

UNIVERSITY OF KWA-ZULU NATAL

**A SYSTEMATIC REVIEW OF THE LITERATURE ON THE
EFFECTIVENESS OF COGNITIVE BASED INSTRUCTION FOR
ADULT LEARNING**

By

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DECLARATION

I Barbara Lynn Mutula declare that:

- i. The systematic review reported in this dissertation is my original work, except where otherwise indicated.
- ii. This dissertation has not been submitted for any degree or examination at any other university.
- iii. This dissertation does not contain other persons' data or information unless acknowledged.

Signature: _____

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ABSTRACT

Instructional research in adult learning has evolved over the years with increasing interest in the shift from behavioural to more cognitive models of instruction. Researchers and instructional designers have been drawn towards learners' cognitive structures and mental processes in learning environments in a bid to create effective instructional methods. Substantive research has been conducted on individual models of instruction, but current research on cognitive models of instruction across a range of disciplines in higher education was necessary. As more models of instruction emerge, an evaluation of their effectiveness is crucial to ensure successful learning. This study assessed the effectiveness of cognitive-based instruction for adult learning. A systematic review of the literature was conducted to locate current relevant studies that presented cognitive-based models of instruction applied to adult learning populations. A search strategy was used to search for relevant literature through databases, journals and reference lists. Inclusionary criteria yielded 31 qualitative and quantitative studies conducted in Africa, Asia, America, Australia and Europe; published between 2000 and 2014. A pooled sample size of over 32,033 male and female adult learners participated in the included studies. Models represented in the selected studies included problem-based learning, cognitive apprenticeship, adaptive instruction and intelligent tutoring systems respectively. The Quality assessment procedure resulted in 12 studies that indicated minimal strength in methodological rigour. Data was extracted with the use of data extraction sheets and presented in graphs and tables. Thematic and textual narrative syntheses were used to analyse the data and the systematic procedure was documented and presented in tables and flowcharts. Results indicated that cognitive-based instruction is most effective when a combination of valid cognitive tools and methods are used in tandem with adult learners' cognitive learning styles in appropriate learning environments.

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CHAPTER 1

INTRODUCTION

1.1 Background

Instructional research has evolved throughout the years and has led to rapid changes in higher learning environments. With the fast development of instructional models, educational psychologists and instructional designers have been drawn to pressing issues of design in cognitive science. The state of the human cognitive system and models of instruction that support cognitive processes in learning scenarios have been the center of debate (Kirschner, Sweller & Clark, 2006; Van Merriënboer, Kirschner & Kester, 2003; Clark & Harrelson, 2002; Boer, Steyn & Toit, 2001). In recent years, researchers have focused on evaluating individual models of instruction for specific groups in various disciplines. Evidence from instructional research has highlighted the importance of designing instruction that engages the complexities of the mind in learning environments (Major & Palmer, 2001). In the adult education literature, comparisons of innovative instructional models have been conducted against traditional models, particularly in medical, social science disciplines.

Furthermore, researchers have adapted more evidence-based approaches to assessing the effectiveness of these instructional models. Most approaches have varied in terms of methodology, context, content and analysis resulting in inconsistent outcomes. In this systematic review, a wide range of evidence-based research in a number of disciplines within education, published between 2000 and 2014 is examined in order to gauge the effectiveness of cognitive-based instruction for adult learning. The systematic review intends to provide current information, mapping out developments, in the effectiveness of cognitive-based instruction in institutions of higher education. This review extends research that has been previously conducted in relation to cognition and instruction. Illuminating current trends in cognitive-based instruction, that address the question of effectiveness, requires an understanding of the origin and development of instruction in the cognitive movement. Therefore a brief historical overview is necessary.

1.1.1. Historical overview of research on cognitive-based instruction

Research in the cognitive route of instruction expanded throughout the 1960s and early 1990s contributing increasingly to instructional psychology. At the time the direction of

instructional research had started to shift from a behavioural perspective to a more cognitive view (Gravett, 2001; Bertrand, 2003). Studies largely focused on the developmental and cognitive processes in children. For example, Vygotsky used children as the center of his sociocultural theory of cognitive development (Wood & Wood, 1996). Major theorists such as Gagne (1967), Glaser (1976), Ausubel (1980) steered research on learning and instruction in a direction that has allowed researchers to focus more on the learner's cognitive processes in a learning situation. Gagne's work on the conditions of learning and instructional events have provided a framework for designing instructional models based on cognitive theories; while Ausubel's schema theory has shed light on the importance of a learner's cognitive structure in a learning environment. All these have sparked an interest in research focusing on adult learning populations. Recent as well as older proponents (Chandler & Sweller, 1991; Sweller, Merrienboer & Paas, 1998; Krischner, 2002) have delved deeper to understand the capacity of the human mind and how instruction can be designed to ensure optimum intellectual performance from the learner. Most importantly, they have focused on the limitations of the working memory and the unlimited abilities of long-term memory. Van Merrienboer, Kirschner & Kester (2003) have proposed that instructional models that are formulated to promote effective learning should take into consideration the complexities of working memory and long-term memory which are major parts that make up the human cognitive structure. This shows growing interest in the cognitive field of educational instruction.

Further evidence-based research in recent years has shown how focus has shifted to individual instructional designs with various studies (Ruiz, Mintzer & Leipzig, 2006; Clark & Harrelson, 2002; Colliver, 2000) assessing the effectiveness of these models. Evidence from these studies has shown inconsistent outcomes concerning effectiveness of individual models most likely due to application of varying research methodologies. Other studies have discussed cognitive-based instruction observing different models of teaching collectively in past years. One of the early studies by Wilson and Cole (1996) reviewed nine cognitive teaching models and compared them to traditional instructional design theory. These have brought to light various existing cognitive models of instruction and have provided implications for further instructional design. However, the review lacked evidence pertaining to whether the models were effective in application for all or specific groups of learners (for example children, older adults or learners with disabilities). In addition, the studies that were reviewed focused on populations in the west hence a lack of generalization of results to other groups. Research on various cognitive models of instruction is needed to provide current

information on the progress or new developments of instructional procedures that is crucial in providing effective training.

1.2 Statement of the problem

As new instructional designs and methodologies spring up, substantive research on cognitive instruction has been carried out through the years; however, most syntheses have focused on individual models of instruction providing inconsistent outcomes or focusing on westernized populations. In addition, the evaluation for efficiency of current designs of cognitive instruction across different disciplines in present day adult learning environments is necessary due to fast paced technology enhanced learning environments. Therefore, this review extends the research on cognitive instruction and focuses on the current status of effectiveness of various cognitive- based forms of instruction across: different disciplines, populations and learning environment in higher learning institutions using a systematic review of the literature. Internationally, past studies on cognitive instruction have focused mostly on child and adolescent learners with a few focusing on adults in old age. This review focuses on active adult learners in higher education institutions. It is hoped that this review will contribute to existing reviews and add to the body of knowledge in the field of instructional education.

1.3 Purpose of the study

The purpose of this review is to assess the effectiveness of cognitive-based instruction used in adult learning in order to provide current knowledge that may inform instructional practise and maximize learning in adult education. The review makes use of various studies to explain and bring meaning to the question of effectiveness in cognitive-based instruction for adult learners.

1.4 Objectives of the study

The broad objective of the study is to systematically review the effectiveness of cognitive-based instruction in adult learning. The specific objectives of the study are:

- i. To explain cognitive-based instruction and how it is conceptualised.
- ii. To map out various existing cognitive-based models of instruction.
- iii. To map out ways in which adults learn.

- iv. To find out how cognitive-based instruction is being used with adult learners.
- v. To assess the effectiveness of cognitive-based instruction for adult learners.

Research Questions

The systematic review aims to answer the following research questions:

- i. How is cognitive-based instruction conceptualized?
- ii. What are the existing cognitive-based models of instruction in the literature?
- iii. How do adults learn?
- iv. How is cognitive-based instruction used with adult learners?
- v. Is cognitive-based instruction effective for adult learners?

1.5 Significance of the study

The evaluation of the effectiveness of cognitive-based instruction in adult learning has potential in contributing to the enhancement of models of instruction that promote effective learning. It is hoped that this review will contribute to the advancement in knowledge on models that work and are compatible with current adult learners in institutions of higher education. The outcome of the review will inform instructors, instructional psychologists and instructional designers on which approaches to use to promote successful adult learning. The outcome of the review may be applicable to other similar adult learning populations.

1.6 Scope and limitations of the study

It is a great challenge to run a systematic review and gain access to relevant studies. This review was limited to 31 studies that focused on different cognitive-based models of instruction. The reviewing of studies is a rigorous process and time consuming. Wright, Brand, Dunn and Spindler, (2007) indicate that the disadvantage of this form of methodology is that it is subject to biases such as publication and language biases.

Publication bias occurs when the reviewer only selects studies that have a positive outcome and excludes those with a negative outcome; while language bias involves the exclusion of articles based on language the researcher is not familiar with (Hannes & Claes, 2007). In preventing such biases, a critical appraisal of the studies was necessary. This was addressed through selective quotation from references and acknowledgement of all references to prevent any copyright breaches. Studies included in the review have already been published and are in the public domain; therefore it was not necessary to seek ethical permission from

the authors of the included studies to carry out the review. The literature reviewed has been diligently acknowledged to comply with copyright violations.

1.7 Operational terms

For the purpose of this review, the following terms can be defined as:

- *Systematic literature review*- A step by step process that is rigorous and sequential in nature which makes use of a collection of similar studies to assess the impact of an intervention. It involves several stages of data collection procedures, analysis, interpretation and discussion of results (Cronin, Ryan and Coughlan, 2008; Kitchenham, 2004).
- *Effectiveness*- The reviewer defines effectiveness as the ability to continuously produce or yield positive results (Cooper, 2007).
- *Instruction*- A series of intentional events that enable the facilitation of learning for the purpose of attaining a desired goal (Jones, 1986; Gravett, 2001).
- *Instructional design*- A complex system of elements made up of a collection of procedures that are applied in educational training (Gustafson & Branch, 2002; Smith & Ragan, 1999).
- *Instructional model*- A set of rules and procedures that influence the direction of learning (Smith & Ragan, 1999).
- *Cognitive-based Instruction*- Is an approach that includes a collection of models that are influenced by theories of cognitivism and focus on making use of cognitive tools and the guidance of an instructor to aid learning processes (Dubin & Okun, 1973; Jones, 1985).
- *Adult Learning*- Is a lifelong process that allows individuals to acquire information through interaction with other individuals and the environment which is social, psychological, behavioural and political in nature (Merill, 2001; Jarvis, 1995; Baumgartner, Lee, Birden & Flowers, 2003).
- *Higher education institutions*- Refer to learning environments that offer tertiary training to prepare learners for the world of work in various professions. These include universities, colleges, technicons and other continuing professional adult learning centres (Ivy, 2001).

1.8 Overview of systematic review methodology

This section gives a synopsis of what a systematic literature review methodology is about. An understanding of the procedures of a systematic review is important in order to conduct a successful review. Systematic literature review has increased in popularity as a research methodology particularly in educational research (Andrews, 2005; Sarkadi, Kristiansson, Oberklaid & Bremberg, 2007). It has been widely used in psychology and medical spheres (Kueider, Parisi, Grass & Rebok, 2012; Guh, Zhang, Bansback, Amarsi, Birmingham & Anis, 2009) and continues to be useful in evaluating the effectiveness of interventions, instructional techniques, as well as treatment programs for the purposes of improving or implementing successful interventions. A systematic literature review can be simply described as a step by step process that summarizes a collection of research evidence that is available on a given topic. In agreement, Andrews (2005) points out that it is a process that requires formulation of a research question, establishment of theoretical foundations, setting out a protocol for reviewing and synthesis of existing literature in order to answer the research question. Cooper and Hedges (2009) describe it as an integration of empirical evidence with the goal of making generalizations, identifying loop holes, resolving conflicts and making recommendations for future research. What sets apart a systematic review from other types of expert literature reviews are its features. According to Kitchenham (2004), systematic reviews involve:

- The development of a protocol to guide the direction of the review.
- A defined and documented search strategy using relevant keywords.
- Specification of inclusion and exclusion criteria.
- The extraction of relevant information using criteria and quality assessment tools.
- Use as prerequisite for development of meta-analyses.

Cronin, Ryan and Coughlan (2008) add that systematic reviews are able to “map out areas of uncertainty”; In addition, they identify where little or no relevant research has been done and where new studies are required (Petticrew & Roberts, 2006). Overall, systematic reviews follow a step- by -step process to ensure transparency in their methodological rigour (MacLure, 2005; Andrews, 2005). Kitchenham (2004) points out that a systematic review consists of three important phases which include: Planning the systematic review; conducting the review; and writing a report. The first phase of planning the systematic review involves a

need to conduct a systematic review, followed by the development of a review protocol. In the second stage which is conducting the review, the identification of research; selection of studies; study quality assessment; data extraction and monitoring progress; as well as data synthesis are conducted. Finally the third stage involves writing the report and dissemination of findings.

1.9 Summary

This chapter provided a background to the history of the cognitive revolution in which cognitive-based instruction originated. It further discussed the rationale for conducting research using systematic reviewing on cognitive-based instruction for adult learning. Research objectives were presented and the significance and scope of the study was stated. In addition a brief overview of the systematic review methodology was presented. The following chapter sets the foundation for conducting the review. The chapter presents the conceptual and theoretical framework that guided the systematic process.

CHAPTER 2

CONCEPTUAL AND THEORETICAL FRAMEWORK

2.1 Introduction

The purpose of this review is to assess the effectiveness of cognitive-based instruction used for adult learning at higher education institutions. The previous chapter provided an historical background of cognitive based instruction and a rationale for conducting this systematic literature review. This chapter provides literature that is necessary in understanding what cognitive-based instruction and adult learning is about as well as factors that aid in the evaluation of cognitive-based instruction for adult learning. The chapter is divided into subsections which focus on: adult learning including the characteristics of adult learners; theories of adult learning; how adults learn; cognitive-based instruction; cognitive theories of instruction; characteristics of cognitive-based instruction; and a summary of the chapter. This summary of conceptual and theoretical literature provides a foundational framework for assessing and understanding the effectiveness of cognitive-based instruction for adult learning.

2.2 Adult learning

Adult learning is a complex phenomenon which many (Gravett, 2005; Baumgartner, Lee, Birden & Flowers, 2003; Merriam, 2001; Brookfield, 1995; Knowles; 1973) have attempted to describe. However, it is evident that there is no specific definition that holistically captures its complexity. Adult learning has been characterized as a puzzle with fitting pieces of information concerning the nature of adult learners (Merriam, 2001). Amstutz (1999) and Brookfield (1995) highlight that, variables such as ethnicity, culture, personality and political views are part and parcel of adult learning. Baumgartner *et al* (2003) further describe adult learning as a lifelong process that is social, psychological, cultural and behavioural in nature. Knowles (1973) devised an umbrella term known as andragogy that characterizes the nature of adult learning with the focus being on understanding the adult learner. Knowles' (1973) assumptions of the adult learner imply that adult learners are: self-directed beings; active learners in that they engage in learning through discussions, problem solving and other experiential techniques; learners with specific needs that are linked to real life events; and motivated when learning is meaningful (Zemke & Zemke, 1995). Adult learners have to keep up with the changes that take place in their lives; whether it is in

relation to family, work, aging, social standing or other challenges. These may impact largely on their learning. Adult learners are seen as self-driven and in control of their own learning as they make their own decisions. Therefore they pursue learning degrees with the aim of expanding their career boundaries or to be empowered (Rodgers & Horrocks, 2010; Cercone, 2008; Hayes, 2006; Amstutz, 1999). To further understand the nature of adult learning an insight into the theories that govern adult learning is crucial.

2.2.1 Theories of adult learning

Research in adult learning (Cercone, 2008; Russell, 2006; Merriam & Leahy, 2005; Ross-Gordon, 2003; Marsick & Watkins, 2001) has allowed educators to formulate instructional methods that are compatible with the characteristics of adult learners. The theories of adult learning have contributed largely to these endeavors. Since the current review focuses on cognitive-based instruction, major cognitive adult learning theories are explored. Theories such as *self-directed learning*, *experiential learning*, *perspective transformation* and *situated cognition* have been highlighted as cognitive-psychological and individualistic in nature; which focus learning on an individual's mental and psychological or cognitive processes (Baumgartner *et al*, 2003; Ross-Gordon, 2003; Amstutz, 1999).

Self-directed learning postulates that adult learners are autonomous or self-seeking in their learning which allows them to plan as well as be in control of what they want to learn, how they learn, including evaluation of their learning (Ross-Gordon, 2003; Amstutz, 1999). Numerous studies (Guglielmino, 2008; O'Shea, 2003; Loyens, Magda & Rikers, 2008) have shown relative importance of self-directed learning in delivering instruction for adult learning groups. However, some studies (Kirschner, Sweller & Clark, 2006) have indicated that adult learners still require some guidance during their learning endeavors. Another theory of adult learning, *experiential learning* highlights the importance of learning through engaging in practice. Adult learners gain competence and enhance their skills when they practice what they learn especially in real world experiences (Illeris, 2007; Kolb, Boyatzis & Mainemelis, 2001; Caffarella & Barnett, 1994). Studies (Nestel & Tierney, 2007; Gremler, Hoffman, Keaveney, & Wright, 2000) have shown that adult learners benefit immensely from practicing what they learn in the classroom.

Perspective transformation highlights the importance of reflection in adult learning experiences. It is described as a form of negotiation within the self in which the adult learner has the ability to change their psychological point of reference; as well as act on the decision

to change, placing value on the process of change (Taylor, 2007; Illeris, 2004; Mezirow, 2000). A systematic review of the literature conducted by Mann, Gordon and MacLeod (2007), evaluated the importance of reflection and reflective practice in health professional education. The results indicated that reflection plays an important role in the learners' learning experience, enabling them to advance professionally in their learning. Finally *situated cognition* implies that the cognitive processes of an individual function within an environment that is able to shape, position and support the processes. Therefore, cognition should be understood as it occurs in its natural context (Seifert, 1999; Brown, Collins & Duguid, 1989). Situated cognition emphasizes on the process of learning through the transfer of application of theory to practice in real world experiences (Cobb & Bowers, 1999). The theories discussed mirror various ways in which adult learning takes place.

2.2.2 How adults learn

Research in adult learning has also illuminated that adult learners differ in their learning styles (Cercone, 2008; Pashler, McDaniel, Rohrer & Bjork, 2008; Hoskins & van Hooff, 2005; Lu, Yu & Liu, 2003; McLoughlin, 1999). In order for a learning experience to be effective, instruction for adult learning has to accommodate the learning styles of the adult learners. Pashler *et al* (2008) describe learning styles from two angles which include: the methods in which instruction is delivered; and the preferences or cognitive abilities of the learners which refer to the way learners receive and process new information. Adult learners approach higher learning institutions with varying life experiences; with these experiences, different learning styles are formed. Thurber (2003) refers to learning styles as the way in which an individual prefers to absorb and incorporate incoming information. Kolb, Boyatzis and Mainemelis, (2001) highlight four types of learning styles that adult learners have which include diverging, assimilating, converging and accommodating. Learners with a *diverging* learning style benefit from learning experiences through engaging in generating ideas through group sessions that allow for brainstorming and sharing of ideas. Those with the *assimilating* learning style learn through engaging in activities that require conceptual exploration and logical analysis of theories such as lectures, reading and testing of theories. In addition learners with a *converging* learning style benefit from learning experiences when they find solutions to a problem task through, simulations or laboratory assignments. Individuals with the *accommodating* learning style benefit through working with people in real world

scenarios or active experience that engages projects and practical experience through field work (Kolb, Boyatzis and Mainemelis, 2001).

Evidence based research has shown the link between learning styles, design of instruction and learner performance (Hoskins & van Hooff, 2005; Lu, Yu & Liu, 2003). In a study by Hoskins and van Hooff, (2005), findings confirmed that learners' learning styles determined their use of web tools in support of a psychology course. They recommended that instruction be designed in a manner that considered the differences in learning styles of learners to appeal to a larger group of learners. In a review McLoughlin (1999) recommended that instructional designers consider learning styles in designing instruction for adult learning. Other studies have shown that instructional approaches don't necessarily have to match the learning styles of adult learners to prove effective. A study by Lu, Yu and Liu (2003), identified the impact of student learning styles, learning patterns and other factors on their performance in a web-based course. The findings of the study showed that learning styles had no significant impact on learners' performance given the instructional procedures applied. With an outline of the nature of adult learning and an understanding of how the adult learner functions, the following section discusses the application of instruction in adult learning.

2.3 Cognitive-based instruction

Instruction as described by Brown (1994) is a major class of aids and tools that enhance the mind which need appropriate theories of learning and development to be designed. In the adult education literature (Gravett, 2001; Driscoll, 2000; Smith and Ragan, 1999) instruction is characterized as a series of intentional events that enable the facilitation of learning for the purpose of attaining a desired goal. The main objective of instruction is to allow the learner to be an active participant in constructing meaningful information for successful learning.

There are various forms of instruction used in adult education; however this review focuses primarily on cognitive-based instruction. The term "Cognitive-based Instruction" is not commonly used in the literature; however, cognitive instruction concept is often used with different meanings. Some (Ciardiello, 1998) have described it as a strategy within a model of instructional design while others (Wilson, Jonassen & Cole, 1993; Jones, 1987) view it as an approach in instructional design. In this review the focus is on cognitive-based instruction as an approach. In this light, this type of instruction has been described as "any effort by the instructor or institutional aids that assists students in: constructing meaning from

reading; solving problems, developing effective learning strategies; selection of appropriate strategies; taking responsibility of own learning; and most importantly the ability to transfer skills and concepts to new situations (Jones, 1985). Molenda, Reigeluth and Nelson (2003) assert that cognitive instruction enables learners to use their memory in formulating strategies that allow for the storage and manipulation of mental representations of information. Cognitive-based instruction draws from cognitive science which advocates for the importance of a learner's mental processes in a learning situation (Dubin & Okun, 1973). These mental processes include: thinking, perception; how knowledge is represented; as well as memory structure which are related to information processing and problem solving (Shuell, 1986, p.414). With the evolution of cognitivism in instructional psychology, cognitivists have constantly strived to illuminate the importance of understanding the learner's cognitive structure, their learning strategies, and how these can be paired to compatible instruction for effective learning (Bertrand, 2003; Nadkarni, 2003). There has been an influx of research focusing on instructional design and the human cognitive structure as well as how these play a crucial role in successful learning (Kirschner, 2001; Kirschner, Paas & Kirschner, 2009; Moreno, 2006). An example is Kirschner's (2001) review of six articles on the instructional implications of a cognitive load theory on the design of learning. These articles focused on instructional techniques, their link to the cognitive load structure of learners and their effects on performance. Kirschner, Paas & Kirschner (2009) have assessed cognitive approaches that use complex tasks and how to reduce the mental load of the learner to promote successful learning. Moreno (2006) has also assessed whether worked examples, a cognitive strategy, really works and whether the application of cognitive theory is useful in formation of effective instructional strategies.

The examples of reviews described above highlight the importance of the learner's cognitive processes in a learning situation and the link between these processes and instruction. Cognitive-based instruction can be viewed as teaching strategies that have been adjusted to match the cognitive characteristics of learners in a learning environment. This form of instruction is built on a foundation of cognitive theories of instruction which are discussed further in section 2.3.1 below.

2.3.1 Cognitive theories of Instruction

A theory of instruction provides guidance on how best instruction can be delivered in order for effective learning to take place (Reigeluth, 1999). A cognitive theory of instruction

links cognitive theories of learning and educational practice. Theories like Gagne's theory of instruction (Gagne, 1977; Gagne, 1972) have been the foundation of cognitive instructional models since the onset of the evolution of cognitivism (Reiser, 2001). Other theories such as elaboration theory (Reigeluth & Stein, 1983), component display theory (Merill, 1983) and instructional transaction theory (Merill, Li & Jones, 1992) follow suite and have generated various cognitive models of instruction. Gagne's theory is most familiar among instructors, instructional designers and researchers due to its comprehensive prescriptions. His instructional theory of conditions of learning consists of three major components which include: taxonomy of learning outcomes; learning conditions; and the nine events of instruction (Driscoll, 2000). However, for the purpose of this review the nine events of instruction are discussed extensively, only highlighting the other three components. This theory is discussed as a point of reference for understanding and assessing the effectiveness of instruction. In addition, alternative theories that support cognitive-based forms of instruction are also discussed.

2.3.1.1 Gagne's nine events

Gagne's theory of instruction emphasizes the gradual sequencing of instructional activities from simple to more complex tasks in the training of a complete skill (Driscoll, 2000). The theory states that for effective instruction to be evident, the following should occur: determining the learning outcome desired; consideration of conditions necessary to reach desired outcome such as providing opportunity for learners to demonstrate problem-solving skills; support should be provided for all internal processes presumed to occur during learning; finally, learners should be part and parcel of planning instructional events (Gredler, 1992; Driscoll, 2000). The theory provides the conditions necessary for the desired learning outcomes in effective instruction with the assumption that different outcomes each need different learning conditions. The taxonomy of outcomes which is the first component of the theory, accounts for learning in all three domains which are the cognitive domain, affective domain and psychomotor domain (Gagne, 1984, p.378). The outcomes include:

Cognitive domain

This consists of:

- *Verbal information* also called procedural knowledge that represents the ability to state, declare facts previously learned.

- *Intellectual skills* also referred to as procedural knowledge that encompasses an individual's understanding of how to perform a task. Gagne proposed a hierarchy for learning the intellectual skills which include:
- *Cognitive strategies* that are skills that learners use for self-regulating internal processes such as problem solving and critical thinking.

Affective domain

- This refers to *attitudes* which are an acquired internal state that influences personal choice.

Psychomotor domain

- That comprises of *motor skills* which involve the use of muscle in accurately performing a given task. (Gagne, 1984, p.378; Driscoll, 2000, p.351)

Within the above stated outcomes Gagne specified *learning conditions* as the second component of the theory. The learning conditions explain what processes are necessary in order to reach the desired outcome. These conditions include: reception, expectancy, retrieval to working memory, selective perception, semantic encoding, responding, reinforcement, retrieval and reinforcement, and finally retrieval and generalization (Driscoll, 2000, p.364; Gagne, 1967). These are known as the internal conditions of learning that take place within the learner. In *reception* a learner is open to receive any incoming information from the learning environment; while *expectancy* describes what the learner expects to achieve throughout a learning process. Additionally, *retrieval to working memory* from long term memory is the process in which a learner recalls previously learned information; while *selective perception* is the ability of the learner to purposefully discriminate among presented stimuli (Driscoll, 2000, p.365). *Semantic encoding* allows the learner to organize meaningful information into categories, considering the meaning, relationship and rules of application (Tulving, 1972, p.386). This is followed by *responding* in which the learner demonstrates through performance what has been learnt (Driscoll, 2000, p.367). *Reinforcement* occurs when the learner gains confidence in their performance and allowing the opportunity for improvement; while in *retrieval and reinforcement*, the learner is able to apply learned information to a given situation. Finally, *retrieval and generalization* is the learners' ability to apply previously learnt skills in varying contexts (Driscoll, 2000; Gagne, 1967).

Gagne further suggested the nine events of instruction that support the internal conditions of learning in order for the desired outcome to be reached. These are described as:

- *Gaining attention-* The instructor appeals to the interests of learners at the onset of instruction and learners are motivated to learn. This supports internal condition of reception- learners are receptive to incoming information (Driscoll, 2000, p.364).
- *Informing learners of the objectives-* Objectives are made clear at the beginning of instruction and learners are aware and expectant of what is to be learned or achieved by the end of the instructional process. An example could be introducing the benefits of participating in a course to the learners (Driscoll, 2000, p.365).
- *Stimulating recall of prior learning-* The instructor encourages recall of prior learning through asking questions in order to review prerequisites that are relevant to current learning. This supports the internal process of retrieving information from long-term memory to working memory (Driscoll, 2000, p.365).
- *Presenting the content-* The instructor presents new content to learners using appealing methods depending on the outcome to be learned. An example could be through use of educational technology. This supports the internal process of selective perception where learners are able to recognize distinctive features (Driscoll, 2000, p.366).
- *Providing learning guidance-* Minimal support may be provided by the instructor to assist learners in understanding new content. This may be in form of indicating which books, articles, or videos may be relevant for the learning process. This supports the internal process of semantic encoding which allows the transfer of meaningful pieces of information into long-term memory (Driscoll, 2000, p.366).
- *Eliciting performance-* Involves creating opportunity for learners to demonstrate what they have learned in relation to the instructional objectives. These could be done through role-play, case-scenarios or laboratory practice. This supports process of response where learners act out through practice to confirm what has been learned (Driscoll, 2000, p.367).
- *Providing feedback-* The instructor provides informative feedback on learners' performances with the intention of making the provision for learners to recognize errors and improve performance. This supports reinforcement which encourages

learners how to improve on errors (Nicol & Macfarlane- Dick, 2004; Driscoll, 2000, p.368).

- *Assessing performance*- Involves the overall evaluation of learners' performance for the purpose of confirming whether learners have understood the content of instruction in relation to the objectives and if learning outcomes have been met. An example could be the use of assessment tools such as examinations or field reports. This supports the internal process of retrieval and reinforcement (Gibbs & Simpson, 2004; Driscoll, 2000, p.368).
- *Enhancing retention and transfer*- Learners are put in real world situations that require them to use their knowledge and what they have learned to select appropriate rules for application to solve problems. An example could be through field practice such as teaching practice in schools. The internal process supported is retrieval and generalization which is the selection of relevant information previously learned and stored in long-term memory applied to a specific problem to enable problem solving (Driscoll, 2000, p.368).

Gagne's theory was found to be appropriate for assessing the effectiveness of cognitive-based instruction as his nine events of instruction support the internal conditions of the human information processing structure in a learning process and covers all domains of learning (Gagne & White, 1978, p.195). Other theorists such as Merrill and Reigeluth have also used this theory as a base for developing advanced theories and models of instruction. The following subsection discusses alternative theories of instruction.

2.3.1.2 *Alternative theories of instruction*

Gagne's theory of instruction has been compared and contrasted to other theories of instruction which are somewhat similar in prescription (Reigeluth, 1999). Reigeluth's *elaboration theory* is one of many which emphasizes on the hierarchical sequencing of instruction starting from a general perspective to a detailed one and the simplest building up to the most complex. The theory focuses on the cognitive domain and highlights the importance of learner-control. The elaboration theory suggests components that share similar characteristics to Gagne's instructional theory. These components include elaborative sequence, learning prerequisite, sequences, synthesis, analogies, cognitive strategies and learner control (Reigeluth, 1999). The theory puts forward that instruction should be

presented in a way that is meaningful to the learner; that information should be broken down into fragments and delivered from simple building up to complex ones; that instruction should allow the engagement of prior knowledge in the learning of new content; and that ultimately instruction should foster learner control.

Another closely related theory that also expands Gagne's conditions of learning is Merrill's (1983) *component display theory* which posits that effective instruction is one presented in primary and secondary forms. The primary includes rules, examples, recall and practice; while the secondary involves prerequisites, objectives, helps, mnemonics and feedback (Merill, 1983). The theory also indicates that learning is two-dimensional which is divided into content and performance. Content covers facts, concepts, procedures and principles; while performance includes remembering, using and generalizing (Merill, 1983).

Therefore, in learning course content, instruction must consider prior knowledge of the learner; provide appropriate conditions for recall of relevant information; allowing demonstration through examples and freedom of learner to choose and appropriately apply rules in problem solving; providing help where necessary; and encouraging practice or performance with adequate feedback. Initially the theory was suitable for application at a micro level focusing on lesson structure. Ultimately, it was developed to *component design theory* for application at a macro level targeting course structure. Overall the theory highlights the importance of learner control with minimal guidance (Merill, 1983).

The *instructional transaction theory* which is advancement to the component display theory is put forward with an exception of incorporating automated systems in instructional design. The theory assumes that for every knowledge and skill, different transactions are required (Merill, Li & Jones, 1992). The theory capitalizes on the interactions that link the proposed components into transactions in order for knowledge or a skill to be acquired; which prove its difference from the component display theory that focused on prescribing components for different skills and knowledge. Instructional transaction theory suggests that effective instruction should allow a balance between learner control and system control (Merill *et al*, 1992). This means that as much as the learner is given the liberty to manipulate cognitive strategies, expert systems also have the power to give adequate direction for learning a given skill through use of transaction shells. An instructional transaction shell is a program designed to correspond with mental processes of a specific group of learners in a learning situation to enable acquiring of knowledge or a particular skill. Instruction mostly linked to Merrill's theory of instructional transaction includes simulations, micro worlds, or computer mediated instruction (Merill *et al*, 1992).

2.3.2 Features of cognitive-based instruction

An understanding of the theories of instruction influenced by cognitive science sheds light on the structure of cognitive-based forms of instruction and their main focus. In their article on cognitive approaches to instructional design, Wilson, Jonassen and Cole (1993) discussed features that are evident in cognitive-based instruction. These include:

- *Fostering a learning culture*- Instruction encourages learners to take risks, allows them to freely commit to achieving instructional goals and most importantly to grow in the experience of learning.
- *Motivation of learners*- Learners are able to value instruction and are confident in their ability to master instructional objectives.
- *Sequencing of instruction*- Thoroughly engages active mental processes that allow learners to immediately benefit from what they learn.
- *Problem-centered learning* - Tasks are relevant to the context and needs of the learners; and embody requirements of real world tasks which enable learners to construct meaning through engaging prior knowledge.
- *Learner control*- Learners are provided with adequate support (through adjustment of cognitive tools, providing assistance for completing a complex task, timely provision of feedback on performance) and encouraged to assume control of their learning by the useful manipulating of cognitive strategies (skills to identify and learn from errors, self-reflection, self- exploration, critical thinking skills).
- *Provisions of meaningful practice*- Learners are provided with opportunities to exercise what they have learned in authentic contexts to demonstrate growth in learning.
- *Encouraging learners to personalize practice*- Learners are able to transfer their knowledge and skills (rules and principles for problem solving) for use in their field of practice (Wilson *et al*, 1993).

2.4 Summary

The conceptualization and theoretical underpinnings of cognitive-based instruction and adult learning revealed that the cognitive approach originated from a generation of cognitive theories of learning which advocated the importance of human cognitive processes in learning. Furthermore, cognitive theories of instruction explored design and features of instruction which provided a foundation for the assessment of effectiveness of instruction in adult learning. Major points of reference included: the sequencing of instructional components; the correspondence of instructional components to the cognitive processes of adult learners; a balance in learner control and provision of adequate support; as well as fostering transfer of knowledge and skill to real world situations.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter discussed the conceptual and theoretical framework which guides the systematic review process. Gagne's theory of instruction was highlighted as a suitable theory for understanding cognitive based instruction. A systematic literature review on the effectiveness of cognitive-based instruction for adult learning was conducted to thoroughly examine research to date. Kitchenham (2004) describes a systematic review as "a means of identifying, evaluating and interpreting all available research relevant to a particular question, or topic area or phenomenon of interest". The format of this review was influenced by the Campbell Collaboration systematic review protocol (2001) which is widely recognized in the social sciences and education for systematic reviews. This chapter presents a narrative of the systematic literature review process which is divided into two sections. The first section describes the planning process, while the second section gives an account of the execution of the systematic review. Petticrew and Roberts (2006) highlight the stages involved when running a systematic review. These include: defining the research question; determining studies to be included; performing comprehensive literature search to locate studies; screening of studies using inclusion criteria; critically appraising studies; synthesis of studies and assessment for homogeneity; reporting and the dissemination of results.

3.2 Planning the systematic literature review

It is imperative to design a protocol which guides the review process so as to give attention to detail in conducting a comprehensive systematic literature review. There were two steps taken in the planning process which included identifying the need to run the review and developing a protocol for conducting the review.

3.2.1 Identifying a need to run a review

The first step was to identify whether running a systematic literature review was necessary. In chapter 1 the reasons for conducting this review were discussed stating that more research on adult instruction is needed. There is an emergence of new theories on adult teaching techniques which need evaluation on their effectiveness and most importantly that updated review information on specifically cognitive-based instruction for adult learning in

institutions of higher education is necessary. The research problem statement was then formulated which led to the development of a review protocol.

3.2.2 Development of a review protocol

The development of a protocol depends on the existence of a need to run a systematic review. A review protocol acts as a guide to ensure that the review process is executed systematically and that all methodological procedures are given attention to detail (Petticrew & Roberts, 2006; Kitchenham, 2004). It contains detailed information on the background of the review question and discusses the methodological procedures that are to be used throughout the review. Furthermore, search strategies; search terms, resources for identifying relevant data, and criteria for including studies are also described. It also specifies the nature of the studies to be included and provides information on instruments that will be used in the extraction of data and assessment of quality. In addition, information on techniques of data synthesis whether quantitative or qualitative, is described. Furthermore, a timeframe is included indicating the dates within which the review activities are to be conducted. The following flowchart presents the initial protocol developed for the current review followed by a brief description of activities.

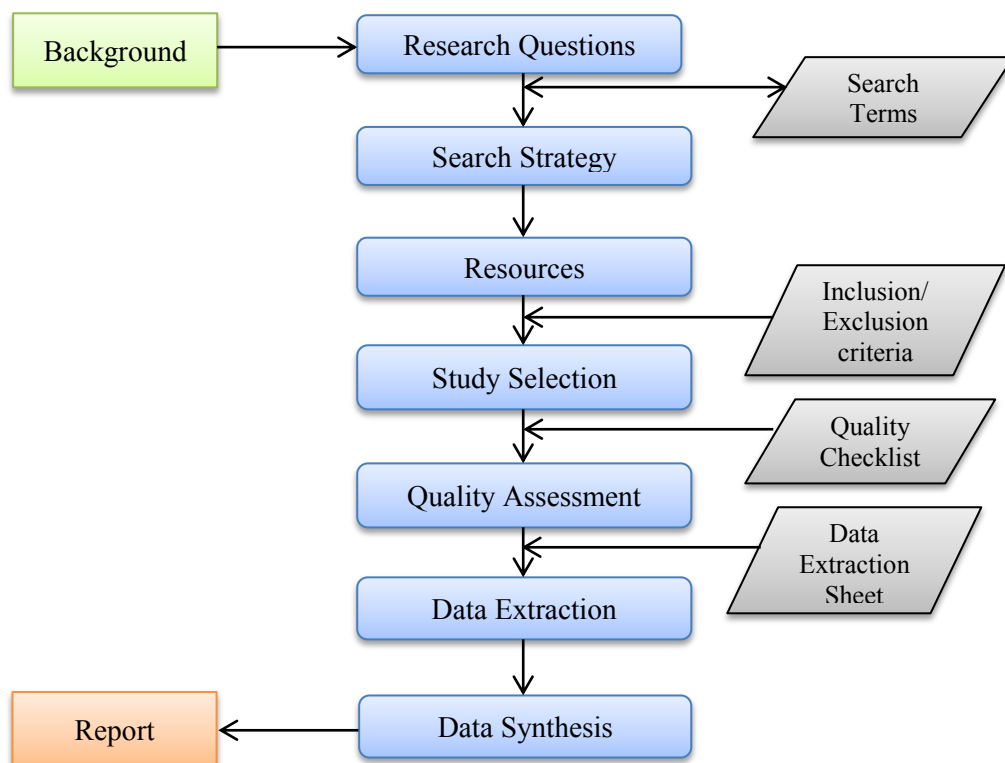


Figure 3.1: Review protocol flowchart

- The **background** consists of information that explains the gaps in literature in the area of research as well as reasons for conducting the review. This is embedded in the planning phase of the systematic review which consists of; the need to conduct a review; and development of protocol.
- The **review questions** are guided by the research topic which is usually characterized by intervention, population and outcome in a study. The questions determine the approach that is used to answer the questions. This is the initial stage of the second phase which is conducting the review (Higgins & Green, 2008; Kitchenham, 2004).
- The **search process** involves the formulation of search terms or keywords and defined search strategies to select relevant studies using data resources. **Search terms** are derived from research questions while **search strategies** are techniques used to search for relevant studies using data sources. **Data sources** provide information or studies specific to the area of research. These may include: databases, journals, books, conference proceedings and reports (Higgins & Green, 2008).
- The **study selection** consists of the use of defined criteria to aid in the inclusion of relevant studies. The criteria specify the type of studies to be included for the review. These include: study design, type of intervention, population, setting and outcome. In this stage studies that do not meet the specified criteria are excluded from the review.
- The **study quality assessment** requires the use of specified quality indicators that are specific to the type of studies included. The assessment of quality considers the strengths and weaknesses of the methodological procedures of the included studies. This stage is important as it contributes to the validity of the systematic review (Petticrew & Roberts, 2006; Kitchenham, 2004).
- **Data extraction** is the process of retrieving useful information from the included studies which will be used in answering the research questions. The retrieval of data is done using a data extraction sheet which is a data collection instrument that specifies what kind of information should be retrieved. The extraction sheet embodies the characteristics of the research questions (Petticrew & Roberts, 2006; Kitchenham, 2004).
- **Synthesis** requires the application of analysis techniques to make sense of the data that is retrieved. The approach to synthesis of data can be either qualitative or quantitative depending on the nature of the data collected. At this stage the choice of approach to synthesis and the validity of application of selected techniques are stated (Petticrew & Roberts, 2006).

- ***Time frame:*** A detailed timetable showing dates of when the systematic review procedures intend to be executed is also included.
- ***Writing the report*** is the final phase and stage of the review process in which a narration of the procedures, the findings and recommendations for further research are stated (Higgins & Green, 2008).

The review protocol was developed based on the procedures recommended by Higgins and Green (2008), Petticrew and Roberts (2006) and Kitchenham (2004). The initial protocol was subject to change with the provision that there might be changes in the criteria for the inclusion and exclusion of studies based on the availability of relevant studies. It was reviewed by a board of reviewers in the School of Education at the University of KwaZulu-Natal, on the Edgewood campus. Upon return with significant feedback for further modification, changes were made in the identified areas of the protocol including data collection instruments for a more comprehensive presentation.

3.3 Conducting the review

In this section the methodological procedures used in conducting the review on the effectiveness of cognitive-based instruction for adult learning are described in detail. Babbie and Mouton (2001, p.75) emphasize that methodology focuses on “the process and kind of procedures used”, while Kothari (2004, p.8) views methodology as “a scientific process in which the aim is to systematically solve the research problem”. The stages involved in conducting the systematic review process included literature searching, study selection, data extraction, quality assessment and synthesis. The searching stage involved systematic identification of relevant studies while study selection involved application of inclusion and exclusion criteria for selection of appropriate studies and examination of references, abstracts, titles and full-texts. Data extraction involved thorough examination of included studies and extraction of evidence of each study; while quality assessment engaged the use of quality appraisal tools to examine the validity of methodology used in each study. Synthesis involved choosing a framework for analyzing data and identifying common themes in the studies. These stages are discussed extensively in the following subsections.

3.3.1 Research questions

In order to evaluate the effectiveness of cognitive-based instruction for adult learning, the review sought to address the following research questions:

Table 3.1: Research questions

Q1	How is cognitive-based instruction conceptualized?
Q2	What are the existing cognitive- based models of instruction in the literature?
Q3	How do adults learn?
Q4	How is cognitive-based instruction used with adult learners?
Q5	Is cognitive-based instruction effective for adult learners?

With the research questions refined, the literature search was conducted using keywords derived from the research questions. The research questions were broken down to form categories in terms of intervention, population, context and outcome to formulate keywords. This was done to ensure that the research questions were well captured in the keywords. Intervention represents the types of cognitive-based instruction; while population represents the adult learners. Setting represents the countries and institutions in which the studies were conducted as well as the year; while outcome embodies the effectiveness of the intervention. The keywords were used in the search strategy to cull irrelevant articles for the review.

3.3.2 Literature search and study selection

Kitchenham (2004) emphasizes that it is insufficient to conduct searches for primary studies using electronic databases only. Therefore, other sources of evidence must be searched, sometimes manually such as reference lists, journals, research registers and internet. Reference lists and research registers can be searched manually as they may contain studies that focus on the reviewer's area of interest. Journals usually contain articles that are likely to focus on a similar field of research. The internet acts as a platform to use on-line resources such as research websites, and search engines to locate electronic books and journals. When using the electronic database, a search strategy shown in figure 3.2 was employed. The figure shows that the first step was to identify resources of which were the electronic databases (see Table 3.2). This was followed by using the search engine to key in

relevant words to conduct a keyword search. If the search yielded irrelevant studies by virtue of their titles, the words were refined and the keyword search would be replicated. If the result was relevant, studies were checked by scanning through abstracts and conclusions to check their relevance and validity. If the studies were not relevant, they were excluded from the study and if they were relevant the full text of the articles were retrieved.

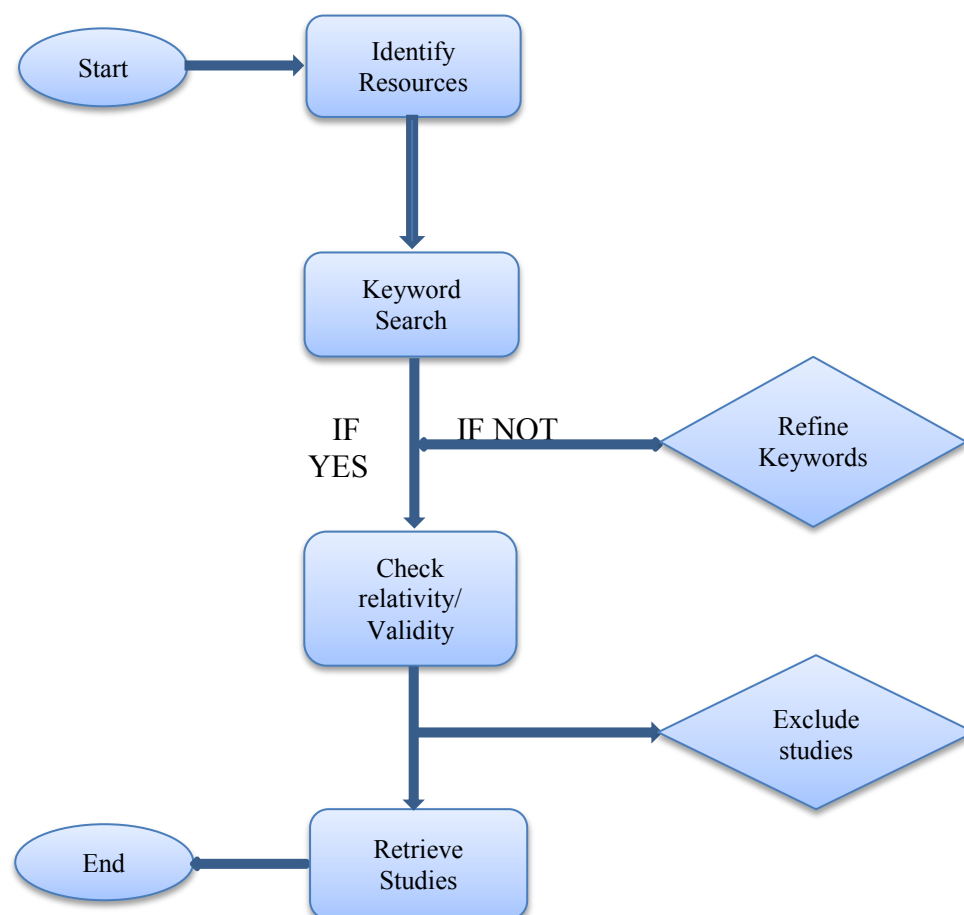


Figure 3.2: Keyword search strategy

3.3.2.1 *Trial literature search*

A trial literature search on Google Scholar was done to identify the amount and availability of primary studies related to cognitive-based instruction in adult learning. The search yielded 703 000 articles of which majority did not directly link to “cognitive-based instruction”, therefore the search was refined to “cognitive instruction and adult learning”. The second search yielded results of primary studies and reviews that were directly and indirectly related to cognitive-based instruction which was useful to the review process. In

addition to electronic databases and websites; journals and books were used to identify the relevant studies. Reference lists within references were also tracked to find relevant studies. Greenhalgh and Peacock (2005) suggest that pursuing references of references and electronic tracking of citations could prove to be powerful in yielding high quality studies. The databases that were searched are shown in the table below.

Table 3.2: Searched electronic databases

Databases
Academic search complete via EBSCOhost
PsychInfo
ERIC via EBSCOhost
JSTOR via Googlescholar
SA ePublications via SABINET
PubMed via Googlescholar
Science Direct via Googlescholar
Emerald text via EBSCOhost
Sage Journals on-line via Googlescholar
SpringerLink via EBSCOhost
Education full text via WilsonWeb
Africa wide information via EBSCOhost

3.3.2.2 *Keyword search technique*

A keyword search technique was carried out using various terms derived from the research question and results from the trial search which were used in the electronic databases. These included adult learners, cognitive, instruction, cognitive-based, cognition, programs, effectiveness, higher education and universities including any terms that were closely related (see Table 3.3). Ely & Scott (2007) point out that keyword search is the most common method of identifying literature. Alternative keywords with similar meanings that elicited information such as cognitive load, memory, colleges, and adult learning, were used to identify articles relevant for the review.

A term within a category was connected using Boolean terms such as „OR“ while „AND“ was used to connect terms from different categories. For example terms such as „Cognitive

instruction OR cognition AND adult learning OR adult students” were used. The Boolean term NOT was used to exclude articles already viewed to control duplication. In addition, manual search techniques in books and journal articles were also utilized to access relevant primary studies. Petticrew & Roberts (2006) note that book chapters and bibliographies of other literature reviews and of primary studies should also be searched by hand. This provides opportunity for the discovery of important studies that could possibly be left out of the loop.

Table 3.3: Keyword Search

Keyword 1	Keyword 2	Keyword 3	Keyword 4	Keyword 5
Effectiveness	Cognitive-based	Instruction	Adult learners	Higher education
Efficacy	Cognitive	Strategy	Postgraduates	University
Successful	Cognition	Adult learning	Undergraduates	College
Effect	Cognitive load	Teaching	University students	Tertiary institutions
Impact	Cognitive learning	Program		Open learning
	Memory	Intervention		Life-long learning
	Working memory	Problem-based		
	Long-term memory	Intelligent tutor		
	Brain	Cognitive apprenticeship		
		Computer-aided systems		
		Inquiry learning		
		Reciprocal teaching		

3.3.2.3 *The actual search*

The first attempt of the actual search produced 38111 hits of which were considered to be closely related to the review research question. In instances where the search did not yield satisfactory results alternative keywords were used to search for studies or an additional keyword was added to the initial search string. The second search attempt was more refined as alternative keywords produced studies that were most likely related to the research question. The search yielded less than 200 articles that were directly related to the research question. Studies that appeared to meet the inclusion criteria were set aside for further examination after the first screening phase which was done twice through examining titles and abstracts in the database. This process yielded close to 88 articles that contained keywords indicated in table 3.2 above. Full texts of the articles were obtained through further examination. Almost 43 studies showed potential characteristics related to cognitive

instruction and adult learning. However, not all met the inclusion criteria. Articles that focused on children, adolescents, adults with cognitive impairment or older adults of ages 60 and above were excluded from the review. Non-peer-reviewed articles published below the year 2000 in other languages apart from English were also excluded from the review (A detailed description of the inclusion and exclusion criteria is presented in the next sub-section of this chapter). In addition a quality assessment was conducted upon which studies were excluded if they only featured less than a half of the quality indicators. Consequently 31 studies were included in this systematic literature review that met the criteria (as discussed on page 31). The journals of the included studies are listed in Table 3.4 below.

Table 3.4: Journals of included studies

Journal of Medical Science	South African Medical Journal
International Journal of Research and Studies	South African Journal of Education
International Journal of Health Care Education	Journal of In-service Education
Advances in Health Science Education	Journal of Engineering Education
Journal of Educational Research	African Journal of Business Management
Journal of Systems and Software	Journal of Learning Design
Journal of Continuing Education in the Health Professions	Journal of Nursing Education
	International Journal of Nursing Studies

The above listed journals were identified and searched for potential studies by conducting a search in the listed databases (see table 3.2) using specified keywords and an inclusion criteria; as well as through scanning references of relevant literature. Although the above listed are not the only journals that contain literature on adult learning, they contained studies that met the inclusion criteria. Journals not included in the list that contain studies focusing on adult learning may have not been within the authors reach or were excluded based on the conditions that did not meet the specified criteria. In the existing literature on systematic reviews, there is no defined number of studies to be included in a systematic review. Researchers have made use of studies that are available within their reach in relation to their areas of research. Kripalani, Yao and Haynes (2007) conducted a systematic review on interventions to enhance medication adherence in chronic medical conditions which included 37 randomized controlled trials; While 16 studies were included in a systematic review by Miller and Archer (2010) on the Impact of workplace assessment on doctor's education and performance. Another systematic review conducted by Spreckley and Boyd (2009) made use of 13 studies in examining the efficacy of applied behavioral intervention on pre-school

children with autism. Thus, the use of 31 studies included in this review was considered acceptable. A flowchart of the selection of relevant studies is presented in Figure 3.3.

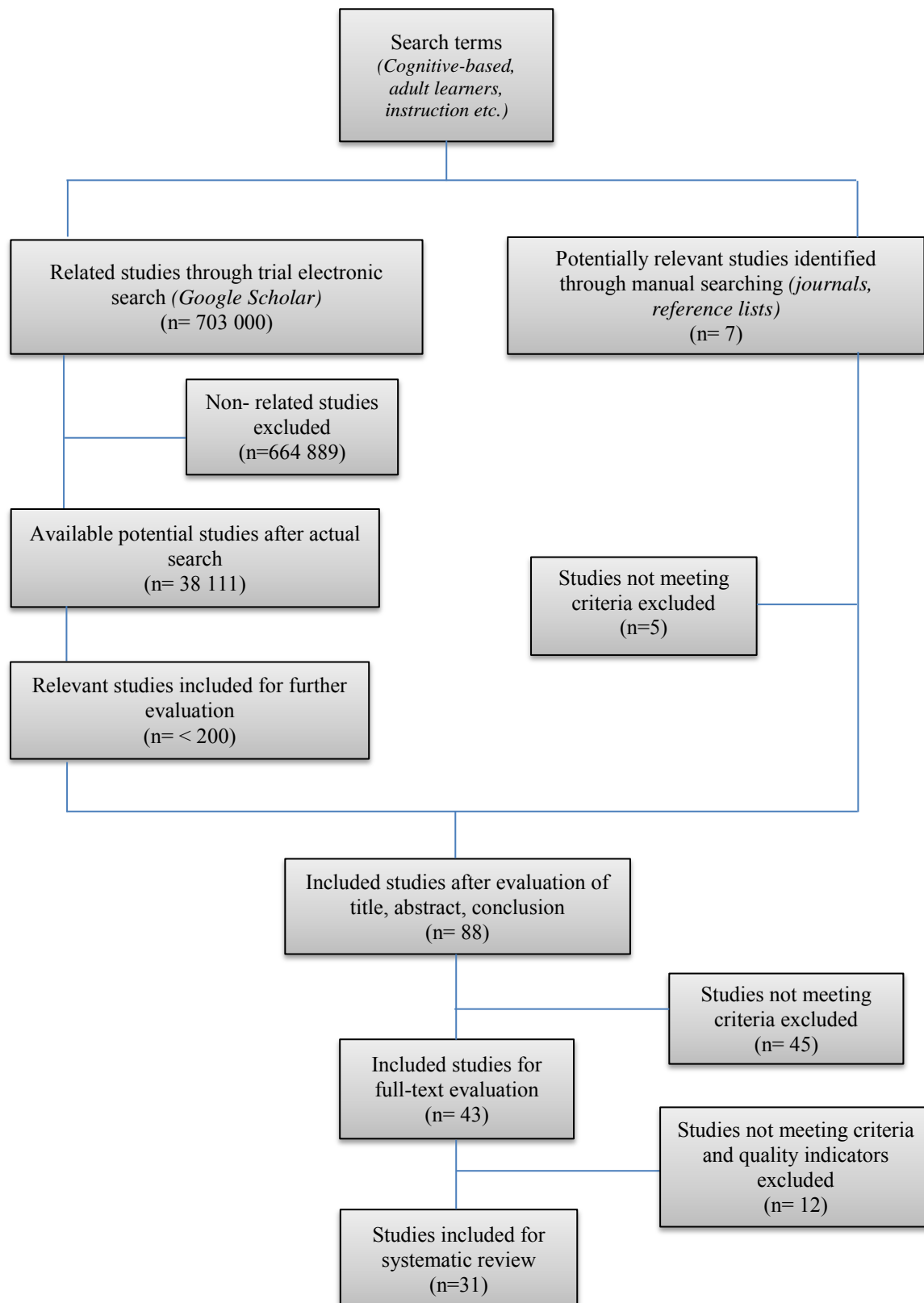


Figure 3.3: Study selection process

3.3.3 Inclusion and exclusion criteria

Cronin et al (2008) specify that systematic reviews use explicit and rigorous criteria to identify, critically evaluate and synthesize all the literature. The following criteria were used to determine the inclusion of studies in the review on the effectiveness of cognitive-based instruction for adult learning:

Table 3.5: Inclusion/exclusion criteria

Parameters	Inclusion criteria	Exclusion criteria
Type of study	<ul style="list-style-type: none"> All pre-test, post-test studies preferably with control groups or comparison groups (quasi-experimental, experimental, case studies, cross sectional). 	<ul style="list-style-type: none"> Non pre-test, post-test studies without any comparison groups or control groups.
Population	<ul style="list-style-type: none"> Studies with male and female adult learner participants preferably between the ages of 18 to 55. Studies should specify the characteristics of participants. 	<ul style="list-style-type: none"> Studies including children, adolescents and older adult populations from ages 60 and above. Studies focusing on mentally impaired populations. Studies not specifying the nature of participants.
Setting	<ul style="list-style-type: none"> Studies that focus on adult learning institutions such as universities, colleges, and other adult learning centers. 	<ul style="list-style-type: none"> Studies focusing on primary and secondary schools.
Intervention	<ul style="list-style-type: none"> Studies that focus on any form of cognitive-based instruction. Studies should specify characteristics of instruction. 	<ul style="list-style-type: none"> Studies that focus on any form of non-cognitive-based instruction. Studies that do not specify characteristics of instruction.
Outcome	<ul style="list-style-type: none"> Studies should specify effectiveness of the application of instruction whether negative or positive. Studies indicating type of measures used and analysis methods to arrive at results. 	<ul style="list-style-type: none"> Studies not specifying overall impact of application of instruction. Studies with no clear indication of measures and analysis methods used to arrive at results.
Geographical context and publication	<ul style="list-style-type: none"> Studies conducted in South Africa and internationally. Studies should be peer-reviewed published between 1999 and 2014. 	<ul style="list-style-type: none"> Non peer-reviewed studies published below 1999.
Language	<ul style="list-style-type: none"> Studies published in English. 	<ul style="list-style-type: none"> Studies published in foreign languages.

- 1) *Type of studies*: Initially to meet the inclusion criteria, studies had to be longitudinal pre-test – post-test case series, case studies or posttest case series. However, there were a few exceptions made to broaden the inclusion criteria as the searching process yielded fewer studies. Therefore other types of studies such as quasi-experimental, experimental studies, exploratory design studies and cross sectional studies were incorporated as part of the inclusion criteria. Studies that did not have control groups, any form of comparison groups or were not case studies were excluded from the review.
- 2) *Population*: The participants in the primary studies to be included had to be adult students or learners between the ages of 18 and 55 who are male and female specifically from higher education institutions or tertiary institutions of learning. Studies that had adolescent, child participants, mentally impaired participants or older adult participants over the age of 60 were excluded from the review.
- 3) *Intervention*: Studies with cognitive-based forms of instruction used in adult learning were included. Any primary studies that did not include cognitive-models of instruction were excluded from the review.
- 4) *Type of setting*: Studies that met the inclusion criteria in this review included those that focused on application of cognitive forms of instruction in adult learning institutions such as, universities, colleges and adult learning centers. Any primary study that focused on schools was excluded from this review.
- 5) *Outcome*: Studies were also included if application of instruction showed either negative or positive outcome including use of outcome measures of pre and post- test comparisons, formal assessments and self-reports. In addition studies included had to have an overall report on the impact of the intervention. Studies were excluded if no clear report on outcome was stated.
- 6) *Geographical context and publication*: To be included in the review, studies had to have been conducted nationally or internationally. In addition, studies included had to have been conducted or published between 2000 and 2013. Studies published from 1999 and below were excluded from the review.

- 7) *Language*: Studies included had to have been published in English since the reviewer had no provision for the translation of foreign languages.

3.3.4 Data extraction and quality assessment

Studies that seemed appropriate through their titles and abstracts were examined further by full text. Data was extracted from included studies during the second screening phase. Coded extraction data sheets were used to extract relevant information from each study in the review. Kitchenham (2004, p.17) illustrates that extraction sheets should be designed in a manner which allows the collection of all relevant data that “addresses the review questions and the study quality criteria”. The data extraction sheet used in this review was designed to contain sections that enabled the appraisal of quality, summary of the details of each study and their findings (see appendix D). The sections comprised of: Reference, source, author and year of publication, title, country, study design, objective of study, field of study, sample population, type of instruction, dependent variables, quality assessment, findings and outcome, and comments on the study. The procedure was documented and the summary of extracted data was presented in tabular form (see table 4.1); Cooper and Hedges (2009) point out the importance of utilizing tables, charts and graphs in presenting data in systematic reviews. In agreement, Petticrew and Roberts (2006) advise that the use of clear detailed tables increases transparency of the review; while flowcharts map the progress of study selection and data collection throughout the review process.

The appraisal of quality for each study was captured in the quality assessment section which focused on the methodology used for each primary study. It was particularly important to run a quality assessment on the included studies as it would later contribute to the assessment of effectiveness of cognitive-based instruction as a whole for adult learning. Cooper (2007) emphasizes on the necessity of performing a quality appraisal on included studies. Wright, Brand, Dunn and Spindler (2007) specify that checklists with the necessary elements for a quality study should capture internal and external validity features in order to be reasonable. Internal validity means ensuring that a study has minimal errors in methodical procedures; while external validity refers to the ability of a study to generalize findings to other populations (Wright *et al*, 2007). The items presented on table 3.6 were used in the assessment of quality for each included study.

Table 3.6: Quality assessment items

Item	Question
Overall research approach	<ul style="list-style-type: none"> • Is research method and study design appropriate? • Does the research method synchronize with the research questions?
Methodological rigour	<ul style="list-style-type: none"> • Are sampling procedures specified and applied methodically?
1. Sampling procedures	
2. Random assignment of groups	<ul style="list-style-type: none"> • Is the assignment of control groups and selection of subjects for comparison clearly defined?
3. Control for confounding variables	<ul style="list-style-type: none"> • Does the study adequately control for potential confounding variables in design or analysis?
4. Testing and instrumentation	<ul style="list-style-type: none"> • Does study indicate any evidence of the reliability of measures?
5. Statistical regression	<ul style="list-style-type: none"> • Is approach to analysis clearly defined? • Are statistical measures specified in the analysis of data (in the case of quantitative studies)?
6. Bias	<ul style="list-style-type: none"> • Are biases considered during the study and measures taken to prevent them from occurring if any?
7. Generalizability	<ul style="list-style-type: none"> • Are outcomes assessed using criteria, results clearly presented and sufficient in order to justify relation between evidence and conclusion?

Due to the nature of the studies that were to be included in the review, it was found necessary by the reviewer to develop critical quality appraisal items that apply to qualitative and quantitative studies. The choice of quality assessment items are consistent with that of standard checklists used in Cochrane Collaboration systematic reviews of qualitative and quantitative studies in education (Higgins & Green, 2005). The decision to include studies after the quality appraisal was based on the methodological rigour and whether studies had enough relevant information that related to the review questions. However, studies were still included if they had more conceptual strength than methodological as this could contribute to the discussion of effectiveness of cognitive-based instruction.

3.3.5 Data Synthesis

Synthesis of data engages gathering of relevant data and summarizing in order to draw conclusions (Kitchenham, 2004; Cooper, 2007; Harden & Thomas, 2005). Data synthesis can be either descriptive in nature (qualitative) or involve statistical measures in analyzing data (quantitative). In this review, the author chose to employ qualitative methods of data synthesis. Due to the inclusion of primary studies that varied in methodological procedures, conceptual and theoretical frameworks, it was most suitable to use a qualitative approach in order to make apparent the characteristics, differences and similarities of primary studies. Cooper (2007, p.27) argues that quantitative methodology is irrelevant in circumstances whereby the goal of the review is to reach generalization of findings using “conceptual and theoretical bridges” especially when studies that are included have different methodologies, participants and outcome measures of which this is the case in this review. The quantitative approach of synthesis is beyond the scope of this review, therefore the qualitative approach is the focus of discussion. Textual narrative synthesis and thematic synthesis which are qualitative methods of analysis (Barnett-Page & Thomas, 2009), were used to map out relevant data that relates to the research questions. Increasing interest in the use of mixed methods of synthesis has brought about debates on crossing the paradigmatic divide amongst research methodologists (Harden & Thomas, 2005; Lucas, Baird, Arai, Law & Roberts, 2007). However, there is limited literature providing guidance on the use of mixed methods in systematic reviews. The use of the above mentioned synthesis methods were influenced by the nature of the research questions and the primary studies included in the review. Since the review included both qualitative and quantitative studies; it was necessary to employ synthesis methods that would allow for the integration and comparison of findings across different studies. The following sub-sections describe the steps taken in the analysis of the extracted data.

3.3.5.1 *Textual narrative synthesis*

Textual narrative synthesis is known for its ability to make transparent the heterogeneity of primary studies through highlighting the context, characteristics, quality and findings. Furthermore, structured summaries of the extracted data are noted and similarities and differences are drawn across studies (Barnett-Page & Thomas, 2009). This qualitative approach has been used widely in systematic reviews of effectiveness of interventions, because of its ability to use words in describing the evidence as put forward by primary

studies (Popay, Roberts, Sowden, Petticrew, Arai, Rodgers, Britten, Roen & Duffy, 2006; Lucas *et al*, 2007). Lucas *et al* (2007) have illustrated how textual narrative synthesis is useful in issues of quality appraisal and that it can be used in reviews which include evidence of both qualitative and quantitative studies. In this review, textual narrative approach assisted in highlighting the diversity of the study designs and context in which cognitive-based instruction was used for diverse groups of adult learners. In addition, a quality appraisal assessment tool was used to assess the level of strength of evidence in each included study (see Appendix C). Commentaries from each of the included studies from the data extraction sheet enabled comparisons across studies for similarities and differences; as well as identification of gaps in the evidence. The similarities noted included characteristics of instruction, sample population and findings of included studies; while the differences included the type of model of instruction, context, characteristics of sample population, quality of evidence and findings. Although the textual narrative synthesis was able to identify similarities and differences in the heterogeneous studies, conclusions could not be drawn across studies. Therefore, thematic synthesis was applied in the next stage to identify the themes in the midst of heterogeneity of included studies to exhibit commonality in the evidence which would enable the generalization of findings.

3.3.5.2 *Thematic synthesis*

The thematic approach is a familiar method in the synthesis of evidence in systematic reviewing (Thomas & Harden, 2008; Lucas *et al*, 2007; Barnett-Paige & Thomas, 2009). Thematic synthesis allows the researcher to identify, analyze and report on recurrent themes across extracted data (Braun & Clarke, 2006). It engages three stages of: coding results of included studies line by line; development of descriptive themes; and further yielding analytical themes that are related to the research question (Lucas *et al*, 2007; Barnett-Paige & Thomas, 2009). In this review, the data extraction sheet aided in presenting extracted data that enabled coding of relevant information across the included studies. In the initial stages of the thematic synthesis, similarities and differences noted through the textual narrative synthesis were used in developing themes that were closely related to the research questions. The final stages of the synthesis involved grouping the studies according to analytical themes which were developed using the organization of the coded data. The following data was coded in order to gauge the effectiveness of cognitive-based instruction:

- *Characteristics of sample population*- Information concerning the age group, ethnicity and gender as well as whether participants were undergraduates, graduates or professional trainees was coded.
- *Similarity in instructional methods*- Instructional methods refer to the way in which instruction is delivered. These include components or activities embedded in an instructional model. These methods may be through lectures, group discussions or online web-based interactions. Similarities in such information were noted for analysis.
- *Characteristics of instruction*- Based on Wilson *et al* (1993) description of the features of instruction from a cognitive approach, the following were identified for coding: learning culture, learner motivation, and sequencing of instruction, degree of learner control, practice, and feedback. In addition, the length of instruction was also included for analysis. Learning culture was coded according to whether the instructional model provided an environment that allowed learners the opportunity for growth in learning experience; while learner motivation was coded according to learners reactions to the learning experience. Sequencing of instruction was coded considering the order in which instruction was delivered and activities done. The degree of learner control was coded according to the level at which learners controlled the direction of the learning experience considering the content, structuring of instruction and length of training. Furthermore, practice was coded according to the opportunity provided for learners to demonstrate what was learned through field work, role-plays, assignments, and tests; while feedback was coded considering whether learners were afforded the chance to identify any errors in their performance for correction as well as evaluate the role of instructor and overall learning experience. Finally the length of instruction was coded according to the time frame in which the instruction was applied.
- *Learning outcome*- This included both declarative and procedural outcomes. Data was coded considering whether learners had learned instructional content. Information related to declarative outcome which included performance test scores, examinations or any written assessments were noted. Procedural outcome data which included any results on the demonstration of cognitive application of skills learned, through field practice reports, presentations and simulations were also coded.

3.4 Summary

This chapter presented step-by-step procedures that were documented throughout the systematic review. The process proved to be time-consuming as each procedure required thorough systematic execution. The procedures defined indicated specific stages that began with the planning phase which involved development of protocol. The protocol indicated the direction and procedures that were to be taken to conduct the systematic review. The second stage described the measures taken through conducting the review. Research questions were clearly defined and search terms were derived to create a search strategy for the selection of relevant studies through use of available resources. Furthermore defined objective criteria and quality indicators were used to identify primary studies relevant to the review question. In addition, a data extraction sheet enabled the extraction of data that was used in answering the review questions. Thematic and textual narrative synthesis procedures were also described as qualitative data analysis methods and the validity of these procedures made clear given the nature of the extracted data (qualitative and quantitative studies). The presentation and narrative of findings following the analysis of data are provided in the next chapter.

CHAPTER 4

DATA PRESENTATION AND INTERPRETATION

4.1 Introduction

In the previous chapter, the methodological procedures were discussed in detail describing the stages that were taken in carrying out the systematic review. The goal of the review was to synthesize quality research evidence that was relevant to cognitive-based instruction for adult learning to assess its effectiveness. During the systematic review process, studies ($n=31$) that met the inclusion criteria and quality assessment provided information that was extracted using a data extraction sheet. This chapter gives a summary of the extracted data and an interpretation of the results. The chapter begins by presenting descriptive findings of the extracted data, followed by the assessment results of their methodological rigour.

4.2 Descriptive Findings

4.2.1 General Characteristics of included studies

The included studies in this review all focused on different cognitive models of instruction and their effectiveness. Eighteen studies were on problem based learning (Applin, William, Day & Buro, 2011; Burch, Sikakana, Yeld, Seggie & Schmidt, 2007; Charmondusit & Charmondusit, 2012; Davis, Kvern, Doren, Andrews & Nixon, 2000; Dyke, Jamrozik & Plant, 2001; Kong, Qin, Zhou, Mai & Gao, 2014; Malan, Ndlovu & Engelbrecht, 2014; Mantri, Dutt, Gupta & Chitkara, 2009; McParland, Noble & Livingston, 2004; Meyer, Summers & Moller, 2001; Newsletter, 2006; Raja Hussein, Wan Mamat, Salleh, Mohd Saat & Harland, 2007; Senocak, Taskesenligil & Sozbilir, 2007; Shipton, 2009; Swann, Andrews & Ecclestone, 2011; Temel, 2014; Tsou, Cho, Lin, Sy, Yang, Chou & Chiang, 2009; Uys, Gwele, McLnerney, Rhyn & Tanga, 2004); while eight studies focused on cognitive apprenticeship model (Batt, 2010; Dickey, 2008; Hautala, Romu, Ramo & Vikberg, 2011; Idris, 2012; Liu, 2005; Mudzielwana & Maphosa, 2014; Nichol & Bisset, 2006; Shen, Chou, Hsiao, Lee & Chen 2011). Three studies were on adaptive instruction (Bell & Kozlowski, 2002; Mihalca, Salden, Corbalan, Paas & Midea, 2011; Pandey, Petrosino, Austic & Barr, 2004); while two studies focused on intelligent tutoring systems (Cheung, Hui, Zhang & Yiu, 2003; Cook, Levinson, Garside, Dupras, Erwin & Montori, 2008). The included studies were in the published year range of 2000 to 2014. The general summary of the included studies is presented in table 4.1.

Table 4.1: Summary of included studies

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
1.	Tsou, Cho, Lin, Sy, Yang, Chou & Chiang (2009)	Taiwan	Investigates the short-term outcome of a near-full Problem- based learning curriculum.	A cohort of 236 Taiwanese male and female medical students from 2 nd year at the Fu Jen Medical School.	Medicine	Quasi-Experimental	<p>PBL curriculum of 3years with a follow-up after 4years.</p> <p>Procedures: System-based units, case-based, assessment, early clinical exposure and tutorial sessions that involved: identifying facts/problems; generating hypotheses; listing need to know; formulating, organizing and prioritizing learning issues/objectives; data searching and self-directed learning; sharing of knowledge; reorganizing patients' problems; individual, group and overall evaluation; feedback on the role of the tutor.</p>	Self-Directed Learning Readiness Scale (SDLRS); Semi-structured qualitative interviews; and the pass rates of students in Taiwan Medical Licensure Examination.	<p>Students were motivated to learn; developed better critical thinking ability, Significant changes in self-directed learning abilities; improved ability in data collection, analysis, summary and understanding compared to those from lecture- based curriculum.</p> <p>Limitations: students indicated that PBL had limited depth and breadth in clinical medicine.</p>

							Learning activities: lectures, resource learning, laboratory exercises and clinical skills teaching		
2.	Charmondusit & Charmondusit (2012)	Thailand	Demonstrates how problem-based learning applied to a training program on industrial ecology and environment can contribute to and support sustainable development of industry.	14 participants from 9 developing and underdeveloped countries in South Asia, Southeast Asia and Middle East joined the training program at the Mahidol University.	Industrial Ecology and Environment	single-case study	<p>PBL consisting of in-class learning, field study and group discussion that ran for 3½ weeks.</p> <p>Procedures: Demonstration of problem-solving skills to acquire knowledge through completion of a problem assignment; understanding and application of concepts; self-assessment through use of reflective journals; writing of reports and presentations; and feedback from participants.</p> <p>Learning activities: Lectures, laboratory practice, research, field site</p>	Questionnaire and evaluation forms that focused on lecturer's ability to deliver, participants' evaluation of field trip and overall quality of training program.	<p>Participants agreed or strongly agreed that PBL enhances transdisciplinarity between academics and practitioners, self-regulated learning and collaboration.</p> <p>Limitations: Training time period was limited.</p>

							study, analysis and synthesis of results in group discussions.		
3.	Idris (2012)	Nigeria	Identifies the effects of cognitive apprenticeship instructional method on the performance of auto-mechanics students in technical colleges.	212 second year auto-mechanics students from four technical colleges in Rivers State Nigeria.	Industrial and Technology Education	Quasi-experimental pre-test post-test design with experimental and non-equivalent control groups.	<p>Cognitive Apprenticeship program</p> <p>Procedures: modelling, scaffolding, coaching, articulation and finally exploration</p> <p>Learning activities: Learning the brake system, lubricating system, cooling system, fuel system and drive train of an automobile.</p>	Cognitive apprenticeship instructional lesson plans, traditional lesson plans and an auto-mechanics achievement test (AMAT).	Cognitive apprenticeship seemed to lead to higher academic achievement, increase in self-confidence and self-reliance, as well as improvement in learning skills and performance; with higher mean post-test AMAT scores compared to those taught using the conventional lecture method.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
4.	Dickey (2008)	United States	Investigates the integration of a cognitive apprenticeship model in a web-based course for P-12 teacher education.	A total of 63 undergraduate and graduate students from 11 different teacher education licensure programs.	Educational technology	single-case study	<p>Cognitive Apprenticeship instructional model ran for 1 semester</p> <p>Procedures: modelling -students were provided with a variety of models and exemplars of lesson plans as well as educational media; scaffolding -provided through response of email requests for assistance that gradually faded overtime; coaching-tools such as emails, instant messenger and weblogs were used to engage in dialogue between instructors, peers and students to provide guidance; articulation and reflection or exploration - by critically analysing resource materials and use of weblogs to express ideas as well as reflect on</p>	Field notes, observation notes of web postings, student questionnaires, students' work and interviews on learning experiences and development of technology skills.	Modelling, coaching and exploration were found to foster skill development and understanding of technology integration through the student reflections and teacher- student interactions.

							<p>the learning process.</p> <p>Learning activities: familiarisation of problem solving and troubleshooting strategies through analysing resource materials; application of knowledge and skills learned from previous modules to new challenges; demonstration of skills through assignment in creating and uploading a WebQuest page; summative reflections, and course evaluation.</p>		
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	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
5.	Liu (2005)	Taiwan	Examines whether a course based on a cognitive apprenticeship model benefits pre-service teachers' learning of instructional planning.	A total of 28 participants consisting of 4 experts and 24 students from an elementary education department of a teachers' college.	Educational Technology	Pre-test post-test field experiment	<p>Web-based cognitive apprenticeship model (7weeks)</p> <p>Procedures: modelling-observing, scaffolding-practicing, and guiding-generalizing</p> <p>Learning activities: Familiarisation with course content; observation of web-based simulations and discussing ideas; instructional planning and design; and recording of reflections on learning experience.</p>	Instructional planning performance rating scale scores; Attitude toward instructional planning self-reporting scale scores; and discussion forums.	Significant improvement in instructional planning performance and rapid progression of web based course group compared to that of traditional course group.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
6.	Davis, Kvern, Donen, Andrews & Nixon (2000)	Canada	Assesses a problem based learning workshop using pre and post-test objective structured clinical examinations and standardised patients.	40 primary care physicians from urban and rural practice	Medical education	pre-test post-test	<p>Problem Based learning workshop consisting of: Case scenarios, group work and assessments on performance.</p> <p>Procedures: Addressing objectives through case scenarios by describing diagnosis and management of condition; demonstrating understanding of risk factors and prevention of condition; projection of skills and judgement required for effective use of investigations; and reviewing of current practice behaviours that result in improved health outcomes for patients; evaluative feedback from participants, patients and the station of practice.</p>	Pre and post-test objective structured clinical examination scores	Significant improvement in post-workshop scores indicating improved knowledge, skills, and judgement in managing osteoporosis; participant satisfaction with content, format of workshop and evaluation process.

							Learning activities: Counselling, application of skills for diagnosis and prevention, keeping a review chart.		
7.	Applin, Williams, Day & Buro (2011)	Canada	Compares competency levels between problem-based learning and non-problem based learning graduate nurses.	A convenience sample of 121 graduate nurses ($n= 64$ PBL, $n=57$ non- PBL) from a Canadian province.	Nursing Education	Survey post-test design	Problem Based learning program. (4years) Consisting of problem based scenarios, group work, evidence-based clinical practice and self-directed learning. Learning activities: small group discussions, dialogues and debates on nursing issues, use of research skills to collect and summarize information and application to nursing issues.	Survey questionnaires graduate competence scale scores	PBL and non-problem based learning programs both support entry to practice competencies. However, PBL significantly promotes development in self-directed learning and evidence based practice. Limitations: limited clinical practice hours.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
8.	Dyke, Jamrozik & Plant (2001)	Australia	Conducts a controlled trial of a traditional and problem - based learning method for teaching epidemiology.	A total of 136 ($n= 122$, PBL; $n= 14$, control group) random sample of second year medical students, both English and non-English speaking from the university of western Australia.	Medical Education	Quasi-experimental	Problem-based learning program consisting of weekly lectures, tutorial sessions and group work. Procedures: familiarization with learning objectives; definition of what is to be learned; research, synthesis and reporting of information; academic assessment; feedback from learners	Student examination and quiz scores; semi-quantitative feedback from students and interviews	No significant difference in examination and quiz scores. Students in PBL program reported better understanding of epidemiologic principles and enjoyed group work experience compared to the traditional program students. Limitations: PBL may present particular challenges for students whose first language is not the language of instruction.
9.	Mihalca, Salden, Corbalan, Paas & Midea (2011)	Not specified	Assesses the effectiveness and learner efficiency of cognitive-load based adaptive instruction compared to non-adaptive and learner control in genetics education.	A total of 201($n=66$, adaptive group; $n=65$, non-adaptive group; $n=70$, learner controlled group) randomly assigned male and female students	Genetics Education	Pre-test post-test	Cognitive-based adaptive instruction (2hours) Procedures: basic introduction to genetics concepts; pre-test before training phase; rating of mental effort before advancing to the next level of training; a post-test at the end of the training phase and	far-transfer test, post-test scores; students' mental effort scores;	The adaptive control instruction showed higher training performance scores compared to the non-adaptive and learner control experimental conditions. However, higher training effectiveness of adaptive control instruction is not reflected in superior

							a far-transfer test; Problem solving provided with a combination of five difficulty levels which include three support levels. Provisions for scaffolding provided at support levels and diminished with advancing stages of training.		post-test and far transfer performance scores. Limitations: The adaptive control instruction had limited training time.
10.	Shen, Chou, Hsiao, Lee & Chen (2011)	Taiwan	Evaluates the effects of implementing a cognitive-apprenticeship based entrepreneur education program.	A total of 40 graduate Participants in an entrepreneur education program	Business Education	single-case study	Cognitive apprenticeship model (20weeks) Procedures: Modelling-observation of mentors and use of multimedia supported simulations for familiarisation with operations; Scaffolding-guidance provided by entrepreneurs and mentors through sharing of experiences and how to create an entrepreneur plan ; coaching-participants worked closely with on-site mentors during	Student GPAs; Conventional course evaluations; feedback from supervisor-student sessions.	Enhancement of student research skills, increased appreciation of experience and outcome of nursing research and confidence to pursue further education. Limitations: Lack of balance between clinical experience and research.

							<p>work experience to learn important skills; articulation-students critically reflected on mentors, reviewers and fellow group members' opinions regarding creating plans; engaging in oral briefings to present final plans; exploration-reflection in which students demonstrated their knowledge and skill by running a micro-business in groups; giving an account of the learning experience through learning reports.</p> <p>Learning activities: Lectures and simulations of entrepreneurial operations through multimedia; group role-play; work experience under mentor supervision; networking, on-site forums to share ideas; evaluation of experience.</p>		
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	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
11.	Nichol & Bisset (2006)	England	Examines cognitive apprenticeship in teachers' professional development.	A total of 15 teacher trainees in a continuing professional development course	Teacher Education	single-case study	<p>Cognitive apprenticeship model (6 to 8 months)</p> <p>Procedures: Demonstration-observation of model expert practices; obstructed replay mental modelling-formation of mental models through critical, analytical and constructive dialogue; implementation-tutors provide support and monitor progress; reflection and action planning-reflection of experience and formation of action plan; fading and autonomy-provision of minimal support.</p> <p>Learning activities: Role-play, action research, presentations,</p>	Teachers' needs analyses; detailed teaching records; experience reports and evaluation; course evaluations; findings from interview sessions and observations.	Evidence of congruence between training team and teacher trainees contributed to increased teacher motivation and development of positive attitudes towards course. It enabled assimilation, accommodation and internalisation of teaching strategies.

							semi-independent practice, record keeping of learning experience and evaluation.		
12.	Newsletter (2006)	United States	Fostering integrative problem solving in biomedical engineering using Problem Based Learning.	A total of nearly 200 biomedical engineering students from second and third year from the Georgia institute of technology	Engineering Education	single-case study	<p>Problem based learning approach applied to a biomedical course that ran for 3 to 4 weeks.</p> <p>Procedures: Articulation and application of what is known from self-inquiry; generation of hypotheses, models and ideas; identification of new areas of research; reflection on the problem and application of solution to solve problem; self-evaluation, peer-evaluation and feedback from tutor.</p> <p>Learning activities: Research, group discussions, written and oral presentations, keeping of reflection notebook and concept maps</p>	<p>Inquiry notes; Post-problem self and peer evaluation; Student concept map scores; Written and oral presentation scores; Facilitator-student evaluation; Final written assessment scores.</p>	<p>PBL approach was found to encourage students' development of integrative thinking and problem solving skills; and highly motivating for the students.</p>

							as well as report writing.		
13.	Mantri, Dutt, Gupta & Chitkara (2009)	India	Use of Problem based learning to deliver a course in digital electronics.	A total of 69 second year ECE students randomly selected for the PBL and traditional groups from the Chitkara Institute of Engineering and Technology	Engineering Education	Quasi-experimental design	Problem based learning Procedures: familiarisation of technical nodes and objectives; understanding of scope, issues and concepts from open-ended technical problems; formulation of hypothesis, theories and solution; application, peer-evaluation and assessment	Knowledge test scores; skill test scores; Viva Voce examination scores; Attitude Survey Questionnaire responses	Results indicated that PBL brought about increased motivational levels, better knowledge acquisition and skills than the traditional lecture approach. PBL students had less confidence in performing well in exams, compared to the traditional group. Limitations: PBL classroom could not accommodate a larger group as it was costly.
14.	Pandy, Petrosino, Austic & Barr (2004)	United States	Assesses adaptive expertise in undergraduate biomechanics.	A total of 9 senior and junior undergraduate engineering students from the University of Texas	Engineering Education	Pre-test post-test experimental design	adaptive instructional design (3 hours) procedures: familiarisation with biomechanics concepts; generation of ideas by students through group discussions; scaffolding and feedback provided by experts in the field and advanced	Pre-test and post-test questionnaires scores on factual knowledge, conceptual knowledge and transfer.	Adaptive instruction group showed significant increase ($p=0.04$) in students' conceptual knowledge and increased ability to transfer knowledge to new situations with an effect size of 0.66 respectively.

							<p>graduate students through computer simulations; research and revision using web-delivered text-files; and formative assessment to test conceptual and transfer of knowledge.</p> <p>Learning activities: half hour lectures on an introduction to biomechanics concepts; a list of objectives; use of video clips to demonstrate the described concepts by experts; use of web-delivered interviews to explain procedures; mathematical exercises; and three challenges presented in increasing complexity; self-directed inquiry using a software shell.</p>		
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	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
15.	Malan, Ndlovu & Engelbrecht (2014)	South Africa	Examines the introduction of problem based learning into a foundation program for development of self-directed learning skills.	A total of 49 adult male and female students aged 17 to 22 from social-economic disadvantaged families and 3 educators in a science and mathematics foundation course at the Stellenbosch University.	Mathematics and Physical Science Education	single-case study	<p>Hybrid Problem based learning approach (1year)</p> <p>Procedures: encountering a problem; understanding of definitions and concepts; analysis of problem; organisation of ideas, identification of issues and research; application of information to problem; reflection and evaluative feedback</p> <p>Learning activities: Integrated lectures, presentations, group meetings and self- inquiry.</p>	<p>ILS questionnaire; student responses in semi-structured focus group interviews; participant experiences through empirical observations.</p>	<p>PBL promoted self-regulation, critical thinking skills and self-directed learning in students. Additional results indicated students' increased motivation to learn.</p> <p>Limitations: lack of sustainability as PBL was only introduced in the foundation year.</p>

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
16.	Uys, Gwele, McLnerney, Rhyn & Tanga (2004)	South Africa	Examines the competency levels of nursing graduates from problem based learning programs.	A total of 49 graduates were interviewed (40 from PBL programs, and 9 from conventional programs) from University of the Free State; University of Natal; University of the Witwatersrand; University of Transkei	Nursing Education	Not specified	Problem Based learning program. (4years) Procedures were not clearly stated. Learning activities: clinical practice included self-directed learning with minimal guidance and support from colleagues	graduate reports on levels of practice; Supervisors perceptions on PBL from interviews	Findings indicated higher levels of functioning, proficiency levels in PBL graduates compared to graduates from conventional programs. In terms of lower levels of functioning, there was no significant difference in the PBL and conventional groups.
17.	Hautala, Romu, Ramo & Vikberg (2011)	Korea	Explores the impact of extreme apprenticeship method in teaching university level mathematics.	A total of 609 ($n=361$ linear algebra and matrices I and $n=248$ linear algebra and matrices II) Mathematics and Statistics students from the University of Helsinki.	Mathematics and Statistics Education	pre-test post-test design	Cognitive apprenticeship Procedures: introduction of new concepts and notation to students; recall of previously learned concepts; creating relations between concepts; training of procedural and notation skills; reflection and articulation of what was learned; bi-directional feedback from	Post-course survey results; examinations	Findings indicate evidence of raised confidence levels in students; enhancement in metacognitive abilities and problem solving skills.

							<p>instructors. Provision of scaffolding by instructors which gradually faded with time.</p> <p>Learning activities: Structured problem tasks that were reflective; minimal lectures; followed by an exam and a post-course online survey for evaluation.</p>		
18.	Senocak, Taskesenligil & Sozbilir (2007)	Turkey	Examines the teaching of gases to prospective primary science teachers using problem based learning approach.	A total of 101 undergraduate chemistry students (PBL group $n=50$; control group $n=51$) from the University of Ataturk, Turkey.	Primary science Education	Pre-test post-test experimental design	<p>Problem based learning approach (4 lecture hours over a period of 4 weeks)</p> <p>Procedures: Introduction to problem case scenarios; Identification of learning issues and organisation according to specific questions; data collection, analysis, synthesis and definition of problem; data presentation and reporting; evaluative feedback and assessment</p>	<p>Gases Diagnostic Test scores; Chemistry Attitudes Scale; Peer Evaluation scale; Self Evaluation scale; Students'' Evaluation of PBL scale</p>	Results showed that PBL has a significant effect on the development of students'' skills such as self-directed learning, cooperative learning and critical thinking.

							Learning activities: Use of problem case scenarios, self-directed inquiry, group discussions, oral presentations and report writing.		
19.	Cheung, Hui, Zhang & Yiu (2003)	Hong Kong	Evaluates SmartTutor, an intelligent tutoring system in web-based adult education.	A random sample of 1300 adult learners (SmartTutor group $n=220$; control group $n=1080$) at the university of Hong Kong.	Professional and Continuing education	Case study design	Intelligent tutoring system (8 months) Procedures: Course manager-coordination of SmartTutor components; content structure-provision of visual presentation of overall structure of the course and learning material; student model-storage of individual student information (students' personal data, learning history, schedules and performance); question bank- use of past test papers and generation of examinations; expert model-selection and presentation of relevant material	Smart tutor evaluation survey Questionnaire;	Results indicate that Smart tutor was effective through stimulating recall of prior learning; providing learning guidance; eliciting performance and enhancing retention and transfer. Additionally students who had not used Smart tutor showed their interest in follow-up evaluations.

							<p>and generation of instruction for task completion; user interface- course registration, self-directed research; and was a platform for discussion forums and feedback</p> <p>Learning activities: familiarisation with core knowledge on a given topic; peer group/instructor discussion forums and self-inquiry; demonstration of learned material through problem solving; scaffolding through provided examples; revision through use of past tests; feedback on performance and guidance; evaluation through tests and examinations; overall course evaluation through online survey.</p>		
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	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
20.	Temel (2014)	Turkey	Determines the effects of problem based learning on pre-service teachers' critical thinking dispositions and perceptions of problem solving ability	A total of 49 first year pre-service teachers from the Department of Secondary Science and Mathematics Education, Hacettepe University, Ankara, Turkey. (PBL group $n=22$; control group $n=27$)	Teacher Education	pre-test post-test control group design	<p>Problem based learning (1 semester)</p> <p>Procedures: Introduction to the Problem based learning process; analysis of problem case scenarios and identification of key issues; data collection; group discussion and analysis of data; redefinition of problem and formulation of hypotheses after guidance from instructor; construction of solution; reflection on the problem solving procedure; report writing and presentation; post – test assessments.</p> <p>Learning activities: group discussions, self-directed inquiry with adequate guidance from the facilitator;</p>	California Critical Thinking Disposition inventory scores; Problem-Solving Inventory scores	Critical thinking dispositions of pre-service teachers in the PBL group were at a higher level than those in the control group; However no significant difference in superiority of PBL over the traditional method was evident. Additionally PBL was more influential in increasing perceptions of problem-solving abilities of the pre-service teachers than the traditional teaching method.

							report writing and group presentations.		
21.	Shipton (2009)	United States	Examines whether Problem based learning provides appropriate levels of guidance and flexibility for use in police recruit education.	A total of 27 police recruit participants in a PBL Instructor Development Course.	Police Recruit Education	single-case study	<p>Problem Based learning program.</p> <p>Procedures: familiarisation of group dynamics and roles; introduction to ill-structured problems; division of tasks within groups during problem-solving process; provision of adequate scaffolding from facilitators; provision for identification of errors and corrections; reflection on problem solving process; writing of reports and group presentation; self-evaluation, evaluative feedback from peers and facilitators.</p> <p>Learning activities: In-class mini-lectures, group discussions; use of documentaries for</p>	Results from empirical observations, assessment rubrics and reflective reports	PBL showed ability to improve functional knowledge, problem-solving abilities and self-directed learning skills

							modelling problem solving; journal writing to reflect on the problem solving process; research and group presentations.		
22.	Batt (2010)	United States	Examines cognitive coaching as a critical phase in professional development.	15 Elementary school teachers from 3 schools	Teacher Education	pre-test post-test design	<p>Cognitive apprenticeship model (1 year)</p> <p>Procedures: familiarisation with the Sheltered Instruction Observation Protocol; formation of goals related to SIOP; refining of instructional practice for implementation; application of coaching principles, implementation of framework and observations; reflection on teaching episodes; evaluation and extensive feedback by coaches</p> <p>Learning activities: long-term training workshops; semi-structured</p>	Knowledge test scores; surveys and interview responses	<p>Higher levels of implementation in teachers' practice in their classrooms after the post-coaching experience compared to levels during the pre-coaching which indicates that coaching had a significant effect in teachers' professional development.</p> <p>Limitations: time allocated to the coaching was short and there was lack of follow-ups on teachers' experiences after training.</p>

							conference interviews and discussions; evaluation surveys and knowledge tests; group meetings; teaching practice episodes and observations.		
23.	Swann, Andrews & Ecclestone (2011)	England	Evaluates the effects of a problem-based approach to developing teachers' assessment practice.	A total of 49 teacher participants from 10 adult education institutions.	Teacher Education	single-case study design	<p>Problem based learning approach consisting of 3 workshops on formative assessment (2 years)</p> <p>Procedures: Identification with learning objectives; identifying with the problem; presentation of defined problem through group discussions; development of formative assessment strategies; creation and adoption of practical solutions; review of effects of application of solution; reflection, reporting and presentation of findings; and evaluative feedback from peers and</p>	Individual interviews; results from questionnaires;	<p>PBL proved to be effective to some extent in teachers' adaptation of formative assessment.</p> <p>Limitations: training was limited to workshops which was short-term. No significant differences were evident at the onset.</p>

							<p>facilitators.</p> <p>Learning activities: Mini-lecture from workshop facilitators including a lecture video; group work and discussions; group report and presentations; interim summative assessments; feedback.</p>		
24.	Kong, Qin, Zhou, Mou & Gao (2014)	China, United States and Korea	Estimates the effectiveness of Problem based learning on the development of nursing students' critical thinking.	Nine articles representing eight randomized controlled trials with a pooled sample size of 985 participants With a mean age of 19.59 to 31.1 (PBL group $n=439$; Control group $n=546$)	Nursing Education	Meta-analysis included quasi-experimental design studies with control groups	<p>Problem based learning approach (1 to 2 semesters with a semester running from 14 to 18 weeks)</p> <p>Procedures: Introduction to the problem based learning approach; identification of learning goals; familiarisation with presented problem scenarios; engagement in self-study; collaborative discussions, application of ideas to solve problem, collective summary and assessments.</p>	Effect sizes of California Critical Thinking Dispositions Inventory, Bloom's taxonomy; and Watson-Glaser critical thinking appraisal, California Critical Thinking Skills Test.	Meta-analysis effect size (SMD = 0.33, 95%CI = 0.13–0.52, $P = 0.0009$) showed that PBL was able to improve nursing students' critical thinking compared to traditional lectures.

							Learning activities: Introductory in-class lectures, tutorial group work, use of ill-structured problem scenarios and self-inquiry.		
25.	Meyer, Summers & Moller (2001)	South Africa	Assessed the effect of a prescribing training intervention for primary health care nurses.	Nurses from 22 clinics that were randomly assigned (control group $n= 11$; Problem based learning experimental group $n= 11$)	Nursing Education	Pre-test post-test experimental study	Problem Based learning intervention with 1 month pre-evaluation and 3 month post-evaluation (over 6 months) Procedures: Defining the patient problem; specifying treatment objective; verifying suitability of choice of drug; writing a prescription; informing and instructing patient; and monitoring progress or stopping treatment Learning activities: Pre- evaluation and post-evaluation of prescribing practice;	Lancaster inventory of learning styles scores; Chi-squared test scores; Attrition rates; throughput rates	PBL curriculum had a significant impact in decreasing attrition rates and increasing throughput rates. Results indicate that students had increased versatility in learning styles.

							prescribing training workshop; and in-service clinical practice.		
26.	Bell & Kozlowski (2002)	USA	Examined the effects of adaptive guidance as a training strategy on enhancing self-regulation, knowledge and performance in technology-based training.	A total of 277 psychology undergraduate students both male (44%) and female (56%) with 86% aged between 18 and 21 from a mid-western university.	Social and Behavioural Sciences	Experimental design	<p>Adaptive guidance instruction (3 hours)</p> <p>Procedures: A brief demonstration of the simulation outlining its procedures and decision rules; provision of on-line instructional manual; familiarization with learning task in a one-minute trial; nine-study, practice and feedback cycles; demonstration of learned skills on a highly cognitive complex task; provision of guidance based on level of task performance; knowledge tests.</p>	Wonderlic personnel test scores; self-report scale scores; On-task cognition scale scores; Basic knowledge test scores	Adaptive guidance had substantial effects on the students' study, practice, self-regulation, knowledge acquired and performance compared to the learner control group.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
27.	McParland, Noble & Livingston (2004)	Britain	Evaluated the change from traditional to problem based learning methods in a psychiatry attachment.	A total of 379 consecutive cohorts of students ($n=188$ traditional psychiatry curriculum and $n= 191$ problem based learning) from second year at the London University college.	Medical Education	pre-test post-test design prospective study	<p>Problem based learning approach (8weeks)</p> <p>Procedures: Introduction to the problem through use of a video related to the theme; familiarisation of problem and source materials; individual and collaborative effort in management of presented problem; description of problem management process; evaluative feedback from peers and facilitators.</p> <p>Learning activities: Modules centered on a problem; group work and presentations; evaluative feedback from peers and facilitators; as well as assessments.</p>	Attitudes to psychiatry scale scores; Study Process Questionnaire findings; Students' performance in the examinations (MCQ test and Clinical viva examinations).	Significantly improved student performance in PBL curriculum compared to the traditional curriculum. There were no changes in student attitudes or learning styles towards psychiatry in both PBL and traditional curriculum.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
28.	Mudzielwana & Maphosa (2014)	South Africa	Explored trainee teachers' experiences of teaching practice by establishing the nature and extent of challenges encountered.	A total of 25 final year Bachelor of Education students.	Teacher Education	Qualitative case study design	<p>Cognitive apprenticeship model</p> <p>Procedures: Lectures provided prior to field practice; preparation of lesson plans; teaching practice; observations by peer, site supervisor and lecturer; scaffolding, evaluation and feedback provided by site supervisor and lecturer</p>	Reflections on teaching practice, open-ended Questionnaire	Findings indicated that teacher trainees experienced lack of confidence, fear of making mistakes during the onset of practice; however trainees acknowledged experiences of excitement and improvement in practice overtime.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
29.	Cook, Levinson, Garside, Dupras, Erwin & Montori (2008)	Not specified	Summarises effects of internet-based instruction on health professions learners compared to no-intervention and non-internet-based instruction.	A pooled sample size of 26 452 participants (physician postgraduates, physician practitioners, medical and nursing students; nurses in practice, dental students, pharmacy students; pharmacists in practice) took part in 201 studies that compared 214 internet-based and non-internet based instruction interventions.	Health Education	Included studies used Pre-test Post-test versus post-test designs	<p>Internet based instruction model (Intelligent tutoring system) with duration of ≥ 1 week</p> <p>Procedures: online diagnostic and therapeutic course content; system-based practice that allowed students to demonstrate knowledge and skills; tutorials provided for self-study; virtual patients; online discussions with peers and instructors for brainstorming and feedback purposes; tests and self-reports for evaluation purposes.</p>	Practice exercises; learner behavior and patient care evaluations;	<p>Internet based learning compared to no intervention had a consistent positive effect size compared to the no internet based groups. With significant effect sizes across outcomes.</p> <p>Satisfaction= 0.10(95%CI, -0.12 to 0.32), I²= 92.2%</p> <p>Knowledge= 0.12(95%CI, -0.003 to 0.24), I²= 88.1%</p> <p>Skills = 0.09(95%CI, -0.26 to 0.44), I²= 89.3%</p> <p>However, behaviours and effects on patient was not significant with 0.15(95%CI, -0.24 to 1.25), I²= 94.6%</p>

							Non-internet interventions- included paper modules; satellite mediated video-conferences; standardized patients and slide-tape self-study modules. No interventions-procedures included communication with patients; critical appraisal, administration of medication, and diagnostic measures.		
30.	Raja Hussein, Wan Mamat, Salleh, Mohd Saat & Harland (2007)	Malaysia, Indonesia & Philippines	Examines problem-based learning in Asian Universities.	A total of 44 students and tutors from university of Malaya, Bandung institute of technology and university of Philippines.	Instructional Education	Case study	Problem based learning program.	Tutor and student interviews, field notes and non-participant observation videos.	PBL provided evidence of development of useful knowledge and lifelong skills. Limitations: Limited evidence of critical engagement between students and tutors due to cultural inappropriateness of challenging tutor authority.

	Author and Year	Country	Purpose	Participants and Setting	Field of study	Design	Instruction	Dependent Variable(s)	Outcome
31.	Burch, Sikakana, yeld, Seggie & Schmidt (2007)	South Africa	Examines the performance of academically at-risk medical students in a PBL programme.	239 academically at-risk medical students from the traditional program and 43 academically at-risk students from the PBL program at the university of Cape town.	Medical education	Pre-test post-test design	Problem Based learning program.	Student retention rates, dropout rates, entrants examination scores and fourth year examination scores.	At-risk students in PBL program performed significantly better compared to ADP students in equivalent year of study demonstrating superior performance.

Findings in table 4.1 show that diverse ethnic backgrounds were represented: six studies were conducted in the United States; six studies in South Africa; three studies in Canada; while in Taiwan, England and Turkey two studies were conducted in each country. A systematic review which was part of the included studies had used studies from China, United States and Korea; while one study was conducted each in Thailand, Nigeria, Australia, India, Korea, Hong Kong and Britain. A pooled sample size of over 32,033 male and female adult learners and practitioners took part in the included studies. Studies focused on various cognitive-based models of instruction including problem based learning, cognitive apprenticeship, adaptive instruction and intelligent tutoring systems. Various disciplines were represented in the included studies: medical education and nursing education appeared to be the most dominant followed by teacher education; others included engineering, mathematics and physical sciences; professional and continuing education; social and behavioral sciences; industrial ecology and environment; as well as industrial and technology education. The majority of the included studies used an experimental, pre-test post-test design; with 35% using a case study design; while 6% of the studies were unclear concerning the study design used.

4.2.2 Models of instruction and their characteristics

Various models of instruction were represented in the findings. The models include: problem based learning, cognitive apprenticeship, adaptive instruction, and intelligent tutoring systems. A narrative of the instructional models is given with each study presented individually in the following subsections.

4.2.2.1 Problem based learning

Out of 31 studies, 58% of the included studies focused on problem based learning as an instructional model. Problem Based learning is presented as the most commonly used model of instruction in adult learning across disciplines. It is known to have originated from McMasters University in Canada with medical educators in 1970 (Hung, Jonassen & Liu, 2008). This instructional model engages higher order thinking skills in solving authentic problems by arriving at solutions through the generation and testing of hypotheses (Savin-Baden & Major, 2004; Wood, 2003). Therefore, it allows students to practice self-directed learning; is problem-centered and allows the instructor to make use of cognitive tools to aid learning and assess learners' acquisition of knowledge.

Tsou, Cho, Lin, Sy, Yang, Chou and Chiang (2009) investigated the short-term outcome of a problem-based learning curriculum in comparison to traditional lecture based curricula on a cohort of 236 male and female Taiwanese medical students. The curriculum consisted of system-based units, case-based tutorial sessions, assessment and early clinical exposure of which involved lectures, resource learning, laboratory exercises and clinical skills teaching. Tutorial sessions followed a 7-jump model procedure that involved: identifying facts/problems; generating hypotheses; listing need to know; formulating, organizing and prioritizing learning issues/objectives; data searching and self-directed learning; sharing of knowledge; reorganizing patients' problems; evaluation of the individual, group and overall learning experience as well as providing feedback on tutor's role in the learning experience. Outcomes were measured using Self-Directed Learning Readiness Scale (SDLRS); semi-structured qualitative interviews; and the pass rates of students in Taiwan Medical Licensure Examinations. The outcome showed that students were motivated to learn; developed better critical thinking ability; significant changes in self-directed learning abilities; and improved ability in data collection, analysis, summary and understanding compared to those from lecture-based curriculum. However, students indicated that problem based learning had limited depth and breadth in clinical medicine. Duration of the problem-

based learning curriculum was 3years with a follow-up after 4years of the implementation of program. The problem based learning experience showed evidence of a balance between learner control and system-control.

In a study by **Charmondusit and Charmondusit (2012)** problem based learning was applied to a training program of industrial, ecology and environment of which 14 participants, male and female from 9 underdeveloped and developed countries in Asia took part. The program which consisted of in-class learning, field study and group discussions ran for 3 and half weeks. Participants engaged in activities including lectures, laboratory practice, research, field site study, as well as analysis and synthesis of results in group discussions. The procedures taken in executing the tasks included: demonstration of problem-solving skills to acquire knowledge through completion of a problem assignment; the understanding and application of concepts; self-assessment through use of reflective journals; writing of reports and presentations; and feedback from participants. Outcomes were measured using questionnaire and evaluation forms that focused on lecturer's ability to deliver; participants' evaluation of field trip and overall quality of training program. A reported finding showed participants agreed or strongly agreed that problem based learning enhances transdisciplinarity between academics and practitioners, self-regulated learning and collaboration. However training time period was limited.

In a South African study by **Burch, Sikakana, yeld, Seggie and Schmidt (2007)**, the performance of 239 male and female, academically-at-risk medical students in a Problem-based learning program was examined in comparison to those in a traditional program. The program consisted of lectures, laboratory practical sessions, small group tutorials and limited clinical practice during clinical skills training which ran for 30 months. The program also followed a 7-jump model procedure familiar in medical education which included: identifying facts/problems; generating hypotheses; listing need to know; formulating, organizing and prioritizing learning issues/objectives; data searching and self-directed learning; sharing of knowledge; reorganizing patients' problems; and evaluative feedback on the individual, group and overall learning experience. Outcome measures included use of student retention rates, dropout rates, entrants' examination scores and fourth year examination scores. Reported outcomes indicated that at-risk students in the problem based learning program performed significantly better compared to students from the control group in equivalent year of study demonstrating superior performance.

Davis, Kvern, Donen, Andrews and Nixon (2000) evaluated a problem-based learning workshop in which 40 Canadian medical professional participants took part in. The workshop consisted of case scenarios, group work and assessments on performance which included activities such as counselling, application of skills for diagnosis and prevention, keeping a review chart. Based on the needs assessment of participants, the procedures involved: addressing objectives through case scenarios by describing diagnosis and management of condition; demonstrating understanding of risk factors and prevention of condition; projection of skills and judgement required for effective use of investigations; and reviewing of current practice behaviours that result in improved health outcomes for patients; as well as evaluative feedback from participants, patients and the station of practice. Outcome measures reported use of pre and post-test objective structured clinical examinations. Reported results indicated that there was significant improvement in post-workshop scores indicating improved knowledge, skills, and judgement in managing osteoporosis. Participants showed satisfaction with content, format of workshop and evaluation process.

Another study by **Applin, Williams, Day and Buro (2011)** compared competency levels between 64 Canadian graduate nurses from problem-based learning and 57 from non-problem based learning programs. Graduates responses indicated that the problem-based program consisted of problem based scenarios, group work, evidence-based clinical practice and self-directed learning through research. Laboratory experience was not identified as a factor contributing to competency. Activities reported included: small group discussions, dialogues and debates on nursing issues, use of research skills to collect and summarize information and application to nursing issues. Reported outcomes indicated that problem based learning and non- problem based learning programs both supported entry to practice competencies. However, problem based learning significantly promoted development in self-directed learning and evidence based practice. Outcome measures included survey questionnaires graduate competence scale scores. Reports indicated that clinical practice hours were limited. The nursing program ran for 4 years.

A study conducted by **Hussein, Mamat, Salleh, Saat and Harland (2007)** examined problem based learning in three Asian universities whereby 33 adult learners and 11 tutors took part. Reports from students and tutors indicated that problem based learning program largely consisted of tutorial sessions, group work, self-directed learning through research and presentations, although in one University lectures were a part of the Problem Based learning program. Students reported the following procedures as key in their learning experiences:

identification of learning needs and goals; presentation of ideas and findings; peer evaluation and feedback from tutors. Tutor and student interviews, field notes and non-participant observation videos were used as outcome measures. Reported outcomes indicated that problem based learning provided evidence of development of useful knowledge and lifelong skills. However, there was limited evidence of critical engagement between students and tutors due to cultural inappropriateness of challenging tutor authority. The tutorial sessions were more tutor-controlled than learner-controlled.

In the same light, **Dyke, Jamrozik and Plant (2001)** conducted a controlled trial of a problem based learning and traditional method of teaching epistemology in an Australian University of which a total of 136 randomly selected undergraduate medical students participated. Of the 136 students 122 were in the problem based learning group; while the remaining students were in the traditional program which was the comparison group. The problem based learning approach consisted of weekly lectures and tutorial sessions in which students worked in groups. During the tutorial sessions, students had to demonstrate problem-solving skills when provided with four problems. Learning procedures involved familiarization with learning objectives; definition of what is to be learned; research, synthesis and reporting of information. This was followed by academic assessment and feedback from learners about learning experience. Student examination and quiz scores; semi-quantitative feedback from students and interviews were used as outcome measures. Additionally reported outcomes indicated that there was no significant difference in examination and quiz scores. Students in the problem based program reported better understanding of epidemiologic principles and enjoyed group work experience compared to the traditional program students. However, it was reported that problem based learning may have presented particular challenges for students whose first language was not the language of instruction.

A study by **Newsletter (2006)** reported on fostering of problem solving skills in a biomedical engineering course in which over 200 second and third year students from the Georgia institute of technology participated in. The program adapted a problem based learning approach which largely consisted of tutorial group sessions and self-directed inquiry which involved use of problem-scenarios. Activities involved research, group discussions, written and oral presentations, keeping of reflection notebook and concept maps as well as report writing. Procedures followed throughout the learning process involved: articulation and application of what is known from self-inquiry; generation of hypotheses, models and ideas; identification of new areas of research; reflection on the problem and application of

solution to solve problem; self-evaluation, peer-evaluation and feedback from tutor. Inquiry notes, post-problem self and peer evaluation; student concept map scores; written and oral presentation scores; facilitator-student evaluation; and final written assessment scores were used as outcome measures. Reported findings indicated that the problem based learning approach was found to encourage students' development of integrative thinking and problem solving skills; and also highly motivating for the students. The course that ran for 3 to 4 weeks was reported to be mostly learner-controlled.

Mantri, Dutt, Gupta and Chitkara (2009) also investigated the use of problem based learning in delivering a digital electronics course at the Chitkara Institute of Engineering and Technology in India. A total of 69 second year students randomly selected for the problem based learning and traditional groups participated. The learning environment was reported to encourage effective learning as the classroom had in-built library, supported internet use, simulation software and use of laboratory equipment. The course consisted of structured lectures when needed, laboratory experiments, group work and presentations. The procedures involved: familiarisation of technical nodes and objectives; understanding of scope, issues and concepts from open-ended technical problems; formulation of hypothesis, theories and solution; application, peer-evaluation and assessment. Knowledge test scores; skill test scores; Viva Voce examination scores; Attitude Survey Questionnaire responses were used as outcome measures. Reported findings indicate that problem based learning brought about increased motivational levels, better knowledge acquisition and skills than the traditional lecture approach. Furthermore, students had less confidence in performing well in exams, compared to the traditional group. Findings also indicated that the classroom could not accommodate a larger group as it was costly. The program presented a balance between learner-control and control by facilitator.

In a South African study **Malan, Ndlovu and Engelbrecht (2014)** examined the introduction of problem based learning into a science and mathematics foundation program at the University of Stellenbosch for development of self-directed learning skills. A total of 49 male and female, science and mathematics undergraduate students of an age range of 17 to 22 and 3 educators took part in the study. The program consisted of integrated lectures, presentations, self- inquiry and group meetings. A 7-jump model procedure adapted in the learning process included: encountering a problem; understanding of definitions and concepts; analysis of problem; organisation of ideas, identification of issues and research; application of information to problem; reflection of what was learned; and evaluative feedback. Learning outcome measures included ILS questionnaire; student responses in semi-

structured focus group interviews; and participant experiences through empirical observations. Reports indicated that problem based learning promoted self-regulation, critical thinking skills and self-directed learning in students. Additional results indicated students' increased motivation to learn. However, a lack of sustainability was reported as problem based learning was only introduced in the foundation year. There was also evidence of balance between learner –control and that of the instructors.

Additionally in another South African study by **Uys, Gwele, McLnerney, Rhyn and Tanga (2004)**, the competency of nursing graduates from problem based learning programs was evaluated in comparison to those in conventional programs. Student responses indicated that problem based learning programs in nursing capitalised on clinical practice with less focus on teaching and management. Procedures followed in training were not clearly stated. However, respondents' descriptions of clinical practice included self-directed learning with minimal guidance and support from colleagues. Graduate reports on levels of practice and supervisors' perceptions on problem based learning from interviews were used as outcome measures. Reports indicated that there were higher levels of functioning and proficiency levels in problem based learning graduates compared to graduates from conventional programs. In terms of lower levels of functioning, there was no significant difference in the problem based learning and conventional groups. The nursing program ran for 4 years with the senior years based on clinical practice. The learning experience proved to be mostly learner-controlled.

A study by **Senocak, Taskesenligil and Sozbilir (2007)** examined the use of problem based learning approach in the teaching of gases to prospective science teachers. A total of 101 undergraduate chemistry students, 50 from the Problem based learning group and 51 from the control group at the University of Ataturk, Turkey participated in the study. While the control group were taught using conventional methods that mainly focused on lectures, including in-class learning and problem solving; the problem based learning group engaged in use of problem case scenarios, self-directed inquiry, group discussions, oral presentations and report writing. The problem case scenarios were designed in a way that resembled real world situations with illustrations that were appealing to students. The procedures included students being introduced to the problem case scenarios; Identification of learning issues and organisation according to specific questions; data collection, analysis, synthesis and definition of problem; data presentation and reporting; evaluative feedback and assessment. Gases Diagnostic Test scores, Chemistry Attitudes Scale, Peer Evaluation scale, Self Evaluation scale, and Students' Evaluation of problem based learning scale were used as

learning outcome measures. Reported findings showed that problem based learning had a significant effect on the development of students' skills such as self-directed learning, cooperative learning and critical thinking. The course was reported to have run for 4 lecture hours per week over a period of 4 weeks.

Similarly, another study by **Temel (2014)** conducted in Turkey at the University of Hacettepe, determined the effects of problem based learning on the perceptions of problem solving and critical thinking dispositions of pre-service teachers. A sample of 49 science and mathematics undergraduate pre-service teachers, 22 randomly assigned to the problem based learning group and 27 to the control group. The problem based learning group engaged in group discussions, self-directed inquiry with adequate guidance from the facilitator; report writing and group presentations. The approach was applied in stages and procedures followed included: an introduction to the Problem based learning process; analysis of the problem case scenarios and identification of key issues; data collection related to key issues; group discussion and analysis of data; redefinition of problem and formulation of hypotheses after guidance from instructor; construction of solution; reflection on the problem solving procedure; report writing and presentation; and post –test assessments. California Critical Thinking Disposition inventory scores and Problem-Solving Inventory scores were used as outcome measures. Reported findings indicate that critical thinking dispositions of pre-service teachers in the problem based learning group were at a higher level than those in the control group. However, no significant difference in superiority of problem based learning over the traditional method was evident. Additionally PBL was more influential in increasing perceptions of problem-solving abilities of the pre-service teachers than the traditional teaching method. Unlike the problem based learning approach, the conventional method consisted of subject-based direct explanations as well as question-answer techniques in the presentation of topics. The true experiment was reported to have been run within a semester of the program.

A study by **Shipton (2009)** conducted in the United States examined the provision of appropriate levels of guidance and flexibility in the use of problem based learning for police recruit education in an instructor development course. A total of 27 participants took part in the study. The program consisted of in-class mini-lectures, group discussions; use of documentaries for modelling problem solving; journal writing to reflect on the problem solving process; research and group presentations. Major procedures reported included: familiarisation of group dynamics and roles; introduction to ill-structured problems; division

of tasks within groups during problem-solving process; provision of adequate scaffolding from facilitators to promote learning; provision for identification of errors and corrections; reflection on problem solving process; writing of reports and group presentation; self-evaluation, evaluative feedback from peers and facilitators. The outcome measures included results from empirical observations, assessment rubrics and reflective reports. Reported findings indicate that problem based learning showed ability to improve functional knowledge, problem-solving abilities and self-directed learning skills. The study reported a balance in learner- control and facilitator-control.

In a study by **Swann, Andrews and Ecclestone (2011)** the effects of a problem-based approach to developing teachers' assessment practice was evaluated. A total of 49 teacher participants from 10 adult education institutions took part in the study. The problem based learning project consisted of 3 workshops on formative assessment that each ran for 4 to 6 hours within a period of 2 years. The workshops included mini-lecture presentations from workshop facilitators including a lecture video; group work and discussions; group report and presentations; interim summative assessments with feedback. Major procedures involved: teachers' identification with learning objectives; identifying with the problem; presentation of defined problem through group discussions; development of formative assessment strategies; creation and adoption of practical solutions; review of effects of application of solution; reflection, reporting and presentation of findings; and evaluative feedback from peers and facilitators. Individual interviews and results from questionnaires were used as outcome measures. Reported findings indicate that problem based learning proved to be effective to some extent in teachers' adaptation of formative assessment. However, training was limited to workshops; which was short-term. No significant differences were evident at the onset of instructional application. The project exhibited a balance between learner- control and facilitator- control.

A systematic review and meta-analysis by **Kong, Qin, Zhou, Mou and Gao (2014)** estimated the effectiveness of problem based learning on the development of nursing students critical thinking and abilities. Nine studies conducted in Korea, United States, Turkey and China were included for review with a pooled sample size of 985 participants, 439 in the problem based learning group and 546 in the control group. Participants were undergraduates; male and female with a mean age range of 19.59 to 31.1 respectively. The summary of reviewed studies presented the following as learning activities of the problem based learning interventions: introductory in-class lectures, tutorial group work, use of ill-

structured problem scenarios and self-inquiry. Furthermore, the presented procedures included: introduction to the problem based learning approach; identification of learning goals; familiarisation with presented problem scenarios; engagement in self-study; collaborative discussions, application of ideas to solve problem, collective summary and assessments. Effect sizes of California Critical Thinking Dispositions Inventory; Bloom's taxonomy; Watson-Glaser critical thinking appraisal, and California Critical Thinking Skills Test were used as outcome measures in the study. Meta-analysis effect size of $SMD = 0.33$, $95\%CI = 0.13-0.52$, $P = 0.0009$ showed that problem based learning was able to improve nursing students' critical thinking compared to traditional lectures. The control group mainly capitalised on the traditional in-class lecture based method of instruction. The duration of the problem based learning interventions were reported to range from 1 to 2 semesters, with a semester lasting from 14weeks to 18weeks.

In another South African study **Meyer, Summers and Moller (2001)** assessed the effect of a prescribing training intervention that used problem based learning approach for primary health care nurses. A total of 24 clinics were randomly assigned; however 22 clinics were the final sample of which 11 were assigned to the experimental group and 11 to the control group. Nurses from these clinics took part in the prescribing training intervention; with the experimental group engaging in a 4-day effective workshop. The intervention consisted of pre- evaluation and post-evaluation of prescribing practice; prescribing training workshop; and in-service clinical practice. The procedures followed in training of prescribers included: defining the patient problem; specifying treatment objective; verifying suitability of choice of drug; writing a prescription; informing and instructing patient; and monitoring progress or stopping treatment. Lancaster inventory of learning styles scores, Chi-squared test scores, attrition rates, throughput rates were used as outcome measures. Reported findings indicate that problem based learning curriculum had a significant impact in decreasing attrition rates and increasing throughput rates. Students also had increased versatility in learning styles. The intervention was conducted for 6 months with pre-evaluation conducted 1 month prior to training and post evaluation 3 months after training.

Finally in a British study by **McParland, Noble and Livingston (2004)** the effectiveness of problem based learning was evaluated in comparison to traditional teaching in a psychiatry attachment. A total of 379 consecutive cohorts of undergraduate students took part in the study; of which 191 participated in the problem based learning curriculum while 188 participated in the traditional teaching. The problem based learning curriculum consisted

of: 12 days of formal teaching which included modules centered on a problem; group work and presentations; evaluative feedback from peers and facilitators; and assessments. Procedures reported to have been followed included: Introduction to the problem through use of a video related to the theme; familiarisation of problem and source materials; individual and collaborative effort in management of presented problem; description of problem management process; and evaluative feedback from peers and facilitators. Attitudes to Psychiatry Scale scores, Study Process Questionnaire findings and students' performance in the examinations (MCQ test and clinical viva examinations) were used as outcome measures. Findings indicated significantly improved student performance in the problem based learning curriculum compared to the traditional curriculum. There were no changes in student attitudes or learning styles towards psychiatry in the problem based learning and traditional curriculum. The duration of the attachment lasted 8 weeks respectively.

4.2.2.2 Cognitive apprenticeship

Another instructional model represented by 26% of the included studies in this review was cognitive apprenticeship. This model of instruction maximises on learning through the guidance of an expert to a learner with exposure to the complexities of the real world (Dennen & Burner, 2008; Dennen, 2004, Ghefailli, 2003). An example is a study by **Idris (2012)** that focused on the effects of a cognitive apprenticeship instructional method on auto-mechanics students in comparison to those of the traditional lecture based instruction. A total of 212 undergraduate students from six technical colleges in Nigeria participated in the study. The cognitive apprenticeship approach was reported to consist of the following components in the presented sequence: modelling, scaffolding, coaching, articulation and finally exploration. The components were applied in the process of learning the brake system, lubricating system, cooling system, fuel system and drive train of an automobile. Outcomes were measured using cognitive apprenticeship instructional lesson plans, traditional lesson plans and an auto-mechanics achievement test (AMAT). The reported results showed that cognitive apprenticeship seemed to lead to higher academic achievement, increase in self-confidence and self-reliance, as well as improvement in learning skills and performance; with higher mean post-test AMAT scores compared to those taught using the conventional lecture method. Duration of the intervention was not reported.

In another study by **Dickey (2008)** the integration of a cognitive apprenticeship model in a web-based educational technology course for P-12 teachers was investigated. A total of

63 undergraduate and graduate students with varying skill levels from 11 different teacher education licensure programs participated in the study. The web-based course consisted of 5 thematic modules which include: learning theories, communication tools, presentation tools, productivity tools and web tools. The cognitive apprenticeship methods applied in the learning process included: modelling in which students were provided with a variety of models and exemplars of lesson plans as well as educational media; scaffolding which was provided through response of email requests for assistance that gradually faded overtime; coaching in which tools such as emails, instant messenger and weblogs were used to engage in dialogue between instructors, peers and students to provide guidance and prompt learning in specific areas; finally articulation and reflection or exploration which was provided by allowing students to critically analyse resource materials and use the weblogs to express their ideas as well as reflect on the learning process. Major activities that students engaged in included: familiarisation of problem solving and troubleshooting strategies through analysing resource materials; application of knowledge and skills learned from previous modules to new challenges; demonstration of skills through an assignment in creating and uploading a WebQuest page; summative reflections, and course evaluation. Field notes, observation notes of web postings, student questionnaires, students' work and interviews on learning experiences and development of technology skills were used as outcome measures. Outcomes reported indicated that modelling, coaching and exploration were found to foster skill development and understanding of technology integration through the student reflections and teacher- student interactions. The intervention was conducted within 1 semester.

Similarly, a study by **Liu (2005)** examined whether a course based on a web-based cognitive apprenticeship model benefited pre-service teachers' learning of instructional planning and was compared to the traditional course. A total of 28 participants consisting of 4 experts and 24 students from an elementary education department of a teachers' college in Taiwan took part in the study. The course supported use of web-based multimedia to simulate cognitive modelling of instructional planning; and web-based conferencing which supported discussion forums, and reflections of pre-service teachers. The procedures involved: modelling-observing, scaffolding-practicing, and guiding-generalizing. Pre-service teachers engaged in activities such as: familiarisation with course content; observation of web-based simulations and discussing ideas; instructional planning and design; and recording of reflections on learning experience. Outcomes were measured using Instructional Planning Performance Rating Scale scores; Attitude toward Instructional Planning Self-Reporting Scale scores; and discussion forums. The reported results showed that there was significant

improvement in instructional planning performance and rapid progression of web based course group compared to that of traditional course group. The course was conducted for 7 weeks respectively.

Shen, Chou, Hsiao, Lee and Chen (2011) evaluated the effects of implementing an entrepreneur education program that used a cognitive apprenticeship approach on 40 graduate participants. The program consisted of: lectures and simulations of entrepreneurial operations through multimedia; group role-play; work experience under mentor supervision; networking and on-site forums to share ideas; as well as evaluation of learning experience. The program components included: modelling in which students observed mentors and multimedia supported simulations in order to be familiar with the operations; Scaffolding that captured the guidance provided by entrepreneurs and mentors through sharing of experiences and how to create an entrepreneur plan to participants; coaching that allowed participants to work closely with on-site mentors during the work experience in order to learn important skills; articulation in which students critically reflected on mentors, reviewers and fellow group members' opinions regarding creating plans and engaged in oral briefings to present their final plans; finally exploration and reflection in which students demonstrated their knowledge and skill through running a micro-business in groups as well as giving an account of the learning experience through learning reports. Outcome measures included student GPAs; conventional course evaluations; and feedback from supervisor-student sessions. The reported findings indicated that there was enhancement of student research skills, increased appreciation of experience and outcome of nursing research; and confidence to pursue further education. Although there was a lack of balance between clinical experience and research. The program was conducted in 1 semester (20 weeks) respectively.

Additionally a study by **Nichol and Turner-Bisset (2006)** examined cognitive apprenticeship in teachers' professional development in a continuing professional development course. A sample population of 15 teachers from a group of 400 were closely observed. The course was conducted from 6 to 8 months and delivered in 5 phases which included: *demonstration* in which teachers observed model expert practices in demonstration classes, through videos and recorded key practical features; *abstracted replay-mental modelling* which allowed teachers to form their own mental models of practice through engaging in critical, analytical and constructive dialogue concerning the main expert practices with their tutor; *implementation* in which tutors worked closely with teachers (coaching) through providing adequate support and monitoring (scaffolding) as they applied their prior knowledge, and what had been learned in teaching a lesson; *reflection and action planning*

where by teachers reflect on the learning experience draw their own action plan; and *fading and autonomy* in which the support from the tutor becomes minimal as teachers apply knowledge and skills in their teaching practice. Learning activities included: role-play, action research, presentations, semi-independent practice, record keeping of learning experience and evaluation. Teachers' needs analyses; detailed teaching records; experience reports; course evaluations; findings from interview sessions and observations were used as outcome measures. Reported findings indicated that there was evidence of congruence between training team and teacher trainees that contributed to increased teacher motivation and development of positive attitudes towards course. It enabled assimilation, accommodation and internalisation of teaching strategies. The study reported a balance in learner-control and facilitator-control.

Another study by **Hautala, Romu, Ramo and Vikberg, (2011)** explored the impact of extreme apprenticeship in teaching mathematics at the University level. A sample population of 609 undergraduate students, 361 from the linear algebra and matrices I course and 248 from the linear algebra and matrices II course at the University of Helsinki in Korea took part in the study. This particular cohort was compared to previous cohorts who used the traditional lecture based and take-home task approaches in learning. The courses followed a cognitive apprenticeship model of instruction which was referred to as extreme apprenticeship. The extreme apprenticeship approach was based on completion of tasks with constant supervision from instructors. Procedures involved: introduction of new concepts and notation to students; recall of previously learned concepts; creating relations between concepts; training of procedural and notation skills; reflection and articulation of what was learned; as well as bi-directional feedback from instructors. Instructors also provided scaffolding which gradually faded with time. The course largely consisted of structured problem tasks that were reflective; minimal lectures if needed; followed by an exam and a post-course online survey for evaluation. Examinations scores and post-course online survey responses were used as outcome measures. Findings indicated evidence of raised confidence levels in students; enhancement in metacognitive abilities and problem solving skills. The duration of the course was not clearly stated.

An additional study by **Batt (2010)** examined cognitive coaching as a critical phase in professional development. The sample population consisted of 15 teachers from 3 elementary schools out of a total of 55 who participated in sheltered instruction observation protocol training. The intervention was conducted in phases which were pre-coaching, cognitive-coaching and post-coaching phase respectively. Activities included long-term training

workshops conducted over a year; semi-structured conference interviews and discussions; evaluation surveys and knowledge tests; group team meetings; teaching practice episodes and observations. Procedures included: familiarisation with the Sheltered Instruction Observation Protocol; formation of goals related to SIOP; refining of instructional practice for implementation; application of coaching principles, implementation of framework and observations; reflection on teaching episodes; evaluation and extensive feedback by coaches. The coaching was reported to have been conducted in the teachers' school sites. Outcomes were measured using knowledge test scores, surveys and interview responses. Reported findings indicate that there were higher levels of implementation in teachers' practice in their classrooms after the post-coaching experience compared to levels during the pre-coaching; which indicates that coaching had a significant effect in teachers' professional development. However, time allocated to the coaching was short and there was lack of follow-ups on teachers' experiences after training.

Mudzielwana and Maphosa (2014) also conducted a study in South Africa that explored trainee teachers' experiences of teaching practice by establishing the nature and extent of challenges encountered. Participants included 25 final-year Bachelor of Education students on teaching practice. Procedures involved: lectures provided prior to field practice; preparation of lesson plans; teaching practice; observations by peer, site supervisor and lecturer; scaffolding, evaluation and feedback provided by site supervisor and lecturer. Reflective reports by trainee teachers were used for over-all evaluation through open-ended questionnaires. Trainees' reflections on teaching practice and open-ended questionnaire responses served as outcome measures. Findings indicated that teacher trainees experienced lack of confidence, fear of making mistakes during the onset of practice; however trainees acknowledged experiences of excitement and improvement in practice overtime. Duration for the teaching practice was not verified.

4.2.2.3 Adaptive instruction

Presented data indicate that of the total included studies, 10% focused on adaptive instruction. This form of instruction capitalizes on the accommodation of individual differences allowing learners to acquire knowledge within their specific times (Park & Lee, 2003). A study by **Mihalca, Salden, Corbalan, Paas and Midea (2011)** assessed the effectiveness of cognitive-load based adaptive instruction and the importance of prior knowledge. A sample population of 201 male and female students (consisting of 74 high

school biology students; 86 first year and 41 second year psychology college students) randomly assigned to groups took part in the study. The experimental group ($n=66$) was compared to non-adaptive ($n=65$) and learner-controlled instruction groups ($n=70$). The learning environment consisted of a web-based application in which students' performance, mental effort scores, choice of problem and time spent on a task was recorded. Procedures consisted of: a basic introduction to genetics concepts; pre-test before training phase; rating of mental effort before advancing to the next level of training; a post-test at the end of the training phase and a far-transfer test. Learning tasks involved solving problems presented with a combination of five difficulty levels in which three support levels were included. Scaffolding was provided at these support levels and diminished with the advancing stages of training. Results indicated that the adaptive control instruction showed higher training performance scores compared to the non-adaptive and learner control experimental conditions. However, higher training effectiveness of adaptive control instruction was not reflected in superior post-test and far transfer performance scores. In addition the adaptive control instruction was reported to have had limited training time. The experiment was conducted in two hours.

Similarly a study by **Pandy, Petrosino, Austic and Barr (2004)** assessed adaptive expertise in an undergraduate biomechanics module. A sample population of 25 undergraduate engineering students from the University of Texas were randomly assigned to experimental and control groups. The How People Learn (HPL) approach based on adaptive instructional design was used in delivering the module to the experimental group. The control group followed a traditional lecture-based instruction with provided examples in a classroom setting which consisted of 2 class periods both 1.5 hours long. The multimedia-based module consisted of: a half hour lecture on an introduction to biomechanics concepts; a list of objectives explaining what was to be learned and achieved upon completion; use of video clips to demonstrate the described concepts by experts; use of web-delivered interviews to explain procedures; mathematical exercises; and three challenges presented in increasing complexity that engaged students in self-directed inquiry using a software shell designed for research purposes. Learning procedures involved: students familiarising themselves with biomechanics concepts that would aid in tackling the presented challenges; generation of ideas by students through group discussions; scaffolding and feedback provided by experts in the field and advanced graduate students through computer simulations; research and revision using web-delivered text-files; and formative assessment to test conceptual and transfer of knowledge to new challenges. Pre-test and

post-test questionnaires scores on factual knowledge, conceptual knowledge and transfer were used as outcome measures. The findings indicated that the adaptive instruction group showed significant increase ($p=0.04$) in students' conceptual knowledge and increased ability to transfer knowledge to new situations with an effect size of 0.66 respectively. The learning environment exhibited a balance between learner-centered and system-control. The duration of the experiment lasted 3 hours respectively.

In addition another study by **Bell and Kozlowski (2002)** examined the effects of adaptive guidance instruction on enhancing self-regulation, knowledge and performance in a technology-based learning environment. The sample population consisted of 277 male (44%) and female (56%) undergraduate psychology major students from a mid-western University in the United States. Majority of the participants (86%) were between the ages 18 and 21. Participants were randomly assigned to the adaptive guidance group and control groups. The learning environment made use of a computer-based radar-tracking simulation system that engaged the students in the following procedures: a brief demonstration of the simulation outlining its procedures and decision rules; provision of an on-line instructional manual; familiarization with learning task in a one-minute trial; nine-study, practice and feedback cycles; demonstration of learned skills on a highly cognitive complex task; provision of guidance based on level of task performance; as well as knowledge tests. Wonderlic personnel test scores, self-report scale scores, on-task cognition scale scores, and basic knowledge test scores were used as outcome measures. Reported findings indicate that adaptive guidance had substantial effects on the students' study, practice, self-regulation, knowledge acquired and performance compared to the learner control group. The control group followed similar procedures; however unlike the adaptive instruction group which had a balance between learner-control and system-control, the control group was purely learner-controlled and received descriptive feedback with no guidance information. The training was reported to have been conducted over a 3 hour session.

4.2.2.4 Intelligent tutoring systems

Intelligent tutoring systems are computerized learning environments that are made up of cognitive computational models designed for individual learners and are developed based on comprehensive and refined cognitive task analysis (Patel, Kinshuk & Russell, 2006). Presented data indicate that two of the included studies focused on intelligent tutoring systems. A study by **Cheung, Hui, Zhang and Yiu (2003)** evaluated the implementation of

SmartTutor, an intelligent tutoring system at the University of Hong Kong. Over 1300 adult learners (SmartTutor group $n=220$; control group $n=1080$) from various disciplines participated in the study. The SmartTutor was presented as an internet-based expert system that was made up of a course manager, content structure, student model, question bank, expert model and a user interface. The purpose of the course manager was to coordinate the components of the SmartTutor. Content structure provided students with a visual presentation of overall structure of the course, what is to be learned and learning material; while the student model enabled storage of individual student information including students' personal data, learning history, schedules and performance. Through the question bank, SmartTutor controlled and evaluated students' learning through use of past test papers and generation of examinations; while the expert model managed the selection and presentation of relevant material as well as generation of instruction for task completion. Finally the user interface enabled students to register for a course, conduct self-directed research and was a platform in which students held discussion forums with peers and instructors as well as receive feedback. Learning activities included: familiarisation with core knowledge on a given topic; peer group/instructor discussion forums and self-inquiry; demonstration of learned material through problem solving; scaffolding through provided examples; revision through use of past tests; feedback on performance and guidance; evaluation through tests and examinations; as well as overall course evaluation through online survey. The online survey questionnaire results were used as outcome measures. Results indicated that Smart tutor was effective through stimulating recall of prior learning; providing learning guidance; eliciting performance and enhancing retention and transfer. Additionally students who had not used Smart tutor showed their interest in follow-up evaluations. The duration of the implementation of SmartTutor was reported to have been conducted for 8 months consecutively.

Additionally, a review conducted by **Cook, Levinson, Garside, Dupras, Erwin and Montori (2008)** summarised the effect of using internet-based instruction for health professions learners in comparison to no-intervention and non-internet based instruction (control group). A total of 201 studies were included which focused on 214 interventions. Participants included a pooled sample size of 26 452 adult learners and practitioners from various health related disciplines (including physician postgraduates and physician practitioners; medical and nursing students; nurses in practice; dental students; pharmacy students and pharmacists in practice). The courses that used internet-based instruction included: online diagnostic and therapeutic course content; system-based practice that

allowed students to demonstrate knowledge and skills; tutorials provided for self-study; virtual patients; online discussions with peers and instructors for brainstorming and feedback purposes; tests and self-reports for evaluation purposes. Practice exercises, learner behaviour and patient care evaluations served as outcome measures. Reported findings indicate that internet based learning compared to no intervention had a consistent positive effect size compared to the no internet based groups; with significant effect sizes across satisfaction outcomes (0.10(95%CI, -0.12 to 0.32), I²= 92.2%), knowledge outcomes (0.12(95%CI, -0.003 to 0.24), I²= 88.1%), and skills (0.09(95%CI, -0.26 to 0.44), I²= 89.3%).

However, behaviours and effects on patient was not significant with 0.15(95%CI, -0.24 to 1.25), I²= 94.6%. Duration of the courses was equal to or more than 1week. The non-internet interventions included: paper modules; satellite mediated video-conferences; standardized patients and slide-tape self-study modules. For no interventions, training involved: communication with patients; critical appraisal, administration of medication, and diagnostic measures.

4.3 Quality Appraisal findings

Primary studies were assessed individually for methodological rigour to determine the level of quality based on a quality assessment checklist designed by the author of this review (see Appendix C). The findings are presented in table 4.2.

Table 4.2: Quality assessment findings

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
1	Tsou, Cho, Lin, Sy, Yang, Chou & Chiang (2009)	specified	specified	specified	specified	Adequately specified	Qualitative content analysis; statistical analysis; use of tabulation	Mean and Standard deviation; Wilcoxon's rank sum test and <i>t</i> -test.	Not specified	Self-directed learning readiness scale; interviews	7
2	Charmondusit & Charmondusit (2012)	specified	specified	specified	Not specified	Not specified	Statistical analysis, use of tabulation	Mean scores	Not specified	In-depth interviews; questionnaire evaluation forms	5
3	Idris (2012)	specified	specified	specified	Not specified	Adequately specified	Statistical analysis, use of tabulation	Mean and standard deviation; analysis of covariance (ANCOVA)	Not specified	Auto-mechanics achievement tests; lesson plans	6
4	Dickey (2008)	specified	specified	specified	specified	Not specified	Qualitative analysis	None	specified	Field notes, student work, email postings, observation notes	6.5

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
5	Liu (2005)	specified	specified	specified	Not specified	Adequately specified	Statistical analysis, use of plotting graphs; qualitative content analysis	Mean and standard deviation, F- test and analysis of variance (ANOVA)	Not specified	Instructional planning performance scale; self-reporting scale; attitudes scale	8
6	Burch, Sikakana, yeld, Seggie & Schmidt (2007)	specified	specified	specified	Not specified	specified	Statistical analysis, use of plotting graphs	Chi-squared; <i>t</i> -test	Not specified	Examination s; retention rates	6.5
7	Davis, Kvern, Donen, Andrews & Nixon (2000)	specified	specified	specified	Not specified	specified	Statistical analysis, use of graph and tabulation	Mean and paired <i>t</i> -test	Not specified	Objective structured clinical examination; standardized patients	7
8	Applin, Williams, Day & Buro (2011)	specified	specified	specified	Adequately specified	specified	Statistical analysis, use of tabulation	Mean, standard deviation; <i>t</i> -test, fisher's exact test	specified	Graduate competency questionnaire	8
9	Hussein, Mamat, Salleh, Saat & Harland (2007)	specified	specified	specified	Not specified	Not specified	Qualitative content analysis	None	Not specified	Interviews and video-taped tutorials	4.5

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
10	Dyke, Jamrozik & Plant (2001)	specified	specified	specified	specified	specified	Statistical analysis, use of tabulation; Qualitative content analysis	Chi-squared tests; t-tests	Not specified	Semi-structured interviews; quizzes and examination	8
11	Mihalca, Salden, Corbalan, Paas & Midea (2011)	specified	specified	specified	Not specified	specified	Statistical analysis, use of tabulation and qualitative review charts	Analysis of variance; t-test	Not specified	Far-transfer test; mental effort scale; pre-test and post-test	7
12	Shen, Chou, Hsiao, Lee & Chen (2011)	specified	specified	specified	Not specified	Adequately specified	Qualitative content analysis, use of tabulation and review charts	None	Not specified	Interviews, learning journals; history files; participant observation	5
13	Nichol & Bisset (2006)	specified	specified	specified	Not specified	specified	Qualitative analysis, use of tabulation and review charts	None	Not specified	Course documentation; teaching records; teachers' portfolios; interviews	6

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
14	Newsletter (2006)	specified	specified	specified	Not specified	Not specified	Qualitative analysis, use of tabulation and review charts	None	Not specified	Inquiry notebooks; written and oral presentations; self and peer evaluations; written assessment	5
15	Mantri, Dutt, Gupta & Chitkara (2009)	specified	specified	specified	Specified	specified	Statistical analysis, use of tabulation and graphs	Analysis of variance (ANOVA); mean	Not specified	Knowledge test; skills test; attitude survey questionnaire; examination	7
16	Pandy, Petrosino, Austic & Barr (2004)	specified	specified	specified	Not specified	Specified	Statistical analysis, use of tabulation	ANOVA; ANCOVA; unpaired <i>t</i> -test; effect size	Not specified	Pre-test post-test questionnaires	7
17	Malan, Ndlovu & Engelbrecht (2014)	specified	specified	specified	Not specified	Specified	Qualitative analysis	None	Not specified	ILS questionnaire; interviews	5
18	Uys, Gwele, McLnerney, Rhyn & Tanga (2004)	specified	specified	specified	None	Adequately specified	Qualitative analysis use of Nvivo; use of tabulation	None	Not specified	In-depth Interviews	5

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
19	Hautala, Romu, Ramo & Vikberg (2011)	specified	specified	specified	Not specified	specified	Qualitative analysis, use of tabulation	None	Not specified	Examination; post-course on-line survey	5
20	Senocak, Taskesenligi I & Sozbilir (2007)	specified	specified	specified	Not specified	Adequately specified	Statistical analysis, use of tabulation	t-tests; ANCOVA	Not specified	Gas diagnostic test; attitude scale; self/peer/tutor evaluation scales;	6
21	Cheung, Hui, Zhang & Yiu (2003)	specified	specified	specified	Not specified	Not specified	Qualitative analysis, use of tabulation and graphs	None	Not specified	questionnaires	5
22	Temel (2014)	specified	specified	specified	Not specified	Adequately specified	Descriptive Statistical analysis, use of tabulation	Independent t-test; two-way ANOVA	Not specified	Critical thinking disposition scale; problem solving scale	6
23	Shipton (2009)	specified	specified	specified	None	Not specified	Descriptive, use of flow chart	None	specified	Self/peer-evaluation rubrics; reflective journal	4.5

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
24	Batt (2010)	specified	specified	specified	None	specified	Qualitative analysis; descriptive statistics, use of tabulation	mean	Not specified	Knowledge test; survey; interview	5
25	Swann, Andrews & Ecclestone (2011)	specified	specified	specified	Not specified	Not specified	Qualitative content analysis	None	Not specified	Individual interviews; questionnaire	4.5
26	Kong, Qin, Zhou, Mou & Gao (2014)	specified	specified	specified	None	specified	Statistical analysis, use of tabulation, flow chart and plotting graphs	Funnel plot; Egger's test of asymmetry ; Cochran's Q statistic; chi-square test; Weighted mean difference; effect sizes	Adequately specified	California critical thinking disposition scale; critical thinking skills test; Watson-Glaser critical thinking scale	8
27	Meyer, Summers & Moller (2001)	specified	specified	specified	specified	specified	Statistical analysis, use of tabulation, flowchart and graphs	Independent and paired t-test; chi-square test	Adequately specified	Lancaster inventory of learning styles; Attrition rates; throughput rates	7.5

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
28	Bell & Kozlowski (2002)	specified	specified	specified	Adequately specified	specified	Statistical analysis, use of tabulation and flow charts	Repeated measures multivariate analysis of covariance (RM-MANCOVA); hierarchical regression analysis; structural equation modeling	Not specified	Wonderlic personnel test; self-report scale; On-task cognition scale; Basic knowledge test	7.5
29	McParland, Noble & Livingston (2004)	specified	specified	specified	specified	specified	Statistical analysis, use of tabulation	Mann-Whitney <i>U</i> -test; independent <i>t</i> -test; split-plot ANOVA; regression analysis	Not specified	Formative examinations, MCQ test; clinical Viva; ATP-30 scale	7.5
30	Mudzielwana & Maphosa (2014)	specified	specified	None	None	specified	Qualitative content analysis; thematic text analysis	None	Not specified	Open-ended questionnaire	4.5

	Included studies	Research design	Sampling Procedures	Assignment of groups to conditions	Control for confounding variables	Reliability of measures	Data analysis procedures	Statistical measures	Consideration of bias	Outcome assessment	Overall quality assessment score (out of 10)
31	Cook, Levinson, Garside, Dupras, Erwin & Montori (2008)	specified	specified	specified	None	specified	Statistical analysis, use of tabulation, plotting graph and flow charts	Chi-square test; Mean and standard deviation; Hedges <i>g</i> effect sizes	specified	Practice exercises; learner behavior and patient care evaluations	8

Based on the quality checklist designed by the reviewer (see appendix C) the overall quality of the included studies was rated on a scale of 1 to 10 (low quality to high quality). Studies that ranged from 1 to 5 were considered low quality to moderate; while studies that ranged from 5.5 to 10 were considered to be of moderate to high quality. Studies were rated considering: the appropriateness of research method, study design and synchronicity with the review research question; application of sampling procedures and assignment of groups to conditions; control for confounding variables and evidence of reliability of measures; use of statistical measures in the case of quantitative studies; consideration of bias; use of outcome assessment criteria, clear presentation of results and justification of generalizability of result. All 31 included studies indicated use of research methods and study designs that were relatively appropriate. In addition all primary studies indicated that research questions were addressed in a logical manner. Studies also addressed various cognitive-based instruction methods which were found relevant for addressing the research question in this review. Furthermore, all studies also applied sampling procedures and stated any assignment of groups to conditions.

Only 8 studies (McParland, Noble & Livingston, 2004; Bell & Kozlowski, 2002; Meyer, Summers & Moller, 2004; Mantri *et al*, 2009; Nichol & Bisset, 2006; Shen *et al*, 2011; Dyke, Jamrozik & Plant, 2001; Applin *et al*, 2011) indicated control for confounding variables in design and analysis; while 7 studies (Hussein *et al*, 2007; Newsletter, 2006; Cheung *et al*, 2003; Shipton, 2009; Swann, Andrews & Ecclestone, 2011; Dickey, 2008; Charmondusit & Charmondusit, 2012) showed no evidence of reliability of measures.

In addition 19 studies specified use of statistical measures in quantitative data analysis procedures (Batt, 2010; Liu, 2005; Tsou *et al*, 2009; Dyke, Jamrozik & Plant, 2001; Mihalca *et al*, 2011; Cook *et al*, 2008; McParland, Noble & Livingston, 2004; Bell & Kozlowski, 2002; Meyer & Summers, 2001; Kong *et al*, 2014; Temel, 2014; Senocak, Taskesenligil & Sozbilir, 2007; Pandey *et al*, 2004; Mantri *et al*, 2009; Applin *et al*, 2011; Davis *et al*, 2000; Burch *et al*, 2007; Idris, 2012; Charmondusit & Charmondusit, 2012).

Only 5 studies indicated use of both quantitative and qualitative data analysis procedures (Batt, 2010; Liu, 2005; Tsou *et al*, 2009; Dyke, Jamrozik & Plant, 2001; Mihalca *et al*, 2011). Majority of these studies used *t*-tests, chi-squared tests analysis of variance and analysis of covariance to determine effectiveness of instruction. Furthermore, only 6 studies (Meyer, Summers & Moller, 2004; Cook *et al*, 2008; Kong *et al*, 2014; Shipton, 2009; Dickey, 2008; Applin *et al*, 2011) indicated consideration of bias. All 31 studies specified use of various outcome assessment criteria which included evaluation scales, questionnaires, examinations, and knowledge tests; and data presentation methods using tabulations, plotting graphs, review charts, as well as flowcharts.

Out of all included studies only 12 attained a score below 5.5 out of 10 which was considered low quality (Mudzielwana & Maphosa, 2014; Swann, Andrews & Ecclestone, 2011; Batt, 2010; Shipton, 2009; Cheung *et al*, 2003; Hautala *et al*, 2011; Uys *et al*, 2004; Malan, Ndlovu & Engelbrecht, 2014; Newsletter, 2006; Shen *et al*, 2011; Hussein *et al*, 2007; Charmondusit & Charmondusit, 2012). Out of these 12 studies, 4 had the lowest score of 4.5 based on their methodological rigour (Hussein *et al*, 2007; Shipton, 2009; Mudzielwana & Maphosa, 2014; Swann, Andrews & Ecclestone, 2011). Studies with low scores mostly had no clear specification of: assignment of groups to conditions; control for confounding variables; reliability of measures; consideration of bias; use of one or very few outcome assessment measures; and no use of statistical measures to calculate effect size. However, these studies were still included in the review as they contributed to the review of the effectiveness of cognitive-based instruction.

4.4 Summary

A detailed presentation of the findings indicates that various ethnic groups from different disciplines and learning environments were represented in the included studies. All included studies gave an account of the type of instructional model used including specific procedures, learning activities, assessment rubrics and outcomes related to the application of instruction. Studies indicated use of sequencing in instructional procedures and a form of guidance provided by instructor or systems. Majority of the included studies indicated use of web-based or computer mediated learning environments and emphasized on adequate field practice. Findings showed that 29 studies were effective while 2 studies had indicated no significant difference in comparison with traditional instructional groups. Effectiveness of instructional application was evident through increased student motivation; enhancement of self-directed learning; increased confidence; higher academic achievement and performance through examination scores and reports; increase in throughput rates and decrease in attrition rates; increased understanding of concepts; development in research skills, critical thinking skills, problem solving and knowledge acquisition. Although the outcomes were positive with regards to effectiveness, limitations reported by studies were attributed to: shorter training time or depth of instructional application; limited critical engagement between instructor and learner; lack of cost efficiency to sustain program or cover larger groups of learners. Overall quality appraisal findings indicated that majority of included studies had strength in methodological rigour.

CHAPTER 5

DISCUSSION OF FINDINGS

5.1 Introduction

In the previous chapter the extracted data from the eligible studies was presented and the methodological rigour reviewed. This chapter further discusses the findings in response to the systematic review questions stated in Table 3.1 (see chapter 3) which are: 1) How is cognitive-based instruction conceptualized? 2) What are the existing cognitive-based models of instruction in the literature? 3) How do adults learn? 4) How is cognitive-based instruction effective for adult learners? 5) Is cognitive-based instruction effective for adult learners? In addition, a reflection of the conceptual and theoretical framework is included in the discussion of findings.

5.2 Discussion of findings

5.2.1 How is cognitive-based instruction conceptualized?

Cognitive-based instruction has been described by many theorists (Molenda *et al*, 1999; Shuell, 1986; Jones, 1985; Dubin & Okun, 1973) as an approach in instructional design that allows use of instructional aids or form of guidance from an instructor to assist learners in engaging their mental processes in learning. In doing so, cognitive-based instruction is described as one that promotes acquisition of knowledge; encourages development of effective learning strategies; engages learners' metacognitive skills; reduces strenuous mental load; and enhances recall and transfer of knowledge to new situations. Additionally, cognitive-based instruction has been further characterized to foster learning culture; increase motivation in learners; engage sequencing in application of instruction; involve problem centered learning tasks; allowing learner control; and providing meaningful practice as well as enabling learners to personalize practice (Wilson *et al*, 1993). The findings of the systematic review embody majority of the characteristics that are described in the definitions given of cognitive-based instruction (Wilson *et al*, 1993; Jones, 1985; Dubin & Okun, 1973). Therefore, cognitive-based instruction is conceptualized as an approach that allows the learner to fully make use of their cognitive skills in the acquisition of knowledge with the aid of appropriate cognitive tools and the guidance of an instructor in a learning environment.

5.2.2 What are the existing cognitive-based models of instruction presented in the literature?

Four cognitive-based models of instruction were represented in the studies which included: problem based learning, cognitive apprenticeship, adaptive instruction and intelligent tutoring systems. Problem based learning can be referred to as a method that engages learners' higher order thinking in a learning process through solving authentic problems (Hung, Jonassen & Liu, 2008; Hmelo-Silver, 2004; Savin-Baden & Major, 2004, Wood, 2003). The findings indicated that problem based learning is the most frequently used model of instruction in adult learning among various disciplines (medical education, engineering, teacher education, industrial ecology and environment, nursing education and police recruit education). It is also used by various ethnic groups in Asia, Africa, Australia, America and Europe (Tsou *et al*, 2009; Charmondusit & Charmondusit, 2012; Burch *et al*, 2007; Davis *et al*, 2000; Applin *et al*, 2011; Hussein *et al*, 2007; Dyke, Jamrozik & Plant, 2001; Newsletter, 2006; Mantri *et al*, 2009; Malan, Ndlovu & Engelbrecht, 2014; Uys *et al*, 2004; Senocak, Taskesenligil & Sozbilir, 2007; Temel, 2014; Shipton, 2009; Swann, Andrews & Ecclestone, 2011; Kong *et al*, 2014; Meyer, Summers & Moller, 2001; McParland, Noble & Livingston, 2004). Problem based learning has maintained its form in the application of procedures which follow a sequence that involves identification of problems; generation of hypotheses; listing of need to know; creating, organizing and prioritizing learning objectives; researching and sharing of knowledge; reorganization of problems; evaluation and feedback (Hung *et al*, 2008; Savin-Baden & Major, 2004).

Findings also indicated that cognitive apprenticeship is also used by various groups in adult learning (Idris, 2012; Dickey, 2008; Liu, 2005; Shen *et al*, 2011; Nichol & Turner-Bisset, 2006; Hautala *et al*, 2011; Batt, 2010; Mudzielwana & Maphosa, 2014). In this model of instruction, experts guide novices through a learning experience that focuses on cognitive skills and processes (Dennen & Burner, 2008; Dennen, 2004; Ghefaili, 2003). Cognitive apprenticeship engages learners in procedures such as modeling, scaffolding, articulation, reflection and exploration (Wooley & Jarvis, 2007, p.75). The findings from the review indicated that modeling involved use of media tools to demonstrate skills to the learners; while scaffolding allowed students to gain assistance through web-based discussion forums with peers and instructors. Furthermore articulation provided learners with the opportunity to present their ideas to other groups and the instructor; while exploration allowed learners to engage in various research strategies in order to maximize their learning experience. Finally reflection involved students' recall of the steps taken to accomplish a learning task and their

overall performance. This is compatible with the review done by Wilson and Cole (1996) of cognitive teaching models which identified cognitive apprenticeship components as modeling, coaching, articulation, exploration and reflection.

Adaptive instruction was also represented in the findings. In adaptive instruction, learning procedures were mostly applied in web-based learning environments (Mihalca *et al*, 2011; Pandey *et al*, 2004; Bell & Kozlowski, 2002) which were tailored to suit individual learner needs. Learning procedures involved familiarization with major concepts; identifying with presented problems; demonstration of learned skills and mental effort through engaging in lower to higher levels of problem solving; performance and time-on-task evaluations; feedback through tests and exercises. This is compatible with the features described by other researchers (Park & Lee, 2003; Atkinson, 1976) of adaptive instruction which include: the provision of specific instructional prescriptions; demonstration of mastering learning objectives; lesson level, course level, and curriculum level summary tests or evaluation exercises; list of activities to choose from; and time allotted to complete tasks at students' pace. Finally, intelligent tutoring system was the least represented cognitive-based model of instruction in the findings of this review (Cheung *et al*, 2003; Cook *et al*, 2008). The findings indicate that the learning procedures are applied within a computer mediated environment that corresponds with the characteristics of the learner. The intelligent tutoring systems consisted of online course content; provisions for system-based practice or simulations; tutorials for self-enquiry; as well as module exercises and tests for evaluation purposes. Wilson and Cole (1996) and the study by Patel, Kinshuk and Russell (2000) confirm that intelligent tutoring systems rely on comprehensive and refined cognitive task analysis to be developed and are designed for individual learners.

5.2.3 How is cognitive-based instruction used with adult learners?

Cognitive-based instruction is tailored to match the cognitive structure and characteristics of adult learners in order to get the most out of a learning experience. The cognitive structure of the adult learner is a processing system which has a reservoir of information that enables: the transfer of information; construction of new knowledge to cope in a changing environment; as well as relating existing information to the external world (Sweller, 2008; Sweller, Van Merriënboer & Paas, 1998). The findings indicated that instructional procedures were applied with consideration of the characteristics of the adult

learners. The cognitive-based models of instruction all exhibited features that are mostly compatible with Gagne's (1967) conditions of learning.

The *awareness of course structure or content material* was made possible at the onset of the application of instruction as indicated by the procedures in the findings. Hayes (2006: p 70) points out that involving students in decisions about the course structure; and highlighting their responsibility in learning through engaging them in discussions about objectives as well as how it can be delivered is crucial at the onset of instruction. As part of the learning process, adult learners were introduced to the learning objectives of the programs. In *gaining attention*, the findings indicated that adult learners were more active and motivated to learn in multimedia-enhanced learning environments (Mihalca *et al*, 2011; Shen *et al*, 2011; Hautala *et al*, 2011; Swan *et al*, 2011; Batt, 2010; Mantri *et al*, 2009; Shipton, 2009; Cook *et al*, 2008; Newsletter, 2006; McParland *et al*, 2004; Pandey *et al*, 2004; Cheung *et al*, 2003; Bell & Kozlowski, 2002). These learning environments made use of videos and internet that introduced or demonstrated course concepts or skills related to the task or problem solving activity at hand. Russell (2006) asserts that a multimedia enhanced environment that includes: use of computer sound cards, live video feeds, internet, television broadcasts, overhead transparencies, video tapes and other technologies; is appropriate as adult learners vary in their learning styles which may be visual, auditory or kinesthetic. In addition, Amstutz (1999) states that adult learners are ready to learn when they experience a need to know in order to be more effective in their performance. In *identifying learning objectives* the instructional models presented in the findings included a presentation of objectives at the onset of instructional application. This is usually done to ensure that learners are well aware of what is to be learnt throughout the learning experience (Driscoll, 2000; Hayes, 2006).

Furthermore, the *stimulation of recall of prior learning* was evident in the findings through the group discussions or discussion forums that the learners engaged in. This gave learners an opportunity to share their knowledge on subject matters. Additionally, findings also indicated *provision of guidance or scaffolding* to learners during problem solving of complex tasks. *Eliciting of performance* was done through allowing learners to conduct presentations or demonstrate knowledge of what was learnt through role plays; while *feedback* was given through interactions with the instructor and peers via emails, video conferencing or live presentations. *Enhancement of retention and transfer* was evident through the learners' participation in exercises, tests, examinations, system-based practice or field practice. This corresponds with Merriam and Leahy's (2005) recommendation from a review on learning and transfer which proposed that strategies for supporting transfer of skills

to the practical world be built into the instructional program. The findings also indicated that the *evaluation of performance* was done using assessment rubrics such as field reports, self/peer/instructor evaluation forms, examinations, Knowledge tests, role-play, interviews, observation of learner behaviours during field practice and reflective journals. In support of this findings, Rodgers and Horrocks (2010, p.300) highlight use of portfolios, self-assessment, peer-assessment, examinations, tests, exercises, presentations, observation and written responses as tools for evaluation.

5.2.4 How do adults learn?

Adult learners are autonomous beings who are seen as self-sufficient and mostly internally motivated. They usually approach learning having specific needs which involve: Increasing their qualifications; stepping up in their career; getting a job and providing for family; or to add to their knowledge (Amstutz, 1999; Zemke & Zemke, 1995; Knowles, 1973). Adult learning theories imply that adult learners learn through: self-inquiry and reflection of past experiences in connection with current learned knowledge; collaborative experiences; as well as application of learnt skills in the real world of work (Illeris, 2007; Taylor, 2007; Ross-Gordon, 2003; Seifert, 1999). In addition, research in adult learning has indicated that adult learners have varying learning styles (Pashler *et al*, 2008; Kolb *et al*, 1999). The findings of this review showed that adult learners engaged in self-inquiry as part of the instructional activities by conducting experiments through lab work; research through field work and using the internet. In addition findings also confirmed that adult learners have different learning styles. The learning environments allowed the learners to use technology such as videotapes and internet in their learning which caters for visual and auditory learners; while presentations and demonstrations through role-plays catered for kinesthetic learners who learn through performing practical work.

According to Kolb, Boyatzis and Mainemelis's (1999) learning styles, adult learners with a diverging learning style benefit more from engaging in collaborative cognitive experiences. They further highlight that those with assimilating learning styles, benefit most from exploration and analysis of theories by attending lectures and seminars. In addition, learners with the converging learning style benefit most from running experiments; while those with the accommodating learning style benefit extensively through projects or field practice (Kolb *et al*, 1999). The findings of this review indicated that adult learners engaged in group work, presentations, and attended lectures as part of the activities in their learning

experience (see table 4.1). Furthermore, findings also showed that learners engaged in field practice. This confirms that adult learners are confident in their skills when they practice what they have learnt through applying their knowledge to real world settings (Illeris, 2007).

5.2.5 Is cognitive-based instruction effective for adult learners?

The effectiveness of cognitive-based instruction is discussed considering the compatibility of adult learner characteristics and instructional features; as well as evidence of achievement or improvement in learner performance.

5.2.5.1 Compatibility of adult learner characteristics and instructional features

Hayes (2006, p.72) states that effective instruction for adult learning should be able to include the use of diverse learning aids and activities that enhance the adult learning experience. Hayes further recommends that instruction should: encourage the use of new technologies; make provisions for students with difficulties or disabilities; manage mixed levels and abilities of adult learners by dividing learners into sub-groups; use of tutorial and provision for guidance; ensure the correct learning pace resulting in completion; and include assessment of progress and feedback (Hayes, 2006). The findings in this systematic review reveal that various learning aids were used in some studies which included; the use of the internet, lab equipment and use of multimedia such as videos in delivering instruction for adult learning. Few studies used advanced technology systems in delivering instruction. Findings also indicated participation in various learning activities that were engaging. These included: video conferencing, forums, experiments, field work, group work, presentations, and tutorials; as well as solving case studies, workshops, clinical practice or simulations, peer/self/instructor evaluations and feedback (see table 4.1).

According to the findings of this systematic review, adult learners were more successful when they were provided with guidance in order to complete a complex task. This is partially compatible with the view by Kirschner, Sweller and Clark (2006) that guidance in instruction is important in order for effective learning to take place; and that minimal guidance is ineffective. Nicol and Macfarlane-Dick (2004) emphasize on the importance of feedback, stating that: it encourages instructor and peer dialogue; encourages development of reflection and self-assessment; clarifies good performance; and encourages positive motivational beliefs. Hayes (2006) also notes that providing pre-course advice and guidance sessions with staff and specialists is required in order for instruction to be effective. Findings

from the extracted data indicated that the instructional models applied in the studies were well able to enhance the learners' metacognitive abilities; increase learner confidence and motivation; reinforce self-directed learning; Increase as well as enhance recall and transfer of skills to new situations.

5.2.5.2 Achievement and improvement in learner performance

Rodgers and Horrocks (2010) assert that effectiveness of instruction can be proved by performance or test scores; certification or qualification as evidence of achievement; satisfaction indicators through verbal or written comments of students; as well as attendance figures and students furthering their studies. The findings from individual studies showed that the cognitive-based models of instruction were more effective compared to traditional lecture-based instruction. This is compatible with evidence-based research that highlights important features of effective instruction for adult learning (Kirschner et al, 2006; Wilson et al, 1993).

The findings also indicated that outcomes of the learning experiences were assessed by observations, testing of learner's performance and providing feedback. Outcome measures included: practical exercises, learner behaviours during field practice, examinations, questionnaire surveys, knowledge and performance rating scales; throughput rates, learner reports, reflective journals, self/peer evaluation rubrics, written and oral presentations as well as written assessments. This is compatible with the tools of evaluation described by Rodgers and Horrocks (2010, p.302).

Rodgers and Horrocks (2010, p.285) further assert that in assessing the effectiveness of instruction, an evaluation of the intended learning goals, achievements, learning structures, learning processes and impact of the experience on the learner should be done. The findings indicated that majority ($n=29$) of the studies reported positive effects of cognitive-based instruction on the adult learners compared to traditional programs; While few studies ($n=2$) showed that instruction had no significant differences compared to traditional lecture based instruction (see table 4.1). The findings indicated that effectiveness was illuminated through: increased student motivation; enhancement of self-directed learning; increased confidence; higher academic achievement and performance through examination scores and reports; increase in throughput rates and decrease in attrition rates; increased understanding of concepts; development in research skills, critical thinking skills, problem-solving and knowledge acquisition. Although the outcomes were positive with regards to effectiveness,

limitations reported by few individual studies indicated that: shorter training time or depth of instructional application; limited critical engagement between instructor and learner; lack of cost efficiency to sustain program or cover larger groups of learners can impact on learner performance.

5.3 Summary

The aim of this chapter was to discuss the findings of the systematic review according to the previously stated review questions. Cognitive-based instruction has been defined as an approach that is driven by cognitivist theories. Its current state of effectiveness was explored through the identification of the existing models of instruction used in adult learning environments. These included problem based learning, cognitive apprenticeship, adaptive instruction and intelligent tutoring systems based on the findings of the review. The models of instruction have proved their success in application across various disciplines, showing the procedures and learning activities that compliment adult learner characteristics. Findings have indicated that cognitive-based instruction can be effective with the combination of various cognitive tools or aids; rather than using individual models. The results highlighted important areas that require attention such as, the importance of instructor-learner interactions, emphasis on more field practice in instructional programs; as well as cost-efficiency in sustaining programs that make use of cognitive-based instruction. With the use of advanced technology; appropriate learning procedures that are compatible with adult learner characteristics, follow-ups and evaluation of instructional processes; cognitive-based instruction can prove to be effective.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The previous chapter discussed the findings from the extracted data in relation to the review questions stated at the onset of the research process. This chapter gives a conclusion of the systematic review reflecting on the research process, leading to the findings that ultimately respond to the question of the effectiveness of cognitive-based instruction for adult learning. Furthermore, the chapter gives a narration of the limitations and presents recommendations for future research.

6.2 Summary of the systematic review

The purpose of this study was to assess the effectiveness of cognitive-based instruction used in adult learning in order to provide current knowledge that may inform instructional practice and maximize learning in adult education. This was done by conducting a systematic review of the literature which made use of an inclusion/exclusion criteria and quality assessment indicators to retrieve relevant studies. As growth in the interest of instructional designs and methodologies occur, extensive research has been conducted on individual models of instruction which have presented inconsistent outcomes. Furthermore, past studies have focused on western populations with majority centered on child and adolescent groups. Recent studies have shown that there is growing interest in adult learning groups and the instructional approaches that are suitable. Therefore conducting a review of the existing literature was necessary to gauge the effectiveness of cognitive-based instruction for adult learning, presenting the current trends. This systematic review has specifically focused on appraising various cognitive-based models of instruction which included problem based learning, cognitive apprenticeship, adaptive instruction and intelligent tutoring systems.

A search strategy was used to search for relevant literature through databases, journals and reference lists. Inclusionary criteria yielded 31 eligible studies conducted in Africa, Asia, America, Australia and Europe, published between 2000 and 2014. A data extraction sheet was used to extract information from the studies that contributed to the review. Furthermore, quality assessment criteria resulted in 12 studies that met minimal requirements for their methodological rigour. Findings from the systematic review confirmed that more authentic evidence based studies with strong methodological approaches should be conducted in order

to capture the efficacy of instructional approaches. The included studies were clear on the cognitive instructional model being assessed; the instruments used to measure effect of instruction of learners; as well as the outcome of the process. Furthermore, the studies only vaguely stated all the necessary characteristics of adult learners. In regards to the question of effectiveness, cognitive-based models of instruction appeared to be more effective compared to traditional lecture based instruction. The findings attributed the following factors as key in providing effective cognitive-based instruction for adult learners: high multimedia-based learning environments; provisions for guidance during instruction; sequencing in instructional procedures; provision of ample time for practice in real world situations, exceptional instructor-learner interaction and a balance between learner- control and system control.

6.3 Limitations

There were limitations presented during the systematic review process. These limitations can provide a base for conducting further studies with regards to the effectiveness of instruction. The first is in relation to inclusionary criteria. Studies in this review were included based on their relevance to the systematic review. However, potential studies were excluded on the grounds that they were published in foreign languages not familiar to the reviewer. In addition only 31 studies were retrieved for analysis of effectiveness due to time constraints which indicates that a small sample size was used. Furthermore, the reviewer was only limited to the available resources for accessing the relevant studies. Another limitation was the lack of the application of meta-analytic procedures in determining effectiveness. Statistical procedures are useful in calculating pooled effect sizes of studies which can contribute to the generalization of results in a systematic review. Overall the systematic review was conducted by a single reviewer which indicates possible subjection to bias.

6.4 Recommendations for future research

This review summarized the current status of cognitive-based instruction based on 31 eligible studies. Considering the limitations and findings of the review, this section provides recommendations for future research.

6.4.1 Implications for running a systematic review of the literature

Running a review of studies is important in order to keep updated information in a field of study as new theories and approaches continuously emerge. It is equally important to follow well defined criteria in including relevant studies that will answer the review research questions.

- *Resources*- The use of a variety of resources to conduct searches to collect data is necessary in order to give the reviewer exposure to the relevant studies. This review only made use of the available resources which included electronic databases, reference lists and journals. Reviewers can also make use of books and acquire permission to access designated institutional websites to collect data.
- *Defined criteria*- Clearly defined criteria is crucial at the onset of the review as it acts as a guide in the selection of relevant studies. In addition, the included studies should be able to provide complete information on the area of study. This review applied criteria that were useful in the selection of studies that provided useful data. However, some selected studies did not provide complete information. This review made use of studies that mostly used pre-test, post-test research designs and single case study designs to measure effect of instructional interventions. However, the duration of the interventions mostly appeared to be limited. This implies that future research should make use of more published longitudinal studies in assessing effectiveness of instructional interventions. Additionally the included studies did not clearly state the complete demographic details of participants. The missing pieces of information could impact the findings of the systematic review. As much as it is important to have a larger sample size in the number of included studies, reviewers must bear in mind the quality of the studies that are being considered for inclusion.
- *Reliability and validity*- The reliability and validity of results in a systematic review is largely influenced by the quality of instruments used to measure a construct and the method of analysis applied. This systematic review made use of a data extraction sheet and a quality assessment instrument (designed by the reviewer) that complied with the format of standard instruments used in Cochrane systematic reviews. Furthermore, qualitative analytical approaches were applied to arrive at the results. Future research could make use of mixed method procedures that include meta-analyses, as statistical measures can provide pooled effect sizes that are important in determining effectiveness. These efforts could generate more accurate results.

- *Eliminating bias*- As much as a systematic review can be conducted by a single reviewer, a review can be prone to biases. This review excluded studies that were published in foreign languages not familiar to the reviewer. Although the reviewer replicated the review of each included study, the presence of two or more reviewers is necessary to eliminate any bias.

6.4.2 Implications for educational practice

This review aimed at providing the current status of cognitive-based instruction for adult learning in order to inform researchers, educational psychologists, adult learners, instructional designers and instructors; as well as contribute to existing research. The findings of this review indicate that the use of cognitive-based instruction is advancing and that adult learners and instructors both benefit from the learning experiences. However, there were some areas that raised questions with regards to effectiveness of instruction which could be points of reference for future research.

- The findings from this review indicated that highly multimedia based learning environments contribute largely to the effective delivery of cognitive-based instruction in adult education. This could be different in cases where the advancement of technology is slow- paced. Therefore future research could investigate the status of effectiveness of cognitive-based instruction for adult learning in underdeveloped countries.
- The findings highlighted the important factors that contribute to the effectiveness of cognitive-based instruction. This raised a concern on the importance of knowing the factors that could impede on the effectiveness of instruction in adult learning. Future research could investigate the factors that impact negatively on the effectiveness of cognitive-based instruction in adult learning.
- The findings also indicate that the connection between learner characteristics and instructional design plays a role in the effectiveness of instruction. As much as instruction is designed to meet the needs of adult learners, the development of instructor expertise is also important in the delivery of effective instruction. Future research could assess the relationship between instructor expertise and the effectiveness of cognitive-based instruction in adult education.

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APPENDIX A

INCLUDED STUDIES

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APPENDIX B

INCLUSION/EXCLUSION CRITERIA

Inclusion Criteria:

- Peer-reviewed studies conducted between 2000 and 2014.
- National and international studies preferably published in English.
- Studies should be longitudinal pre-test post-test, case series or post case series, case studies, quasi-experimental, experimental studies with comparison or control groups.
- Studies should specify characteristics of sample population which should include male and female adult participants preferably between the ages of 18 to 55.
- Studies with a focus on any defined form of cognitive-based instruction specifying characteristics and duration.
- Studies focusing on adult learning institutions such as universities, colleges or any other adult learning centers.
- Studies with a clear account of effectiveness of application of instruction whether negative or positive. As well as analysis measures used to arrive at conclusions.

Exclusion Criteria:

- Non- peer-reviewed studies conducted below the year 2000.
- Studies published in foreign languages.
- Non pre-test, post-test studies without comparison or control groups.
- Studies including children, adolescents and older adult population from the ages of 60 and above; including mentally impaired populations as well as studies with no specification of the nature of participants.
- Studies focusing on primary and secondary schools.
- Studies focusing on non- cognitive-based forms of instruction with no specification of the characteristics of instruction.
- Studies without specification of overall effectiveness of the application of instruction, as well as unclear indication of measures used to arrive at conclusions.

APPENDIX C

QUALITY ASSESSMENT INDICATORS

Items	Yes	No
<ul style="list-style-type: none"> Is research method and study design appropriate? Does the research method synchronize with the research questions? Are sampling procedures specified and applied methodically? 		
<ul style="list-style-type: none"> Is the assignment of control groups and selection of subjects for comparison clearly defined? Does the study adequately control for potential confounding variables in design or analysis? Does study indicate any evidence of the reliability of measures? 		
<ul style="list-style-type: none"> Is approach to analysis clearly defined? Are statistical measures specified in the analysis of data (in the case of quantitative studies)? Are biases considered during the study and measures taken to prevent them from occurring if any? Are outcomes assessed using criteria, results clearly presented and sufficient in order to justify relation between evidence and conclusion? 		

Rating scale:

1	2	3	4	5	6	7	8	9	10
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Low
Quality

Moderate

High
Quality

APPENDIX D

DATA EXTRACTION SHEET

Data extraction No.	
Reference	
Source (Database, website etc.)	
Author & year	
Title	
Country	
Study design	
Objective	
Field	
Sample population (sample characteristics, age, gender, year of study)	
Instruction (type of instruction, components/procedures, duration)	
Dependent variables	
Quality assessment	
Outcome	
Comments	

