: True or False questions
3	Indicated to the teachers that to be able to create a computer-based version of the test we needed to create a flowchart of all the actions that would take place.	
4	Showed teachers an example of a flowchart. The symbols of the flowchart were discussed.	Information sheet 2: Flowchart
5	Developed a flowchart for the envisaged computer-based test together with the teachers.	<ul style="list-style-type: none"> • Flipchart • Markers • Ruler
6	Divided the flowchart into screens slides working together with the teachers. Thereafter the trainer would provide teachers with Information sheet 3: Flowchart divided into slides.	<ul style="list-style-type: none"> • Ruler • Different markers • Information sheet 3
7	Transferred the design into Microsoft PowerPoint - this would be done by creating nine slides.	<ul style="list-style-type: none"> • Computer • Microsoft Office
8.1	Created nine PowerPoint slides together with the teachers on the computer.	<ul style="list-style-type: none"> • Computer • Microsoft office
8.2	Indicated to teachers how to create navigation buttons on each screen.	• Microsoft Office
8.3	<ul style="list-style-type: none"> • Demonstrated to teachers how to create hyperlinks on each slide. • Provided teachers with the definition of a hyperlink. 	<ul style="list-style-type: none"> • Computer • Microsoft Office
9	Demonstrated the hyperlinked slide show to the teachers.	<ul style="list-style-type: none"> • Computer • Microsoft Office
10	Showed the teachers how to save the hyperlinked slide show on the computer hard disk space or compact disk.	<ul style="list-style-type: none"> • Computer • Blank CD

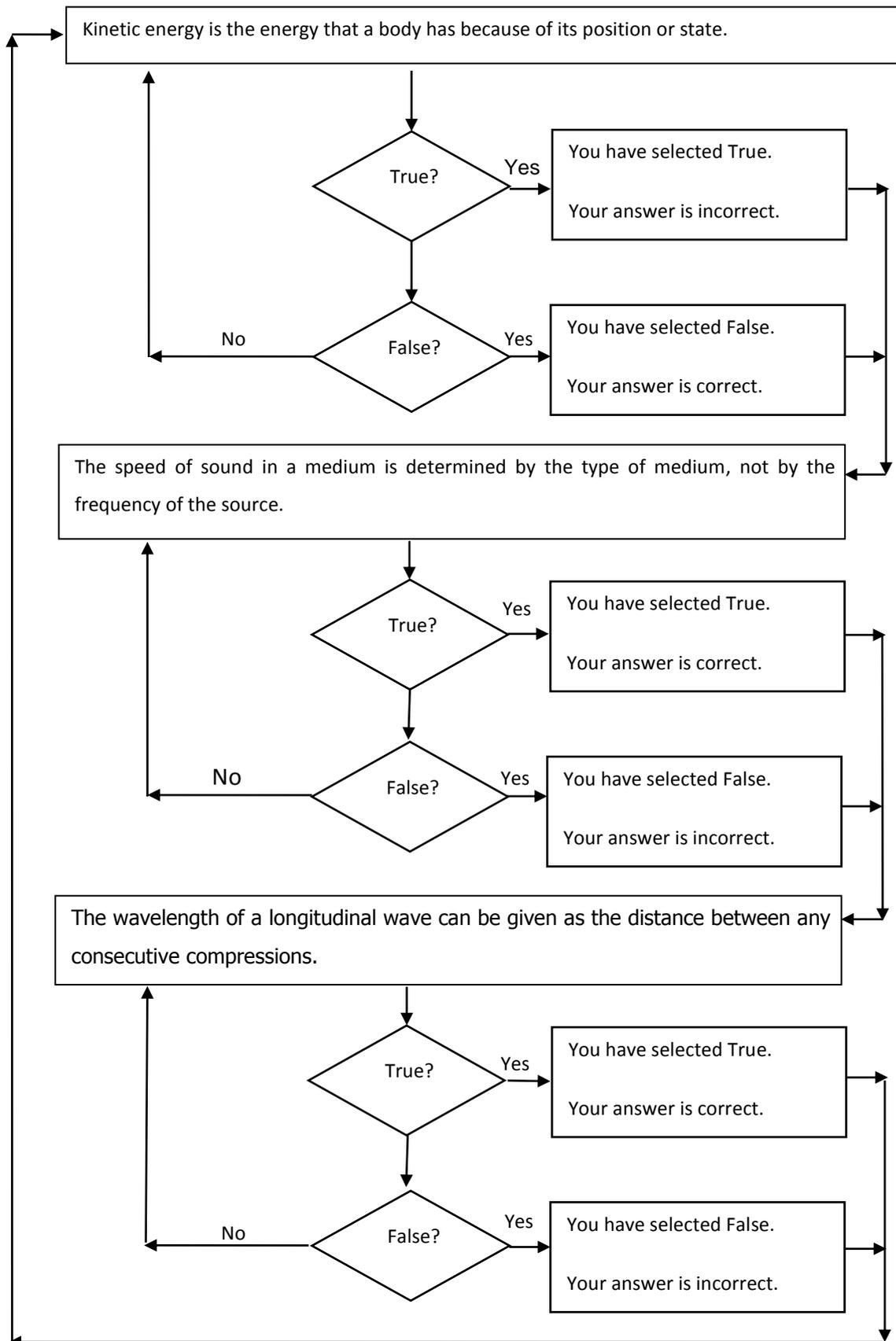
Worksheet 2: True or False questions

1. Kinetic energy is the energy that a body has because of its position or state. **True / False**
2. The speed of sound in a medium is determined by the type of medium and not the frequency of the source. **True / False**
3. The wavelength of a longitudinal wave can be given as the distance between any consecutive compressions. **True / False**

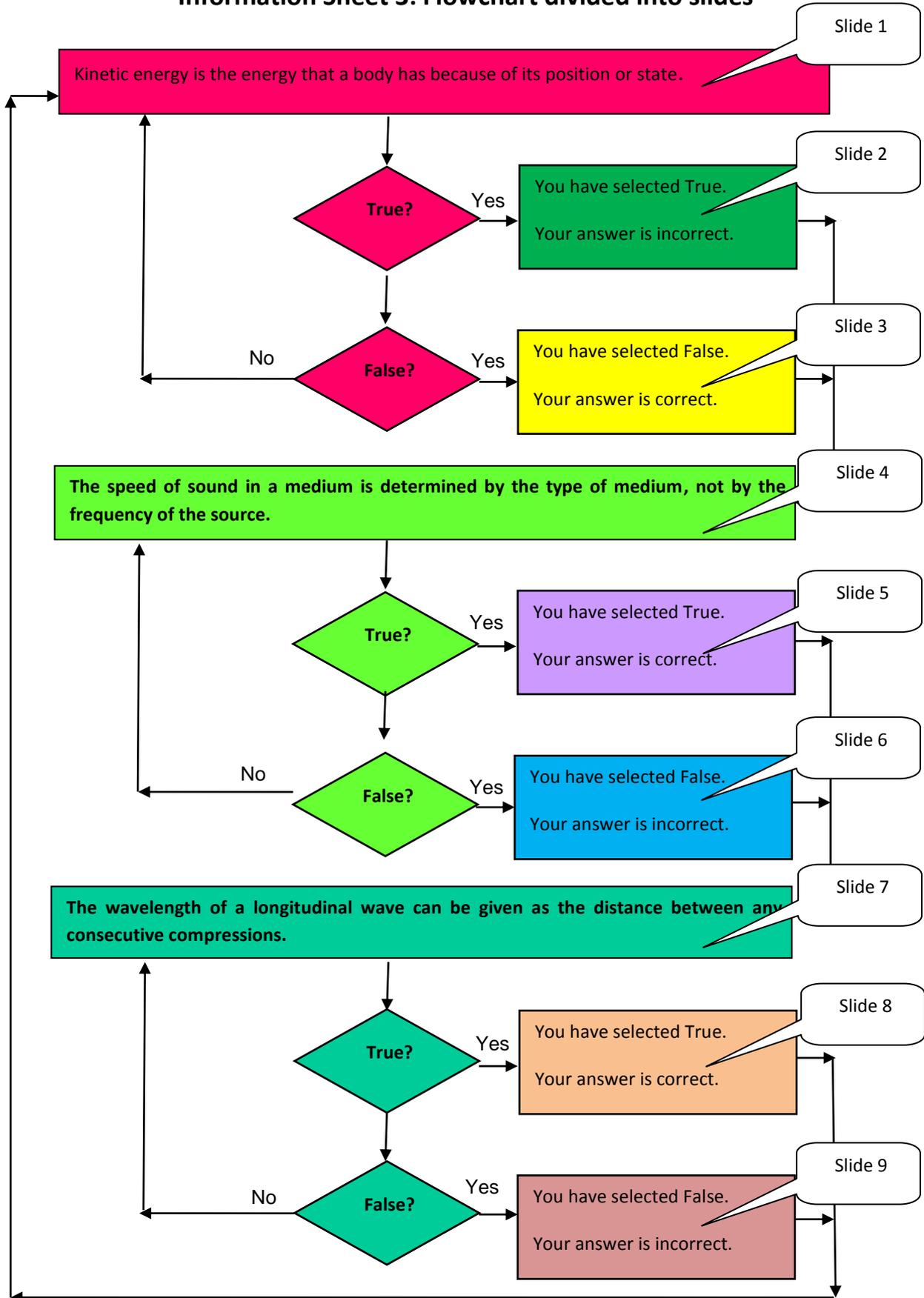
Information Sheet 2: Flowchart



Session 2: Solution to the True or False questions



Information Sheet 3: Flowchart divided into slides



Addendum E: Development of an algorithm and the EPSS

Researcher's notes 3

No	Actions	Resources
The researcher		
1	Provided teachers with three Physical Science problems about kinetic energy.	Worksheet 3
2	Indicated to the teachers that to be able to solve the problems they need to analyse and write down all the actions that will take place.	<ul style="list-style-type: none"> • A4 papers • Flipchart
3	Explained to the teachers that the purpose of analysing the problem is to develop the step-by-step instructions on how to solve a given problem.	
4	Indicated to the teachers that all the written actions will be transferred into a flowchart.	
5	Asked teachers questions about the symbols used to create a flowchart. The trainer will provide them with an example of a flowchart and the names of the symbols used.	Worksheet 3
6	Indicated to the teachers that they will analyse problem 1 from the Worksheet 5 as an example in order to create a flowchart.	
7	Demonstrated to the teachers how to analyse the selected problem (working together with the teachers).	<ul style="list-style-type: none"> • Flipchart • Markers
8	Write all the actions on a flipchart to create a flowchart (working together with the teachers).	<ul style="list-style-type: none"> • Worksheet 4 • Flipchart
9	Indicated to teachers that a flowchart that is used to solve a problem is an algorithm.	
10	Divided the flowchart into screens and will ask the teachers questions based on the number of screens created.	<ul style="list-style-type: none"> • Ruler • Markers
11	Indicated to the teachers that the purpose of dividing a flowchart into screens is to determine the number of slides that they will require when using Microsoft PowerPoint.	Worksheet 4

No	Actions	Resources
12	Transferred the flowchart into Microsoft PowerPoint together with the teachers. (During this process the trainer will demonstrate to them how to create the required number of slides using Microsoft PowerPoint).	<ul style="list-style-type: none"> • Computer • Microsoft Office
13	Show teachers how to create textboxes on each slide working with them.	<ul style="list-style-type: none"> • Microsoft Office
14	Demonstrated to the teachers how to hyperlink different slides using textboxes so that they can create a computer-based algorithm.	<ul style="list-style-type: none"> • Computer • Microsoft Office
15	Run the computer-based algorithm with the teachers to check if all the hyperlinks are working as required.	<ul style="list-style-type: none"> • Computer • Microsoft Office
16	Demonstrated to the teachers how to solve the selected problem using the developed computer-based algorithm.	EPSS
17	Explained to the teachers that they have created an EPSS that they can use to solve similar problem.	
18	Instructed the teachers to use the designed EPSS to solve the remaining problem.	Worksheet 3
19	Provided assistance and feedback to the teachers when they were engaged in the process of solving the remaining problems using an EPSS.	<ul style="list-style-type: none"> • Worksheet 3 • EPSS

Worksheet 3: Kinematics Problems

1. A girl throws a ball of mass 200 kg vertically upwards with an initial velocity of 12 m/s. What is the kinetic energy of the ball when it leaves the girl's hand?
2. A car of mass 8 000 g has a kinetic energy of 42.5 KJ. Calculate the magnitude of the car's velocity.
3. A ball is thrown vertically upwards with an initial velocity of 5 m/s. If the kinetic energy of the ball when it leaves the ground is 300 J, calculate the magnitude of its mass.

Session 3: Solutions to the Kinematics Problems

1 $E_k = \frac{1}{2} mv^2$

$$E_k = \frac{1}{2} (200 \text{ kg}) \times (12 \text{ m/s})^2$$

$$E_k = 100 \text{ kg} \times 144 \text{ m}^2/\text{s}^2$$

$$E_k = 144 \times 10^2 \text{ m}^2/\text{s}^2$$

$$E_k = 144 \times 10^2 \text{ J}$$

2 $E_k = \frac{1}{2} mv^2$

$$42.5 \text{ kJ} = \frac{1}{2} (8 \text{ kg}) \times v^2$$

$$v^2 = (42.5 \times 10^3 \text{ kgm}^2/\text{s}^2) / (4 \text{ kg})$$

$$v = \sqrt{10625 \text{ m}^2/\text{s}^2}$$

$$v = 103.1 \text{ m/s}$$

3 $E_k = \frac{1}{2} mv^2$

$$300 \text{ J} = \frac{1}{2} m (5 \text{ m/s})^2$$

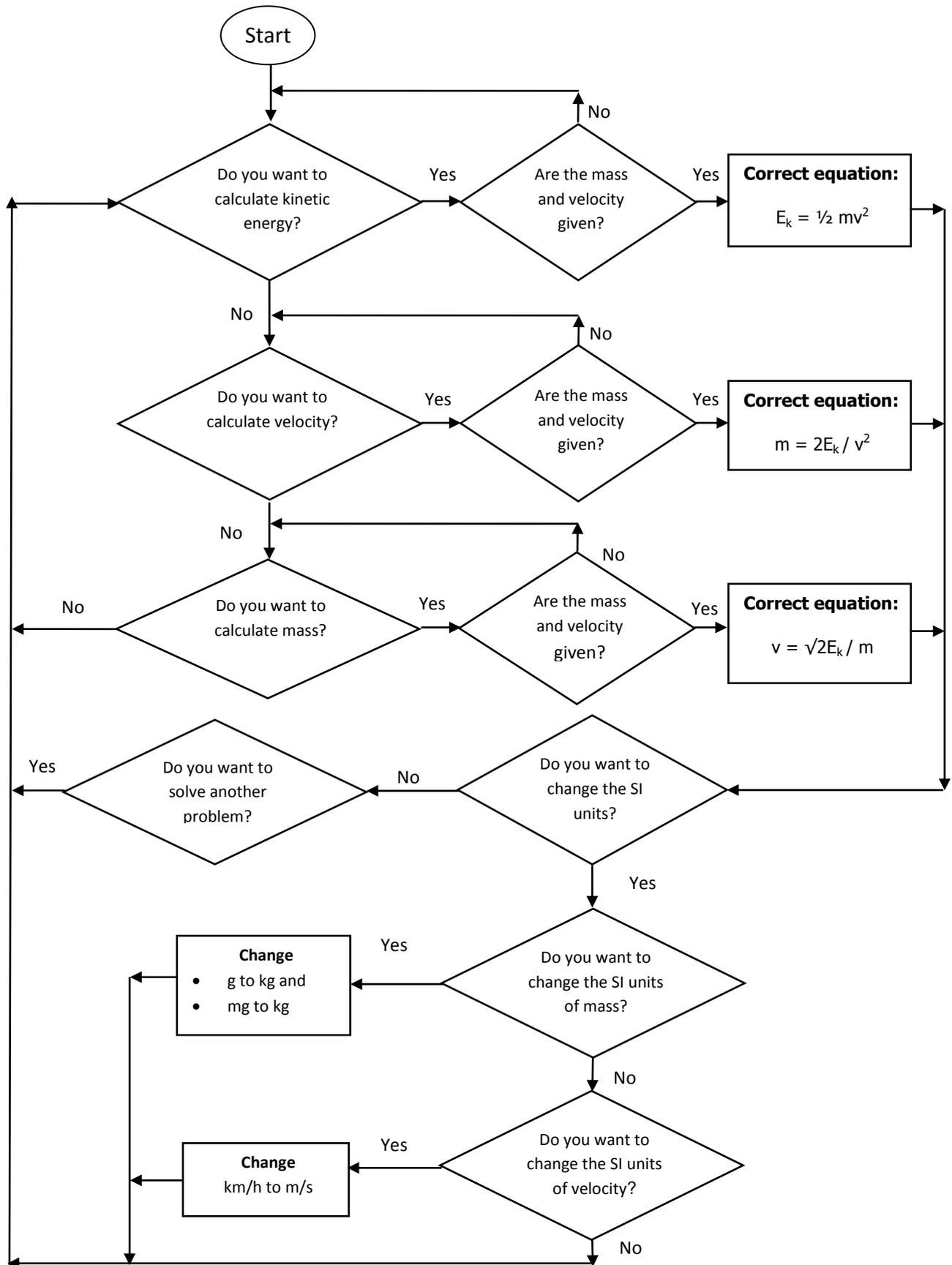
$$300 \text{ J} = \frac{1}{2} (25 \text{ m}^2/\text{s}^2) \times m$$

$$300 \text{ kgm}^2/\text{s}^2 = 12.5 \text{ m}^2/\text{s}^2 (m)$$

$$m = (300 \text{ kgm}^2/\text{s}^2) / (12.5 \text{ m}^2/\text{s}^2)$$

$$m = 24 \text{ kg}$$

Solution



Addendum F: Fill-out the questionnaire and the opinionnaire

Researcher's notes 4

No	Actions	Resources
The researcher		
1	Provided teachers with the <ul style="list-style-type: none"> • Customer Satisfaction Index Questionnaire (CSIQ) and • Retrospective Opinionnaire (RO). 	<ul style="list-style-type: none"> • CSIQ • RO
2	Informed teachers that we were going to fill-out the CSIQ to determine their satisfaction with the course material, training process and trainer's competencies after attending training on how to use and design an EPSS.	CSIQ
3	Indicated to the teachers that the CSIQ has two set of questions <ul style="list-style-type: none"> • how important • how satisfied 	CSIQ
4	Informed teachers that each question has the following 5 options to choose from: <ol style="list-style-type: none"> 1. Satisfied <ul style="list-style-type: none"> • Extremely satisfied • Satisfied • Neutral • Dissatisfied • Extremely dissatisfied 2. Important <ul style="list-style-type: none"> • Extremely important • Important • Neutral • Unimportant • Extremely unimportant 	CSIQ
5	Informed teachers that we were going to fill-out the RO to determine their change in knowledge and skills after using an EPSS.	RO
6	Indicated to the teachers that the RO has two set of questions <ul style="list-style-type: none"> • Before training • After training 	RO
7	Informed teachers that each question has the following rating scale key <ol style="list-style-type: none"> 1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree 	RO
8	Demonstrated to the teachers how to make a tick on the CSIQ and RO.	<ul style="list-style-type: none"> • CSIQ • RO
9	Demonstrated to the teachers how to fill-out the CSIQ and the RO.	<ul style="list-style-type: none"> • CSIQ • RO • Pens

Information sheet 5: Electronic Performance Support System

1. Definition of an EPSS

Raybould (1990) as cited by Wild and Kirkpatrick (n.d., p. 2) defines a performance support system as “a computer-based system that improves worker productivity by providing on-the-job access to integrate information, advice and learning experiences”. He further indicates that the performance support system is aimed at providing training and support to novice as well as advanced users in the performance of tasks.

Additionally Gery (1991), as cited by Laffey (1995, p. 31) defines an EPSS as the “use of technology to provide on-demand access to integrated information, guidance, advice, assistance, training and tools to enable high-level job performance with a minimum of support from other people”. Furthermore Gery (1995) as cited by Maughan (n.d, p. 49) indicates that an EPSS is the “configuration of hardware and software, and content accessible by employees or students and structured to provide users with information to permit them to do their jobs or perform tasks with minimal intervention by others”.

Most importantly, Shepherd (2001, p. 2) refers to an EPSS as an “electronic infrastructure that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable an individual to achieve required level of performance in the fastest possible time and with the minimum support from other people”. Lastly he indicates that an EPSS is company specific rather than generic, thus encompassing specific policies and procedures of an organisation.

From the above deliberation an EPSS can be defined as an online system that:

- is delivered to the desktop;
- encompasses all software needed to support the work of individuals;
- integrates knowledge assets into the interface of the software tools;
- is aimed at helping the users steps with what actions to take;
- simplifies the steps required to perform a task; and
- delivers information on a just-in-time basis.

2. The goal of an EPSS

Laffey (1995, p. 31) indicates that the goal of an EPSS is “to provide whatever is necessary to ensure performance and learning at the moment of need.” Maughan (n.d.) adds that an EPSS provides prescriptive information to enable a user to accomplish a task. Furthermore Grey (1995) as cited by Maughan (n.d., p. 49) indicates that an electronic performance support system “is employed to support skills and knowledge growth in real-time and at the work situation”.

Moreover, Singhal et al. (n.d.) suggest that an EPSS is aimed at helping users with “how to perform a task”, at having “access to knowledge bases” and access to “various forms of knowledge representation (e.g. videos, audio, text, image and data)”. Rupel (n.d.) states that the goal of an EPSS is to improve users’ performance on the system. Once this has been understood, then users will be able to understand the Performance Support Continuum (PSC) (ibid).

3. Components of an EPSS

Singhal et al. (n.d.) indicate that an EPSS consists of:

- an “*advisory component*” as it entails task identification and thus develops the job aid;
- an “*information component*” since it encompasses databases, hypertext and an online help system;
- a “*training component*” through its ability to provide relevant training to the users when required;
- a “*user interface component*” through which the user is allowed to access the required information when performing a task easily.

In addition Carr (1992) as cited by Marion (1998) indicates that an EPSS be regarded as:

- an “*advisor*” because it provides advice via expert systems and knowledge-based systems;
- an “*assistant*” since it provides tools and online help for users;
- a “*librarian*” for the reason that it provides relevant reference materials and information databases; and
- a “*teacher*” through its ability to provide users with Computer-Based Training (CBT).

Zubak (1997) as cited by Marion (1998) categorises an EPSS as:

- a “*stationery embedded help*” where an interface is developed as part of the support interface;
- a “*process embedded help*” which is a step-by-step task-driven support system that enables the user to accomplish a work-related task;
- an “*instructional embedded help*” whereby users are provided with detailed information related to the task given; and
- “*context embedded help*” because the system can interpret the users’ action and provides relevant assistance.

Rupel (n.d.) further concurs with Banerji (1999) that an EPSS has three different performance support spectra:

- “*intrinsic support*” – information is embedded within the interface and support is provided to the users as is they are engaged in the process of completing the task;
- “*extrinsic support*” – information is embedded in the system and support is provided to the users outside the process of task completion; and
- “*external support*” – information is accessed as text or through a help desk.

Additionally Abraham (2005) also identified the following components as being critical in the development of an EPSS, namely knowledge base, knowledge base acquisition facility, inference engine, user interface, users, expert knowledge and explanation facility.

4. Content features of an EPSS

According to Singhal et al (n.d., p. 5) the content features of an EPSS encompass:

- “the step-by-step instructions on performing a task”;
- “demonstration on how to conduct selected transactions”;
- “process maps, flow charts and process review”;
- “glossaries and keyword search function”;
- “checklist, frequently asked questions, exercise and job refreshers in text or graphic format” and
- “computer-based training (CBT)”.

Addendum G: Customer Satisfaction Index Questionnaire raw data

Parameter	Participant 1					Participant 2					Participant 3					Participant 4					Participant 5				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
P 1.1			1							1					1					1					1
P 1.2			1							1					1					1					1
P 2.1					1					1					1					1					1
P 2.2					1					1					1					1					1
P 3.1			1							1					1					1					1
P 3.2			1							1					1					1					1
P 4.1					1					1					1					1					1
P 4.2					1					1					1					1					1
P 5.1					1					1					1					1					1
P 5.2					1					1					1					1					1
P 6.1					1					1					1					1					1
P 6.2			1							1					1					1					1
P 7.1			1							1					1					1					1
P 7.2			1							1					1					1					1
P 8.1			1							1					1					1					1
P 8.2			1							1					1					1					1
P 9.1					1					1					1					1					1
P 9.2			1							1					1					1					1
P 10.1					1					1					1					1					1
P 10.2					1					1					1					1					1
P 11.1					1					1					1					1					1
P 11.2					1					1					1					1					1
P 12.1			1							1					1					1					1
P 12.2			1							1					1					1					1
P 13.1					1					1					1					1					1
P 13.2			1							1					1					1					1
P 14.1					1					1					1					1					1
P 14.2					1					1					1					1					1

Addendum G: Customer Satisfaction Index Questionnaire raw data (continued)

Parameter	Participant 6					Participant 7					Participant 8					Participant 9					Participant 10				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
P 1.1					1					1					1				1					1	
P 1.2					1					1					1			1						1	
P 2.1					1					1					1									1	
P 2.2					1					1					1									1	
P 3.1					1					1					1									1	
P 3.2					1					1					1			1						1	
P 4.1				1						1					1			1						1	
P 4.2				1						1					1			1						1	
P 5.1				1						1					1			1						1	
P 5.2				1						1			1			1								1	
P 6.1				1						1					1									1	
P 6.2				1						1					1									1	
P 7.1				1						1					1			1						1	
P 7.2				1						1					1			1						1	
P 8.1				1						1			1					1						1	
P 8.2				1						1			1					1						1	
P 9.1				1						1					1		1							1	
P 9.2				1						1					1			1						1	
P 10.1				1						1					1									1	
P 10.2				1						1					1						1				
P 11.1				1					1						1					1				1	
P 11.2				1					1						1								1		
P 12.1				1					1						1									1	
P 12.2				1					1						1			1						1	
P 13.1				1					1						1									1	
P 13.2				1					1						1		1							1	
P 14.1				1					1						1									1	
P 14.2				1					1						1			1						1	

Addendum G: Customer Satisfaction Index Questionnaire raw data (continued)

Parameter	Participant 11					Participant 12					Participant 13					Participant 14					Participant 15				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
P 1.1				1						1					1					1					1
P 1.2					1					1				1						1					1
P 2.1					1					1					1					1					1
P 2.2				1						1					1					1					1
P 3.1				1						1					1					1					1
P 3.2				1						1					1					1					1
P 4.1					1					1				1						1					1
P 4.2				1						1				1						1					1
P 5.1				1						1				1						1					1
P 5.2					1					1					1					1					1
P 6.1				1						1					1					1					1
P 6.2				1						1					1					1					1
P 7.1				1						1				1						1					1
P 7.2					1					1				1						1					1
P 8.1				1						1				1						1					1
P 8.2				1						1				1						1					1
P 9.1				1						1				1						1					1
P 9.2				1						1				1						1					1
P 10.1					1					1					1					1					1
P 10.2				1						1				1						1					1
P 11.1					1					1				1						1					1
P 11.2				1						1				1						1					1
P 12.1				1						1				1						1					1
P 12.2					1					1				1						1					1
P 13.1					1					1				1						1					1
P 13.2				1						1				1						1					1
P 14.1				1						1				1						1					1
P 14.2				1						1				1						1					1

Addendum G: Customer Satisfaction Index Questionnaire raw data (continued)

Parameter	Participant 16					Participant 17					Participant 18					Participant 19					Participant 20				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
P 1.1				1						1					1					1					1
P 1.2				1						1					1					1					1
P 2.1					1					1				1					1						1
P 2.2				1						1				1					1						1
P 3.1					1					1				1					1						1
P 3.2					1					1				1					1						1
P 4.1					1					1				1					1						1
P 4.2				1						1				1					1						1
P 5.1				1						1				1					1						1
P 5.2				1						1				1					1						1
P 6.1					1					1				1					1						1
P 6.2					1					1				1					1						1
P 7.1					1					1				1					1						1
P 7.2				1						1				1					1						1
P 8.1				1						1				1					1						1
P 8.2				1						1				1					1						1
P 9.1					1					1				1				1							1
P 9.2				1						1				1				1							1
P 10.1				1						1				1				1							1
P 10.2					1					1				1			1								1
P 11.1					1					1				1				1							1
P 11.2					1					1				1			1								1
P 12.1					1					1				1			1								1
P 12.2					1					1				1			1								1
P 13.1				1						1				1			1								1
P 13.2				1						1				1			1								1
P 14.1					1					1				1			1								1
P 14.2					1					1				1			1								1

Addendum G: Customer Satisfaction Index Questionnaire raw data (continued)

Parameter	Participant 21					Participant 22					Number of selections per parameter					Total number of participants	Total Score per parameter
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	N	T
P 1.1					1					1	0	0	1	7	14	22	101
P 1.2				1					1		0	0	2	12	8	22	94
P 2.1				1					1		0	0	0	7	15	21	103
P 2.2				1						1	0	0	0	10	11	21	95
P 3.1				1						1	0	0	1	8	13	22	100
P 3.2				1						1	0	0	1	10	11	22	98
P 4.1					1					1	0	0	2	6	14	22	100
P 4.2				1						1	0	0	2	11	9	22	95
P 5.1				1						1	0	0	0	12	10	22	98
P 5.2			1							1	0	1	3	11	7	22	90
P 6.1				1						1	0	0	0	6	16	21	104
P 6.2			1							1	0	0	3	6	12	21	93
P 7.1				1						1	0	0	1	6	15	22	102
P 7.2			1							1	0	0	3	8	11	22	96
P 8.1				1						1	0	0	3	9	10	22	95
P 8.2				1						1	0	0	3	13	6	22	91
P 9.1				1						1	0	0	1	9	12	22	99
P 9.2			1							1	0	1	2	11	8	22	92
P 10.1			1							1	0	0	2	5	15	22	101
P 10.2			1						1		0	1	3	8	10	22	93
P 11.1				1						1	0	0	1	6	15	22	102
P 11.2				1						1	0	0	1	10	11	22	98
P 12.1				1						1	0	0	2	7	13	22	99
P 12.2				1					1		0	0	1	11	10	22	97
P 13.1				1						1	0	0	1	5	16	22	103
P 13.2			1							1	0	1	3	9	9	22	92
P 14.1				1						1	0	0	2	8	12	22	98
P 14.2			1							1	0	0	4	10	8	22	92

Addendum H: Retrospective Opinionnaire raw data

Statements		Participant 1					Participant 2					Participant 3					Participant 4					Participant 5				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1	Before	1					1					1							1						1	
	After				1					1						1				1					1	
S2	Before		1				1					1					1									1
	After					1				1				1					1					1		
S3	Before			1				1					1				1							1		
	After					1				1			1							1				1		
S4	Before			1			1					1					1						1			
	After				1						1		1							1			1			
S5	Before	1					1					1					1						1			
	After			1						1				1					1				1			
S6	Before	1					1					1					1								1	
	After		1								1			1					1						1	
S7	Before	1					1					1					1							1		
	After					1					1			1					1					1		
S8	Before	1					1					1					1								1	
	After				1						1			1					1						1	
S9	Before	1					1					1					1								1	
	After				1						1			1						1					1	
S10	Before	1						1				1					1						1			
	After		1							1				1					1				1			
S11	Before	1					1					1						1							1	
	After				1					1						1				1					1	
S12	Before	1					1					1					1									1
	After			1						1				1						1						1
S13	Before	1					1					1					1								1	
	After			1						1				1					1						1	

Addendum H: Retrospective Opinionnaire raw data (continued)

Statements		Participant 6					Participant 7					Participant 8					Participant 9					Participant 10				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1	Before				1			1					1						1				1			
	After				1					1					1					1					1	
S2	Before				1			1				1							1				1			
	After				1						1			1						1					1	
S3	Before				1			1						1					1				1			
	After				1					1					1					1					1	
S4	Before				1					1				1					1				1			
	After				1						1				1					1					1	
S5	Before				1			1				1						1					1			
	After				1						1			1					1					1		
S6	Before		1				1					1						1					1			
	After				1					1				1					1						1	
S7	Before			1			1					1						1					1			
	After			1						1				1					1					1		
S8	Before			1			1					1							1				1			
	After			1						1				1					1						1	
S9	Before			1			1					1							1					1		
	After			1						1				1					1					1		
S10	Before			1			1					1								1			1			
	After			1						1					1					1				1		
S11	Before			1				1					1						1				1			
	After			1							1				1					1					1	
S12	Before		1				1					1							1				1			
	After			1						1				1						1					1	
S13	Before		1				1					1								1			1			
	After			1						1				1							1				1	

Addendum H: Retrospective Opinionnaire raw data (continued)

Statements		Participant 11					Participant 12					Participant 13					Participant 14					Participant 15				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1	Before				1	1						1						1			1					
	After				1			1				1						1			1					
S2	Before	1				1				1							1			1						
	After			1				1				1						1					1			
S3	Before	1				1						1				1					1					
	After			1				1				1					1						1			
S4	Before	1				1						1				1						1				
	After			1				1					1				1							1		
S5	Before	1				1						1			1					1						
	After			1				1					1			1						1				
S6	Before	1				1				1					1					1						
	After				1			1				1						1				1				
S7	Before	1				1				1					1					1						
	After			1				1				1					1					1				
S8	Before	1				1				1						1				1						
	After			1				1				1						1				1				
S9	Before	1				1				1						1				1						
	After			1				1				1					1					1				
S10	Before			1		1				1						1				1						
	After				1			1				1				1						1				
S11	Before				1	1						1				1					1					
	After				1			1				1						1					1			
S12	Before	1				1				1					1							1				
	After			1				1					1			1							1			
S13	Before	1				1				1					1						1					
	After			1				1				1				1							1			

Addendum H: Retrospective Opinionnaire raw data (continued)

Statements		Participant 16					Participant 17					Participant 18					Participant 19					Participant 20				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1	Before			1			1							1				1				1				
	After				1						1				1					1					1	
S2	Before			1			1						1							1		1				
	After				1						1			1							1				1	
S3	Before				1			1						1							1	1				
	After					1				1					1						1				1	
S4	Before		1					1						1							1		1			
	After			1						1				1							1				1	
S5	Before		1				1						1						1			1				
	After		1								1			1						1					1	
S6	Before		1				1						1						1			1				
	After				1						1			1						1					1	
S7	Before		1				1						1					1					1			
	After			1					1					1					1						1	
S8	Before			1				1						1				1					1			
	After				1						1				1					1					1	
S9	Before			1				1						1				1					1			
	After				1					1				1					1						1	
S10	Before		1				1						1						1			1				
	After			1						1				1						1				1		
S11	Before		1					1						1				1				1				
	After				1						1			1					1						1	
S12	Before		1				1					1							1			1				
	After				1					1				1						1				1		
S13	Before		1				1						1					1				1				
	After			1					1					1					1					1		

Addendum H: Retrospective Opinionnaire raw data (continued)

Statements		Participant 21					Participant 22					Number of selections per parameter					Total number of participants	Total Score per parameter
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	N	T
S1	Before	1					1					9	5	5	2	1	22	47
	After			1						1		0	0	2	15	5	22	91
S2	Before	1						1				11	5	3	2	1	22	43
	After			1						1		0	0	6	11	5	22	87
S3	before		1					1				4	9	5	2	2	22	55
	After			1						1		0	1	4	11	6	22	88
S4	Before			1				1				5	7	7	2	1	22	53
	After				1					1		0	2	3	11	6	22	87
S5	Before	1					1					13	6	2	0	1	22	36
	After		1							1		0	4	7	7	4	22	77
S6	Before	1					1					15	5	1	1	0	22	32
	After		1							1		0	2	6	9	5	22	83
S7	Before	1										13	6	2	0	0	21	31
	After		1							1		0	1	11	7	3	22	78
S8	Before	1						1				11	6	2	3	0	22	41
	After		1							1		0	1	5	11	5	22	86
S9	Before	1					1					12	4	4	2	0	22	40
	After		1							1		0	1	7	13	1	22	80
S10	Before	1										11	6	3	0	1	21	37
	After		1							1		0	4	9	6	3	22	74
S11	Before	1					1					7	9	3	2	1	22	47
	After			1						1		0	0	2	14	6	22	92
S12	Before	1					1					15	3	3	0	1	22	35
	After		1							1		0	2	5	13	2	22	81
S13	Before	1					1					14	6	0	2	0	22	34
	After		1							1		0	2	8	11	1	22	77

Addendum I: Wilcoxon Signed rank test results pertaining to the design of a flowchart

Statement 1: Necessary skills to design a flowchart

Notes

	Output Created	29-Sep-2010 10:57:44
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_1.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.017
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	20 ^b	10.50	210.00
	Ties	2 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.963 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 2: Acquired knowledge about the symbols used to create a flowchart

Notes

	Output Created	29-Sep-2010 11:00:35
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_2.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Handling	Value Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	19 ^b	10.00	190.00
	Ties	3 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.858 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 3: Acquired knowledge on how to divide a flowchart into slides

Notes

	Output Created	29-Sep-2010 11:01:54
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_3.sav
	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	1 ^a	10.00	10.00
Before_training	Positive Ranks	21 ^b	11.57	243.00
	Ties	0 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.832 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Addendum J: Wilcoxon Signed rank test results pertaining to the design of a hyperlinked slide show

Statement 4: Necessary skills to design a flowchart

Notes

	Output Created	29-Sep-2010 11:03:39
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_4.sav
	Active Dataset	DataSet3
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	18 ^b	9.50	171.00
	Ties	4 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.787 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 5: Acquired knowledge on how to create a flowchart

Notes

	Output Created	29-Sep-2010 11:04:55
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_5.sav
	Active Dataset	DataSet4
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.015
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	20 ^b	10.50	210.00
	Ties	2 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.998 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 6: Acquired knowledge on how to divide a flowchart into slides

Notes

	Output Created	29-Sep-2010 11:09:49
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_6.sav
	Active Dataset	DataSet5
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.016
	Elapsed Time	0:00:00.016
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	19 ^b	10.00	190.00
	Ties	3 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.867 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Addendum K: Wilcoxon signed rank test pertaining to the design of an Algorithm and the EPSS

Statement 7: Possesses knowledge pertaining to the functions of an EPSS

Notes

	Output Created	29-Sep-2010 11:11:31
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_7.sav
	Active Dataset	DataSet6
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	21 ^b	11.00	231.00
	Ties	1 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-4.053 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 8: Possesses knowledge pertaining to the components of an EPSS

Notes

	Output Created	29-Sep-2010 11:14:22
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_9.sav
	Active Dataset	DataSet8
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.015
	Elapsed Time	0:00:00.016
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	19 ^b	10.00	190.00
	Ties	3 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.872 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 9: Necessary knowledge to integrate an EPSS in my learning area

Notes

	Output Created	29-Sep-2010 11:16:07
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_9.sav
	Active Dataset	DataSet9
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	<pre> NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS. </pre>
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	19 ^b	10.00	190.00
	Ties	3 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.872 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 10: Necessary skills to integrate an EPSS in my learning area

Notes

	Output Created	29-Sep-2010 11:16:07
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_10.sav
	Active Dataset	DataSet9
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	18 ^b	9.50	171.00
	Ties	4 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.767 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 11: Necessary skills to create an algorithm

Notes

	Output Created	29-Sep-2010 11:17:10
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_11.sav
	Active Dataset	DataSet10
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	<pre> NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS. </pre>
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	17 ^b	9.00	153.00
	Ties	4 ^c		
	Total	21		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-3.684 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 12: Acquired knowledge on how to design an EPSS in education

Notes

	Output Created	29-Sep-2010 11:18:05
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_12.sav
	Active Dataset	DataSet11
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS.
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	21 ^b	11.00	231.00
	Ties	1 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-4.064 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

Statement 13: Knowledge on how to develop an EPSS in education

Notes

	Output Created	29-Sep-2010 11:19:22
	Comments	
Input	Data	E:\University of Pretoria\SPSS\Statement_13.sav
	Active Dataset	DataSet12
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
	Syntax	<pre> NPAR TESTS /WILCOXON=Before_training WITH After_training (PAIRED) /MISSING ANALYSIS. </pre>
Resources	Processor Time	0:00:00.000
	Elapsed Time	0:00:00.000
	Number of Cases Allowed ^a	112347

a. Based on availability of workspace memory.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
After_training	-Negative Ranks	0 ^a	.00	.00
Before_training	Positive Ranks	21 ^b	11.00	231.00
	Ties	1 ^c		
	Total	22		

a. After_training < Before_training

b. After_training > Before_training

c. After_training = Before_training

Test Statistics^b

	After_training - Before_training
Z	-4.083 ^a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.