EFFICACY OF META-ADJUNCT MODE OF QUESTIONING AS A FORMATIVE ASSESSMENT TECHNIQUE IN SECONDARY SCHOOLS IN KENYA

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DECLARATION

This research project is my original work and has not been presented for an academic award in any other university.

Sign……. **Date……..**

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E58/64126/2013

Supervisor's Declaration

This project has been submitted for examination with my approval as University of Nairobi Supervisor.

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DEDICATION

I dedicate this work to my lovely wife Gladys and son Lionel.

ABSTRACT

The purpose of this study was to investigate the effect of meta-adjunct questioning on students' academic attainment. To accomplish this purpose, three smaller objectives were addressed. The objectives were: (a) To determine if meta-adjunct mode of questioning has an effect on academic attainment of low and high achieving students; (b) To determine if the effect of meta-adjunct mode of questioning on academic attainment depends on student gender, (c) To determine the if effect of meta-adjunct mode of questioning on academic attainment depends on students' academic performance.

The research was guided by both quantitative and qualitative approach. The sample was secondary school students in form III. The data was collected using a "meta-cognitive test" to establish higher order thinking. Secondary data was collected from students' academic scores from teachers progress reports on classroom based formative assessment. The data was analyzed using paired raters as well as MANOVA statistics.

The results showed that student learning across all types of learners does not reflect meta-cognitive abilities. There was a difference in that lower achievers compared to high achievers showed differences in meta-cognitive abilities. Recommendation is made that teachers should be trained in meta-adjunct questioning skill so as to further enhance learning of meta-cognitive abilities across learners of all types.

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LIST OF ABBREVIATIONS

MOE- Ministry of Education

DEO- District Education Office

O.P.T- Oxford Placement Test

HOD- Head of Department

ISLES-S- Instructional Strategy Lessons for Educators Secondary Education

D.A .M- Directed Attention Model.

KNEC- Kenya national examinations council

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The art of questioning is one of the most important skills for teachers because questions play a central role in the learning process. Philip Groisser in his book, *How to Use the Fine Art of Questioning* (Groisser, 1964), emphasizes that the use of questioning skills is essential to systematic investigation in any subject area. In such an investigation, Groisser (1964) notes that teachers ought to ask questions that motivate students' reflective thinking and therefore metacognitve abilities. However, information generated from recent research indicates that teachers largely ask wrong questions. Most teachers focus primarily on questions regarding the specific information a student possesses rather than questions to promote learning (Willingham, 2014). Teachers can develop their students' metacognitve abilities by posing meta-adjunct questions. This study is on the efficacy of meta- adjunct mode of questioning in academic attainment of secondary school students Andre (1979) defines meta-adjunct questions as higher-order questions put in, before or immediately after prose passages and asking students to answer such questions while studying the passages. Higher-order questions are those questions on the comprehension and application levels of Bloom's taxonomy. This is a scaffold approach to instruction for improving comprehension (Lai & Elen, 2013) so that learners move from basic knowledge to deep understanding.

Most researchers on adjunct questions share the assumption that answering higher order questions requires more than a simple recollection of information, induces more complex cognitive processes and benefits learning (e.g. Andre 1979, Hamaker 1986;

Hamilton 1985), in Lai Jiang (2012). Patananya (2009) defines meta-adjunct questions as questions of meta-cognitive nature inserted throughout a given text. Meta-adjunct questioning borrows heavily from the cognitive theory of learning. Tofade (2012), in his paper on *Linking Formative Assessment to Scaffolding*, posits that meta-adjunct questions help students to develop their Metacognitive abilities. Questioning techniques that do not develop students' Metacognitive abilities produce students who cannot solve real life problems. Complex real life problems often demand complex solutions, which are obtained through higher order thinking processes (DeVries & Kohlberg, 1987).

Some researchers have designed experiments which investigate the effects of questions framed at different cognitive levels in the Bloom's Taxonomy of learning (Lai J.E *et. al.;* 2013).These levels, in ascending order of sophistication, are: knowledge, comprehension, application, analysis, synthesis, and evaluation. The majority of researchers have looked at the relative effects on student outcomes produced by what they call higher and lower cognitive questions. Lower cognitive questions are those which ask the student merely to recall material previously read or taught by the teacher (a behaviorists approach). Lower cognitive questions are also referred to in the literature as knowledge questions. Higher cognitive questions are defined as those which ask the student to mentally manipulate bits of information previously learned to create an answer or to support an answer with logically reasoned evidence (a cognitivists' approach). Higher cognitive questions are also called open-ended, interpretive, evaluative, inquiry, inferential, and synthesis questions.

The findings from research into the effects of meta-adjunct questions on learning suggests that having student answer questions interspersed both before and after a

passage segment can enhance their understanding (Rothkopf, 1969). Pre-questions have a facilitative effect upon the comprehension and retention of information elicited by the questions. When students encounter a relevant question before reading a passage of material, their attention is apparently directed to the information needed to respond to the question. In this case, students are given a purpose for reading which is search for an answer to the question.

Post-questions have been found to have both direct and indirect effects. According to Frase (1967), the direct effect is when they facilitate retention of question specific information while the indirect effect is when they facilitate retention of material not actually questioned.

The direct and indirect effects of meat-adjunct questions have been attributed to both backward and forward processing behaviours. In later work by Frase (1970), both backward and forward process could be produced even simultaneously by meta-adjunct questions. Since Frase made this suggestion, investigations conducted have confirmed the backward and forward hypothesis (Rothkopf, 1974). More recent empirical studies have identified four processes of meta-adjunct questions. These processes are; specific backward processing, general backward processing, specific forward processing, and general forward processing.

Specific backward processing involves review of material actually questioned. Meta-adjunct questions are hypothesized to engender a specific backward process when they produce good recall of question specific statements. A number of researchers have reported findings which support backward processing hypothesis.

Meta-adjunct questions have the following applications in teaching; teachers who want students to search for specific textual information, they should consider focusing student's attention on that particular information by asking a pre-question before the text segment containing the said information. This is the basis of the Directed Attention Model DAM according to Andre (1976). In the D.A.M, the teacher can focus the attention of the student on salient information in a passage by posing a purpose question. Meta-adjunct questions are also applicable when the teacher wants learners to read in a global fashion. Meta- adjunct questions attain this by increasing the students' overall attentiveness to the text in two ways. By causing them to review text material and by causing them to anticipate questions. This leads to them becoming attentive.

Meta-adjunct questions can be employed by teachers who wish to provide more individualized instruction (Hacker, 2009). Readers who have difficulty on focusing on any type of information benefit from the question placement of meta-adjunct questions.

Finally, teachers who intend to develop their students' ability to ask questions can use meta-adjunct questions to model the type of questions they want students to ask.

Teachers can use reciprocal questioning technique to develop students' ability to formulate their own questions about reading material (Manzo, 1969). This can be done by placing meta-adjunct questions in different text locations to point out to students where it would be appropriate to ask different types of questions.

1.1.1 Meta-Cognitive Abilities

Meta-cognition is a regulatory system that helps an individual to understand and take control of their own cognitive performance (Hacker, 2009). Metacognition allows

students to take charge of their own learn. It enables on to be aware of how they learn, set own learning goals, generate strategies to meet these goals and evaluate these strategies. Hacker contends that learners who develop meta-cognitive skills show an increase in self-confidence. It is this self-confidence that improves motivation and thus learning success.

Writing in American Handbook of meta-cognition, Dunlosky and Arthur argue that successful learners typically use meta-cognitive strategies whenever they learn. They, however, point out that sometimes learners fail to use the best strategy for each type of learning situation. They advocate for higher order questions that allow learners to reflect on their own learning processes and strategies. Such questions, when inserted in text material, can enhance comprehension.

Research on the relationship between the cognitive level of teachers' questions and the achievement of their students has not produced definitive results. Quite a number of research studies have found higher cognitive questions superior to lower ones, many have found the opposite, and still others have found no difference (Nuray, 2003). The main aim of this study will be to determine the effect of meta-adjunct mode of questioning on academic attainment. The results of the study will clarify the relative importance of meta-adjunct questioning in general. New knowledge such as this would benefit a wide range of professionals, including teacher trainers, classroom teachers. Ultimately, such knowledge would benefit their students whose academic attainment might be increased through meta-adjunct questioning technique.

1.2 Statement of the Problem

Psychologists have been developing and evaluating the efficacy of questioning techniques for more than 100 years. Nevertheless, some effective questioning techniques are underutilized. Recent research on questioning techniques has revealed that teachers largely focus on low-order questions regarding the specific content rather than questions to promote learning (Willingham, 2014). One disadvantage of such low-order questions is that they do not allow students to demonstrate their level of knowledge or lack of knowledge (Gipps, 1994) and does not therefore develop Metacognitive abilities of students. It is therefore necessary for teachers to shift their emphasis from questions based solely on content, to questions based on learning process to enable students deal intelligently with their world and lives. Students who can analyse situations while in school will comprehend effectively their reality when outside the formal school setting.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of meta-adjunct mode of questioning on students' academic attainment.

1.4 Objectives of the Study

The specific objectives of the study were;

a) To determine if meta-adjunct mode of questioning has an effect on academic attainment of low and high achieving students.
b) To determine if the effect of meta-adjunct mode of questioning on academic attainment depends on student gender.
c) To determine if the effect of meta-adjunct mode of questioning on academic attainment depends on students' academic performance.

1.5 Significance of the Study

The findings from this study have practical significance. Low achieving students who are exposed to meta-adjunct questions are more likely to improve their academic performance. Such new knowledge will be used by teacher trainers in designing training modules since training teachers in asking higher cognitive questions is positively related to high academic achievement of students. The research findings will also be useful to the classroom teacher in the following ways; developing interest and motivating students to become actively involved in lessons, developing critical thinking skills and inquiring attitudes, and to stimulate students to pursue know.

1.6 Justification of the Study

Several studies have indicated that meta-adjunct mode of questioning holds more promise for low ability students. Worldwide, there is plenty of research ongoing on meta-adjunct questioning technique. However, internet search did not reveal such a study in Kenya hence the need to conduct one. This study was also triggered by the need to develop meta-cognitive abilities of the student through educational assessments.

1.7 Scope and delimitations of the study

This study focused mainly on the effect of meta-adjunct questions on academic attainment in chemistry as a discipline for secondary school students. The nature of skills required in chemistry such as analytical skills were found to be much in line with meta-adjunct question. Results of this study may therefore not apply to other disciplines such as history. Further, the area of study was Hamisi sub-county, Vihiga county western Kenya. This is a rural setting and therefore results may not be generalized to urban students who may be attending private academies.

1.8 Definitions of key terms

Formative Assessment	Assessment aimed at determining students' misunderstandings or learning gaps and what can be done next to help them learn. It is conducted during the implementation stage of a programme of learning.
Question	A sentence that has an interrogative form or function. They are instructional cues or stimuli that convey to the students the content elements to be learned and directions for what they are to do and how they are to do it.
Meta-Adjunct questions	Questions of meta-cognitive nature inserted throughout the text.
Meta-cognitive	Higher-order thinking that enables understanding, analysis, and control of one's cognitive process.
High cognitive level questions	Questions that test judgmental skills such as critical thinking and problem solving.
Low cognitive level questions	Questions that test acquisition of knowledge and comprehension of the material.
Scaffold approach	A teaching approach used to move students progressively towards stronger understanding and,

	ultimately, greater independence in the learning process.
Mathemagenic behavior	Those activities that give birth to learning i.e., those kinds of actions or inspection behavior executed by the learner while reading a piece of text that lead to attainment of specified instructional objectives
Academic attainment	The outcome of educational instruction. The extent to which a student has achieved education goals. In this study, academic attainment by the score on the test to be administered.
Effective questioning technique	A way of presenting questions to deepen the level of discourse students apply to their work

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Recent advances in research and theory provide some basis for arguing that students' academic performance can be enhanced by use of meta-adjunct mode of questioning. Meta-adjunct questions have been praised for their role in developing meta-cognitive skills in learners. Meta-cognition in turn enhances students' academic performance by improving self-esteem. In an attempt to demonstrate the concept of meta-adjunct questioning, the literature reviewed in this section is organized into the following sub-sections: (1) related studies and (2) related literature.

2.1 Related studies

There exists a wide literature on adjunct question research. Rothkopf is regarded as the ancestor of this kind of research because of his early explanation for the effects of adjunct questions in the form of "Mathemagenic" hypothesis. Below is a chronological review of some studies on adjunct questions.

Thorndike 1917, in an experiment with sixth graders, placed questions after a simple paragraph to determine features of a text that are characteristic of student reasoning when reading. Thorndike's finding revealed the importance of the wording of the question associated with a paragraph (e.g. in Ordynans, 2012).

Rothkopf, a trailblazer in adjunct questions research (Ordynans, 2012), investigated the additive effect of pre- and post- adjunct questions on learning achievement for

college students in 1966. Performance on intentional items by the pre-question group was significantly lower ($p < .05$) than the post question group. These results indicate that post adjunct questions produce more facilitative effects on learning. These findings were further reinforced by Sagaria *et al.* (1978) in a similar study.

After Rothkopfs recommendation on the level of processing in 1966, (Sagaria & Di Vesta, 1978), mid-1970s studies on adjunct questions switched from factual to higher-order items (Ordynans, 2012). In 1974, Shavelson et al. found that high-level adjunct items enhanced achievement of junior college students.

In reviewing Rothkopf's work, Faw and Waller 1976 argue that what the learner does during reading is important to how much they will retain. Faw and Waller identify four techniques important to learning; advance organizer, response modes, objects and inserted adjunct questions. However, Faw and Waller posit that of the four techniques, adjunct questions are in "many ways the most promising method".

A further review of research on adjunct items was done by Hamilton (1985) and Hamker (1986). Several studies supported the finding that higher level adjunct questions increased performance on higher-order criterion tests, as well as possibly on related tests. Higher cognitive questions were asserted to cue students to select and encode relevant information (Lai & Elen, 2012).

Adolescents who have reading disabilities can be assisted by adjunct questions to comprehend texts. A study conducted by Pevely and Wood in 2001 to examine effects of various questioning strategies on improving student's reading comprehension found out that adjunct questions were more effective than other questioning strategies. Pevely and Wood administered a comprehension test after four groups of students

practiced on inserted and massed post-questions. The comparison group read story segments without questions. They found that inserted questions were more effective in improving students' comprehension of text than other questioning strategies. In another study, Karpicke and Roediger (2008) presented undergraduates with Swahili-English translations for cycles of study. Performance on the final test a week later was better for the group that used adjunct question than that using continuous reading strategy.

Forutan (2011) investigated the effect of pre-reading and inserted questions on incidental vocabulary learning and retention. Two homogeneous groups selected based on their performance on Oxford Placement Test (OPT). Different treatment for each group was administered two weeks after a pre-test. Two weeks after the last session of treatment, a post-test was administered. The results indicate a significant difference between the performances of the two experimental groups. The group receiving inserted questions performed better than the group receiving pre-reading questions.

Contrary findings have also come up in other studies. For example, in a study conducted by Nuray (2003) to investigate the effect of inserted questions on learning related theoretical knowledge to the context, it was found that there was no significant difference between the achievement of the subjects who read the scientific text supported with inserted questions and subjects who read the text without inserted questions. It is important to note that Nuray utilized inference questions with expository text for high school students. Pevely & Wood incorporated inference, main idea, and detail question again for high school students but with narrative text. Similarly Brantmeier et al. (2014) established that with advanced learners, embedded

questions do not aid reading comprehension. This followed a similar study by the same researcher back in 2011 which had similar findings. In both studies Brantmeier et al. (2011 & 2014) utilized elaborative embedded items with narrative text for advanced L2 learners. The import of these findings is that research is needed to determine the efficacy of higher order adjunct questions with a different type of text (expository) and whether the effectiveness is affected by age.

More recently, Callendar and McDaniel (2007) investigated the efficacy of various types of adjunct questions for readers of different comprehension abilities with an expository text. They utilized undergraduates of low and high comprehension abilities. The results demonstrate that high ability subjects were not helped by both high cognitive and low cognitive adjunct questions. Low ability subjects were, however, able to recall a great deal of information.

The boost to memory is quite long-lasting. For example, in one experiment, (McDaniel *et. al*, 2011) 8th graders practiced on three low-stakes quizzes over a science course. On the final test, students scored 13-25 percent better on the material that had appeared on the quizzes. (The questions probed the same knowledge but were not identical). Most impressive, the gains lasted to cumulative semester and end-of-year tests. The questions used in above experiment are referred to as Meta-questions. They probe the same knowledge, but they are not identical. It is interesting to find out the effect of using such questions on high school students since the study was conducted on 8th graders.

2.2 Summary of the studies

While it is important to note that research has demonstrated the benefits of different types of adjunct questions for older and younger students' comprehension of both narrative and expository texts, studies have not been done to investigate the effect of meta-adjunct questioning science disciplines. Based on other findings on inserted questions, meta-adjunct questions appear to be a technique with considerable promise as a scaffold to learning from expository texts. It provides students with a framework from which to build comprehension of texts that require them to learn how to learn. With practice developing this framework, students can conceptualize and internalize this approach, thus improving learning from expository texts.

2.3 Related Literature

2.3.1The concept of meta-adjunct questions

According to Andre (1979), meta-adjunct questions are higher-order questions put in, before or immediately after prose passages and asking students to answer such questions while studying the passages. Higher-order questions are those questions on the comprehension and application levels of Bloom's taxonomy. Hiller (1988) also defines meta-adjunct questions as questions of meta-cognitive nature inserted throughout the text on students reading comprehension. Higher-order cognitive questions can also ask students to apply knowledge from a previous reading, or interpret a graph or a chart. As an informal assessment tool, this can give a teacher an idea of which students need further focus on the topic.

Hiller argues that meta-adjunct questions are normally of higher order level requiring students to make predictions, speculate, construct and device lifelike problems and

their solutions, express opinions and make choices and decisions (Wiley in his book; *Questioning Skills for Teachers,* 1971). On the other hand, Giacomozzi (2007) argues that meta-adjunct questions are interactive and whenever used, they facilitate active learning.

Meta-adjunct questions are associated with development of meta-cognition. Meta-cognition is a regulatory system that helps a person understand and control their own learning. Hacker (2009) posits that meta-cognitive abilities allow students to take control of their own learning. Meta-cognition enables one to be aware of how they learn, evaluate their learning needs, generate strategies to meet these needs and then implement the strategies. Studies have reported that learners who have developed meta-cognitive abilities show increase in self-confidence. It is this self-confidence that improves motivation and therefore learning success.

2.3.2 Processes of Meta-Cognition

Meta-cognition has two constituent parts; knowledge about cognition and monitoring of cognition, as reported by Lai (2011). Knowledge of cognition is defined as knowledge about one's cognitive strengths and limitations, including both internal and external factors that interact to affect cognition. Lai (2011) classifies this knowledge into three components namely; knowledge of own learning, knowledge of different types of strategies and knowledge of which type of strategy for a given learning situation**.** Lai contends that these three components can interact.

The other part of meta-cognition is regulation of cognition. Researchers have argued that this component includes activities of planning, monitoring or regulation and

evaluation. Therefore it has three components namely; setting own learning goals and planning, monitoring and controlling own learning, evaluating results and strategy used. Planning involves identification and selection of appropriate strategy and allocation of resources including setting goals, activating background knowledge, and managing time. Monitoring or regulation involves attending to and being aware of comprehension and task performance. Monitoring can include self-testing. The last component which is evaluation can be said to be appraisal of the products and regulatory processes of one's learning. Evaluation includes revisiting and resetting one's goals.

2.3.3 Application Meta-Adjunct Questions

Review of literature has identified several applications of meta-adjunct questioning technique. Meta-adjunct questioning has been found to induce higher-order processing and therefore better recall. Andre (1976) was able to demonstrate that when meta-adjunct questions guide the encoding process, better performance was realized. Meta-adjunct questioning can therefore be applied to help students in the following ways;

Firstly, if teachers want students to search for specific textual information, they should consider focusing student's attention on that particular information by asking a pre-question before the text segment containing the said information. This is the basis of the Directed Attention Model DAM according to Andre (1976). In the D.A.M, the teacher can focus the attention of the student on salient information in a passage by posing a purpose question.

Secondly, meta-adjunct questions are applicable when the teacher wants learners to read in a global fashion. Meta- adjunct questions attain this by increasing the students'

overall attentiveness to the text in two ways; by causing them to review text material, and by causing them to anticipate questions hence leading them to become attentive.

Thirdly, meta-adjunct questions are applied by teachers who wish to provide more individualized instruction. Readers who have difficulty in focusing on any information benefit from the question placement of meta-adjunct questions.

Finally, teachers who intend to develop their students' ability to ask questions can use meta-adjunct questions to model the type of questions they want students to ask.

Teachers can use the reciprocal questioning technique to develop students' ability to formulate their own questions about reading material (Manzo, 1969). This can be done by placing meta-adjunct questions in different text locations to point out to students where it would be appropriate to ask different types of questions.

In particular, all the above applications are meant to help students who are poor at comprehending to be able to organize and relate the text material to the main idea.

In literature, meta-adjunct questions have mainly been used to enhance comprehension especially for second language learners (Brantmeir et al. 2011). They enable the learner to fill in the gaps for unsaid facts in a given texts. According to Andre (1969), meta-adjunct questions direct students to attend to more of the material and thus, to recall information directly related to the knowledge needed to respond to a question.

2.3.4 The Role of Meta-Adjunct Questions

Instructional design experts emphasize the role of meta-adjunct questions in learning and improving the knowledge (Nuray, 2003). Under certain conditions, the

incorporation of questions in the instructional material (i.e., adjunct questions) facilitates learning due to their "Mathemagenic" properties (Rothkopf, 1966). "Mathemagenic" was coined by Rothkopf to mean those activities that "give birth to learning," i.e. those kinds of actions or "inspection" behaviors executed by the learner while reading a piece of text that lead to the achievement of specified instructional objectives. Adjunct questions refer to questions put in, before or immediately after prose passages and asking students to answer such questions while studying the passages (Lai & Elen, 2011). This is a scaffold approach to instruction for improving comprehension so that learners move from basic knowledge to deep understanding. Higher-order questions (those that are on the comprehension and application levels of Bloom's taxonomy) are one type of adjunct questions. One assumption shared by most researchers on adjunct questions is that answering higher-order questions requires more than a simple recollection of information, induces more complex cognitive processes and benefits learning (e.g. Andre, 1979; Hamaker, 1986; Hamilton, 1985), in Lai Jiang (2012). Winne (1979) contends that higher order questions ask students to manipulate bits of information previously learned to create an answer with logically reasoned evidence.

According to the cybernetic model of behavior advanced by Frase, 1969, an adjunct question can be used by the learner to monitor their learning i.e. whether or not achieved behavior (what the student places in memory) coincides with the criterion of acceptable behavior (the correct answer). A learner confronted with a question will proceed to read the paragraph to find the answer. Failure to do so will generate an error signal (negative feedback). The error signal has the effect of requiring the learner to alter the strategy applied to subsequent paragraphs to find positive feedback in the form of meeting some (externally or internally imposed) criterion (Sagaria *et*

al., 1978). Adjunct questions, therefore, direct the students' attention to those responses necessary to correctly answer the question. Furthermore, they increase the probability that the learner responds discriminately in unique ways and depending on the implied objectives, to the passage.

Although theoretically it is widely accepted that questions deeply influence the processing of instructional materials, the evidence from extensive research on the effects of high cognitive questions is not always consistent and conclusive, (Dornish & Sperling, 2006, in Lai J. 2012). In the work of Brantmeier *et a*l. (2011), second language L2 learners of Spanish utilized domain specific embedded items. Results revealed no significant effect of inserted adjunct questions for recall and multiple choice items. Mean recall scores for embedded elaborative questions were high, whereas the mean recall score for a version without adjunct was lower. This may mean that the depth of operation is the relevant operation to focus on (Segaria and Di Vesta, 1978). Thus, more studies need to be conducted that provide information about the efficacy of higher-order adjunct questions.

2.4 Theoretical Basis of Meta-adjunct Questioning

The following theories guide Meta-adjunct questioning:

2.4.1 The Mathemagenic Theory

In 1966, Rothkopf coined the term mathemagenic for behaviors that lead to learning. Mathemagenic theory is one of the first theories of learning that focused on internal processes. His ideas were based on his observations that what students learned from instruction is a transformed version of the knowledge their instructor intended to impart. Rothkopf thought that this would require more than just the stimulus-response

model of behaviorism. In this theory, Rothkopf offers an explanation for the effects of meta-adjunct questions in facilitating recall of information. Mathemagenic, as explained by Rothkopf refers to those activities that give birth to learning i.e. those kinds of actions or inspection behavior executed by the learner while reading a piece of text that lead to the attainment of specified instructional objectives.

Rothkopf explains this concept of mathemagenic activities as moving away from the black box of stimulus-response behaviorism. The argument of the theory is that during instruction, learners often learn something different than expected. This is because learners develop personal interpretations of instruction through active observation and transformation. These observations and transformations constitute mathemagenic behaviors. Rothkopf explains mathemagenic activities can be classified into three classes; overt (observable behavior in learning), attendance to these materials, and translation and processing of new information.

Moeser notes that what precisely these mathemagenic strategies constitute has never been clearly determined (Moeser, 1978). Rickards (1979) agrees with Moeser that the term mathemagenic is too amorphous and inadequately explains how different types of questions as specified by the Bloom's taxonomy, (1956), would influence the kinds of information recalled.

2.4.2 The Directed Attention Model (D.A.M)

The directed attention model (D.A.M) suggested by Andre (1979) offers an attempt to explain how different types of questions affect prose learning. Earlier studies on adjunct questions (Rothkopf & Bisbiscos, 1967; Watts & Anderson, 1973) had

reported that experimental group provided with the "higher-order" questions recalled more information than the group with "lower-order" questions. According to Andre, this is the "directed attention effect" where higher-level adjunct questions are to direct students to attend to more of the material and thus, to recall information directly related to the information needed to answer the questions (Andre, 1979, p.287)

According to the D.A.M, "Attention" is the processing of information to form a "unified mental structure that combine the elements attended to" (Andre, 1979, p.289). Higher-level items encourage learners to attend and semantically encode more information and thus facilitate the recall of more information. However, this effect will be at its maximum only if the learner sees his or her task as one of the "principle of least effort." In other words, the learner has only a "finite amount of processing capacity and thus is using only a few strategies" (Andre, 1979, p.293) as specified by the question. Higher-order questions will thus be most effective in enhancing comprehension among learners.

On the other hand, if the learner perceives his or her task to be one of learning as much as possible from the material, then the higher cognitive questions may not make a difference i.e. the directed attention effect will not operate. Since higher ability and mature learners tend to process all sorts of information using multiple strategies, the attempt by higher order questions to facilitate comprehension is greatly reduced.

In summary, the D.A.M postulates that different levels of adjunct questions cue learners to adopt different strategies when encoding information. Therefore, the effect of higher cognitive questions is to direct the reader's attention to more of the material

in the text. Having to attend to more, the reader can recall more facts than those who have to answer lower order or factual level questions on specific items only.

2.3.3 The Elaboration Theory

Anderson and Reder (1979), present an alternative view. They argue that "meaning is not simply processed as either all or none as dictated by the orienting tasks. Instead, meaning is processed as a continuum of elaborations, and retention is determined by the number of elaborations performed on the information."

According to the elaboration theory, instruction should be organized in increasing the order of complexity for optimal learning. In all lessons, the learner should be reminded of all levels taught. The key idea of elaboration theory is that the learner needs to develop a meaningful context into which meaningful ideas and skills can be assimilated. Elaboration theory proposes seven major strategy components: elaborative sequence, learning prerequisite sequences, summary, synthesis, analogies, cognitive strategies, and learner control. Elaborative sequence (simple to complex) is the most important as far as this theory is concerned.

It is claimed that elaboration approach results in the formation of more stable cognitive structures. The basic assumption of the Elaboration Hypothesis is that information is represented in long-term memory as a network of interconnected propositions (Anderson, 1979). As a learner encounters information, new propositions are added to this memory network that can vary in richness and redundancy.

2.5 Conceptual Framework

From literature, meta-adjunct questions are mainly high-level questions. High-level questions have been found to be the one at the last three levels in the Bloom's taxonomy (Fan *et.al,* 2014). They test analysis, evaluation, creation, logical thinking, judgment, critical thinking, and problem-solving. In chemistry, the specific skills developed include analytical skills, data collection and data interpretation, and innovativeness. If students utilize meta-adjunct questioning in chemistry then the product will be development of meta-cognitive abilities and

high academic achievement in chemistry. This conceptualization is represented in figure 1 below.

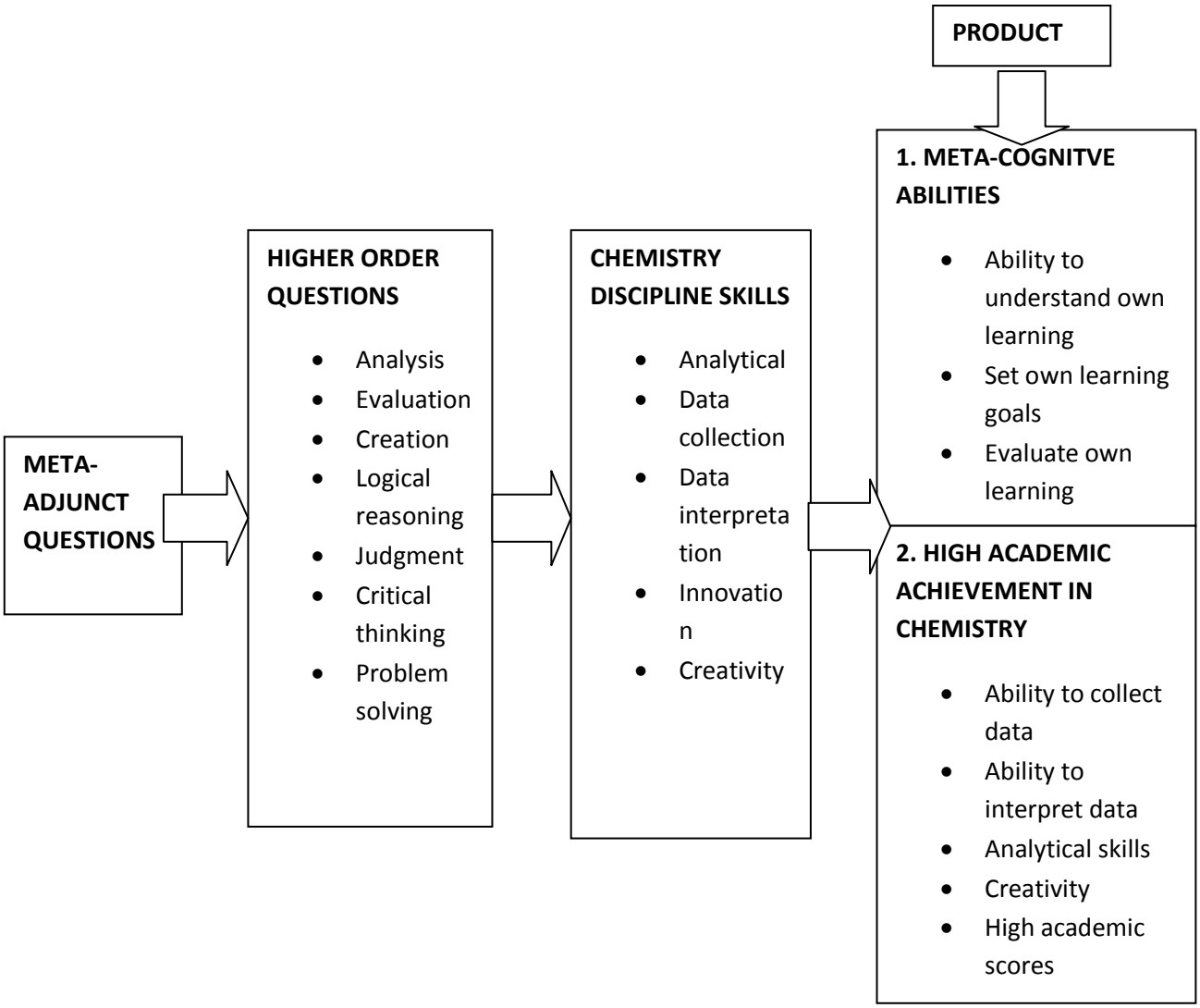

Figure 1: Conceptual framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter describes the research methodology used in this study and provides a general framework for this research. Details of research design, target population, sample and sample size, sampling procedures, research instrument, validity and reliability issues, data collection procedures, data analysis techniques and ethical issues while conducting research.

3.1 Research Design

Ogula (2005) argues that a research design is a plan, structure, and strategy of investigations to obtain answers to research questions and control variance. Orodho (2003) further defines a research design as the scheme, outline, or plan used to generate answers to research questions. This study employed a pre-test delayed post test research design to collect quantitative data so as to compare participant groups. The design involved classification of participants, measurements, analysis, comparison, and interpretation of data.

3.2 The Sample of the Study

The target population for this study was secondary school students in form three in Hamisi sub-county, Vihiga County in Western Kenya. Mugenda (1999) defines a sample as a small group obtained from the accessible population. This sub-group

should be selected skillfully in order for it to be a representative sample of the larger population with the relevant characteristics.

Four intact form three classes in Hamisi sub-county secondary schools participated in the study. The schools were selected based on their previous year (2014) KCSE mean scores and gender. These four classes participated in the study by studying an inquiry based learning passage on making ammonia and writing a high-order metacognitive test.. The sample for the study was drawn from two high performing (2014 KCSE mean $\geq$ 7.00) boys and girls schools and two low performing (2014 KCSE mean $\leq$ 4.60) boys and girls schools. Since the population of form three students in Vihiga County is about 3000, the rule of thumb on sample size will be 10% (John Curry, 1984 in Yount, 2006). The sample (n= 307) was therefore purely form three students. Of this, some (n=207) were male while the remaining (n=180) were females. The subjects were arrived at by stratified sampling of schools by gender and performance in 2014 KCSE as reported in the D.E.O reports (Hamisi Sub-county, 2014).

3.3 The Sampling technique

Sampling is a procedure or process of choosing a sub-group from a population to participate in the study (Ogula, 2005). It is a process of selecting a number of individuals for a study in such a way that the individuals selected represent the large group from which they are selected. This study employed stratified sampling plan. The accessible population was divided into relevant strata such as gender and the school's level of performance according to KCSE 2014 mean scores. Four schools were selected to take part in the study. Two of the schools were boys only were the other two were girls' school. Of the two pairs, one was a top performer (2014 KCSE mean $\geq$ 7.00) while the other was a low performer (2014 KCSE mean $\leq$ 4.60). In

summary, the schools were stratified according to performance in 2014 KCSE (high and low performers) and the best two in each stratum selected.

3.4 Data Collection Instruments

The study utilized both primary and secondary data. Secondary data was the academic achievement of teacher-made tests. These data were retrieved from the subject teachers' progress records.

Primary data was collected empirically using an inquiry based learning text and an inquiry based learning worksheet developed by *Creative Chemistry* website with permission. The instrument comprised of two texts and two tests. Test I was paired with a text without meta-adjunct questions while test II paired with meta-adjunct questions. The meta-adjunct questions used were mainly of higher order level.

3.5 Data Collection Process

Prior to collecting data, the researcher obtained necessary documents including authority to collect data from the University and D.E.O Hamisi sub-county. Upon getting clearance, the researcher with the assistance of from three chemistry teachers in participating schools administered the texts and tests over a period of one month. An interval of two weeks was given before administering test II in order to reduce the effect of carryover knowledge. Test I was scored by the researcher since it included multiple choice items which are relatively easy to mark without bias. Test II was however marked by two experienced KNEC examiners to establish the reliability of

the instrument. During the administration of the tests, the purpose of the study was explained to participants.

3.6 Data Analysis Procedure

Both qualitative and quantitative approaches were used to analyze data. Quantitative data from test scores was entered into the computer for descriptive statistics. Statistical package for social sciences (SPSS) version 19 was used to run descriptive statistics such as frequency tables, and one-way multivariate analysis of covariance. The qualitative data such as gender and school type were reported alongside quantitative data in accordance with research objectives.

3.7 Validity and Reliability

3.7.1 Validity

Validity refers to the degree to which the evidence and theory support the interpretation of test scores entailed by the use of tests. The validity of the instrument is the extent to which it does measure what is supposed to measure. According to Mugenda and Mugenda (1999), validity is the accuracy and meaningfulness of inferences, which are based on research results. It is the degree to which the results obtained from the data analysis actually represent variables of the study. The instrument was sought creative chemistry website. The instruments' validity was already established since it is a published instrument. The letter of permission to use the instrument is attached in the appendix section. The research instruments were validated regarding content and face validity. The question items reflected the specific areas of the chemistry syllabus covered.

3.7.2 Reliability

Reliability is the ability of research instruments to consistently measure characteristics of interests over time. It is the degree to which a research instrument yields consistent results or data after repeated trials. Mugenda (1999) argues that if a researcher administers a test to a subject twice and gets the same score on second administration as the first, then there is reliability of instruments. The inter-scorer technique was used to estimate the reliability of the instruments. This involved two scorers rating the same test for the participating students. A quantitative determination was performed using SPSS version 20.0 computer program to test statistically the reliability of the research instrument. The sum variables were used in the analysis. A correlation co-efficient was then worked out using Spearman's Product Moment Correlation. A correlation co-efficient of 0.92 showed a strong reliability of the research instrument.

3.8 Ethical Considerations in Research

The researcher explained to the respondents about the research and that the study was for academic purpose only. It was made clear that participation was voluntary and that the respondents were free to decline or withdraw any time during the research period. Respondents' privacy was protected by a strict standard of anonymity.

CHAPTER FOUR
RESEARCH RESULTS

4.0 Introduction

This chapter presents the data collected from respondents (students from secondary schools). The respondents are grouped by school type (low performing or high performing) and gender (male or female). The tests (data collecting instruments) are attached to appendices IV and V.

4.1 Demographics

This study employed a total of 387 participants with 207 being males and 180 females.

Table 1: Distribution of students by Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	207	53.5	53.5	53.5
	Female	180	46.5	46.5	100.0
	Total	387	100.0	100.0	

The participants were drawn from schools within Hamisi Sub County in Vihiga County. The participants were further divided into four groups namely; Low performing males (98) low performing females (78), High performing males (109) and High performing females (102).

Figure 4.0: distribution of students according to gender and school category

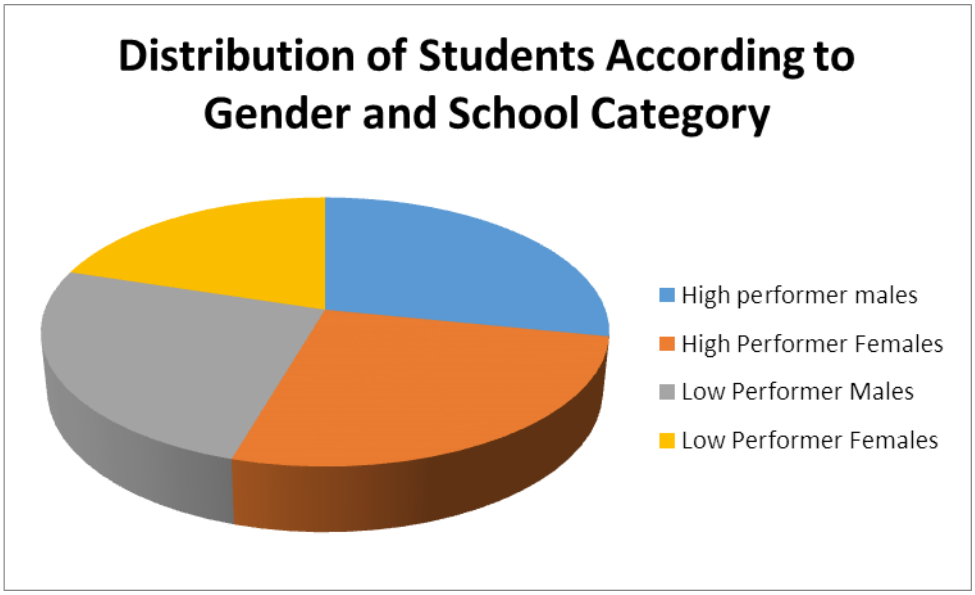

Figure 2: Performance Levels by Gender

Schools were categorized into either low performing or high performing according to previous year's (2014) KCSE results obtained from the sub-county education office.

Table 2: Distribution of students by nature of school

Category of school	2014 KCSE Mean Scores	Number of students	Percentage
High performer males	8.20	109	28.20
High performer females	8.03	102	26.40
Low performer males	4.49	98	25.30
Low performer females	4.94	78	20.20

Source: Hamisi Sub-county education office 2015

It can be noted that majority of the students were high performer male (28.2%) while 26.4% were high performer females. Some 25.3% were males from a low-performing school while the remainder (20.2%) was females from a low-performing school.

4.2 Data Analysis

4.2.1 Objective One: To determine if meta-adjunct mode of questioning has an effect on academic attainment of high and low achieving students

First and foremost, the study set to determine if the meta-adjunct mode of questioning has an effect on academic attainment of high and low achieving students. Students were organized into low and high performing schools as shown in table above.

Table 4.3 below presents results of students on test 1 and test 2.

Table 3: Tests Results

Category of school	Test 1(mean1)	Test 2(mean2)	mean 2-mean1
High performer males	53.83	57.62	3.79
High performer females	52.45	55.39	2.94
Low performer males	31.12	41.97	10.85
Low performer females	33.97	48.44	14.47

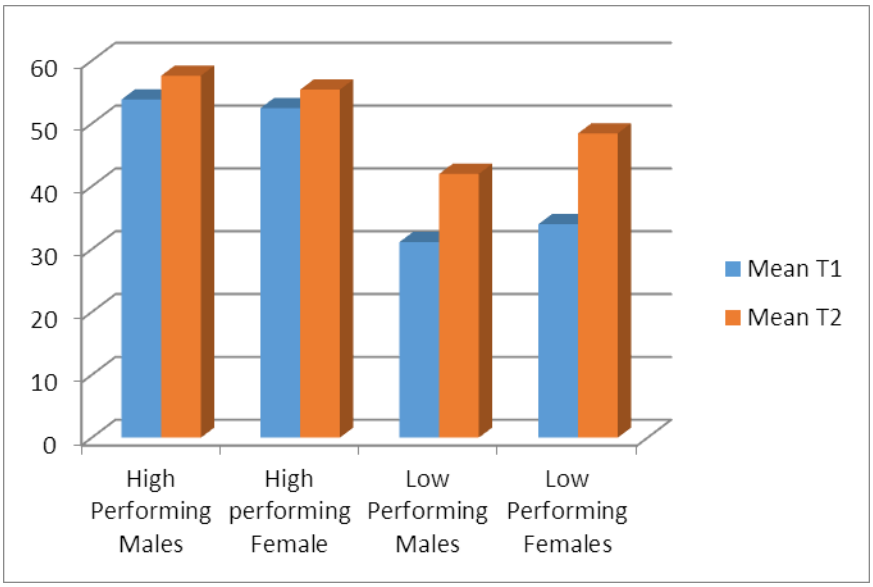

Figure 3: Performance of students on tests 1 and 2

One-way multivariate analysis of variance was run to determine the effect of meta-adjunct mode of questioning on academic attainment of high and low achieving

students. Two measures of academic performance were assessed; Test 1 and Tests 2 scores. Data are expressed in mean± standard deviation. Preliminary assumption checking revealed that data was normally distributed, as assessed by Q-Q plot test.

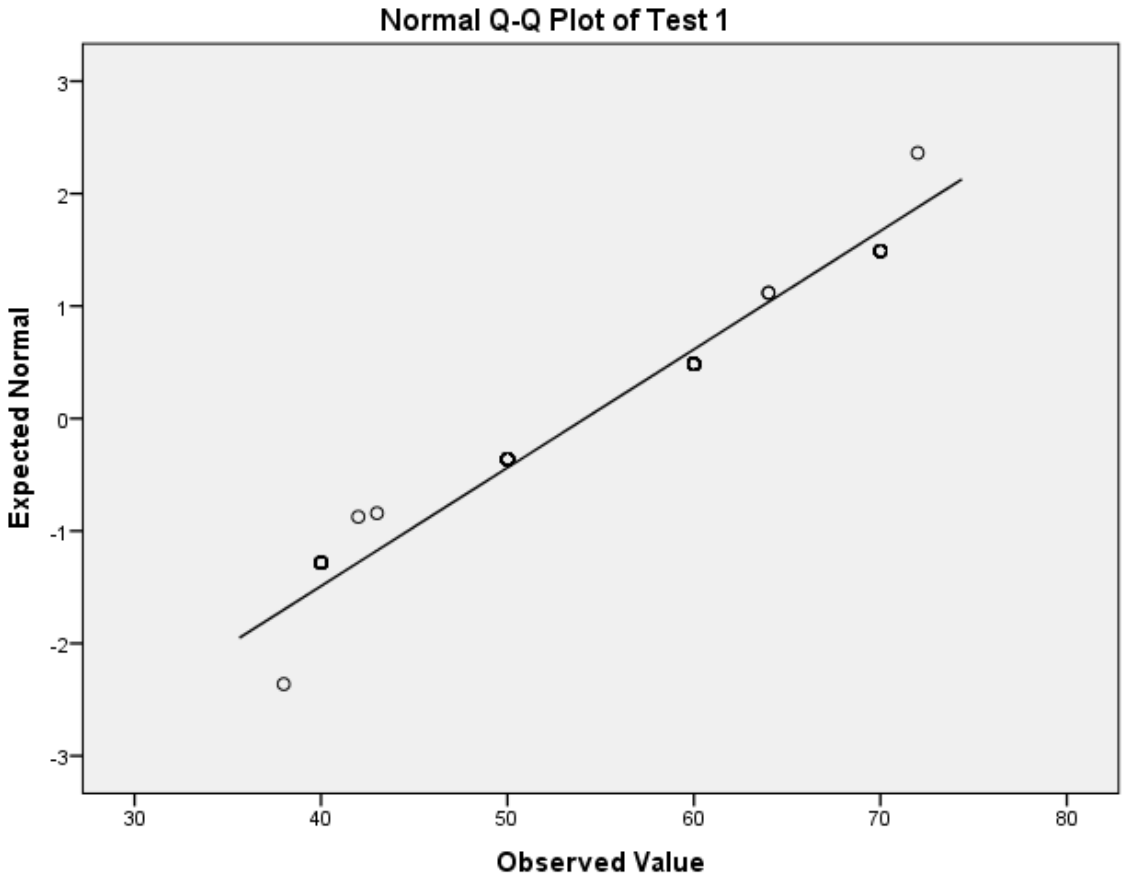

Figure 4: Normal Q-Q Plot of Test 1

There were no univariate or multivariate outliers as assessed by Mahalanobis distance ($p>0.001$). There were linear relationships as assessed by scatter plots, no multicollinearity ($r= .405$, $p= .001$).

Table 4: Correlations coefficients for test 1 and test 2

		Test 1	Test 2
Test 1	Pearson Correlation	1	.405**
	Sig. (2-tailed)		.000
	N	387	387
Test 2	Pearson Correlation	.405**	1
	Sig. (2-tailed)	.000	
	N	387	387

There was also homogeneity of variance-covariance matrices, as assessed by Box's M test ($p>0.003$).

Table 5: Test of Equality of Covariance Matrices

Box's M	123.960
F	13.641
df1	9
df2	1308766.910
Sig.	.002

Scores of test 2 were higher than scores of test 1. The difference between students (high-performing males, high-performing females, low-performing males, low-performing females) on combined dependent variable (test 1 and test 2) was statistically significant F (6,764) =59.519, p<.005, Wilk's lambda=.464; Partial eta squared=.319.

Table 6: Multivariate Tests for high and low academic achievers on test 1 and test 2

Effect		Value	F	Hypothesis df	Error df
Intercept	Pillai's Trace	.961	4710.136[b]	2.000	382.000
	Wilks' Lambda	.039	4710.136[b]	2.000	382.000
	Hotelling's Trace	24.660	4710.136[b]	2.000	382.000
	Roy's Largest Root	24.660	4710.136[b]	2.000	382.000
School_category	Pillai's Trace	.592	53.713	6.000	766.000
	Wilks' Lambda	.464	59.519[b]	6.000	764.000
	Hotelling's Trace	1.031	65.489	6.000	762.000
	Roy's Largest Root	.895	114.258[c]	3.000	383.000

Table 7: Multivariate Tests

Effect		Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.000	.961[b]
	Wilks' Lambda	.000	.961[b]
	Hotelling's Trace	.000	.961[b]
	Roy's Largest Root	.000	.961[b]
School_category	Pillai's Trace	.000	.296
	Wilks' Lambda	.000	.319[b]
	Hotelling's Trace	.000	.340
	Roy's Largest Root	.000	.472[c]

A follow-up univariate ANOVAs indicated that scores of tests1 and 2 were significantly different for high and low performing students, F(6,764)= 59.519, p<.005, Wilk's lambda= .464 ; partial eta squared =.319.

4.2.2 Objective Two: To determine if the effect of meta-adjunct mode of questioning o academic attainment depends on student gender

Secondly, the study sought to determine if the effect of meta-adjunct mode of questioning depends on student gender. 207 male students and 180 female students took part in the study.

Table below presents students' results on test1 and test 2 according to student gender.

Table 8: Students' Results According To Gender

Student Gender	Test 1(mean1)	Test 2(mean2)	mean 2-mean11
Males	42.90	49.80	6.90
Females	43.21	51.915	8.71

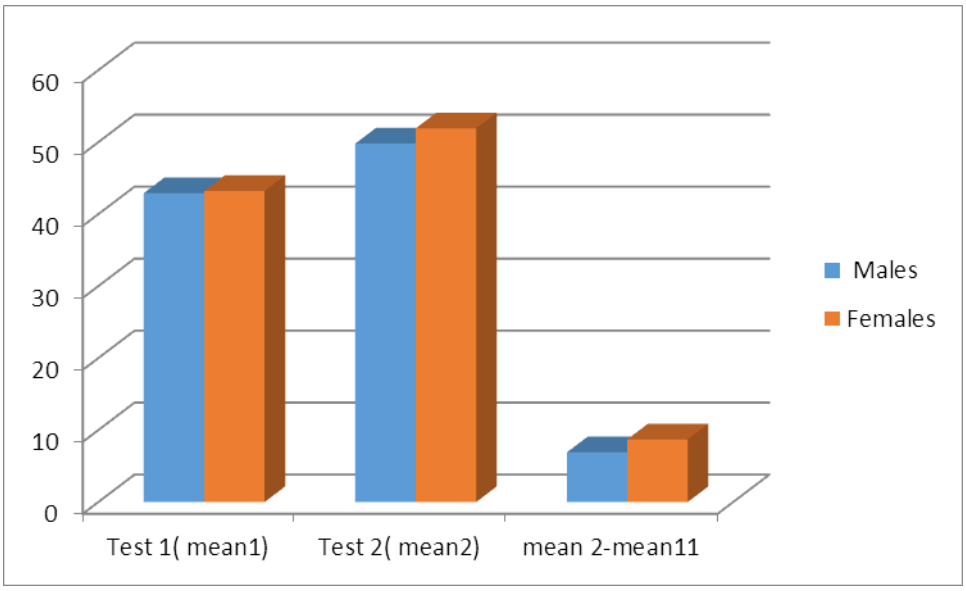

Figure 5: Graphical representation of students' results according to gender

A one- way multivariate test was run to determine the effect meta-adjunct mode of questioning on student gender. Assumptions of one-way MANOVA (non multi-collinearity and absence of outliers) were not violated. The difference between the groups on combined dependent variable was statistically significant. F (2,384) =8.553, $p<0.005$, Wilky's lambda= 0.957, partial n^2= .943

Table 9: Multivariate Tests gender and performance on test two

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.943	3183.319[b]	2.000	384.000	.000
	Wilks' Lambda	.057	3183.319[b]	2.000	384.000	.000
	Hotelling's Trace	16.580	3183.319[b]	2.000	384.000	.000
	Roy's Largest Root	16.580	3183.319[b]	2.000	384.000	.000
Gender	Pillai's Trace	.043	8.553[b]	2.000	384.000	.000
	Wilks' Lambda	.957	8.553[b]	2.000	384.000	.000
	Hotelling's Trace	.045	8.553[b]	2.000	384.000	.000
	Roy's Largest Root	.045	8.553[b]	2.000	384.000	.000

Table 10: Multivariate Tests

Effect		Partial Eta Squared
Intercept	Pillai's Trace	.943
	Wilks' Lambda	.943
	Hotelling's Trace	.943
	Roy's Largest Root	.943
Gender	Pillai's Trace	.043
	Wilks' Lambda	.043

Univariate ANOVAs that was conducted as follow up indicated that both test 1 and test 2 performance were not significantly different for students of different gender (male and Female). F (2, 384) =8.553, p= .0051

4.2.3 Objective Three: To establish if the effect of Meta adjunct mode of questioning depends on students' academic performance

The last aim of the study was to establish if the effect of Meta adjunct mode of questioning depends on students' academic performance. In this study, academic performance was the score that students had attained on the previous test score administered by the subject teacher prior to research. Tests scores of CAT 1 Term two were therefore utilized as academic performance. The test scores were obtained from examinations departments of each school with the authority of the school Principal.

A one way-MANOVA was conducted to compare the score of test 2 and academic performance. A significant difference was found, F (6, 764) =50.151, p<.005, multivariate = .515.

Table 11: Multivariate Tests 1

Effect		Value	F	Hypothesis df	Error df
Intercept	Pillai's Trace	.958	4357.461[b]	2.000	382.000
	Wilks' Lambda	.042	4357.461[b]	2.000	382.000
	Hotelling's Trace	22.814	4357.461[b]	2.000	382.000
	Roy's Largest Root	22.814	4357.461[b]	2.000	382.000
School_category	Pillai's Trace	.538	46.964	6.000	766.000
	Wilks' Lambda	.515	50.151[b]	6.000	764.000
	Hotelling's Trace	.841	53.384	6.000	762.000
	Roy's Largest Root	.693	88.520[c]	3.000	383.000

Table 12: Multivariate Tests 2

Effect		Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.000	.958[b]
	Wilks' Lambda	.000	.958[b]
	Hotelling's Trace	.000	.958[b]
	Roy's Largest Root	.000	.958[b]
School_category	Pillai's Trace	.000	.269
	Wilks' Lambda	.000	.283[b]
	Hotelling's Trace	.000	.296
	Roy's Largest Root	.000	.409[c]

Examination of coefficients for linear combinations distinguishing academic performance indicated that previous grades contributed most to distinguishing the groups.

Table 13: Post-hoc tests

Dependent Variable	(I) Category of school	(J) Category of school	Mean Difference (I-J)
AP	High performers (Male)	High Performers (Female)	4.7864
		Low perfomers (Male)	21.0413*
		Low performers(Female)	23.0797*
	High Performers (Female)	High performers (Male)	-4.7864
		Low performers (Male)	16.2549*
		Low performers(Female)	18.2934*
	Low performers (Male)	High performers (Male)	-21.0413*
		High Performers (Female)	-16.2549*
		Low performers(Female)	2.0385
	Low performers(Female)	High performers (Male)	-23.0797*
		High Performers (Female)	-18.2934*
		Low perfromers (Male)	-2.0385
Test 2	High performers (Male)	High Performers (Female)	2.1029
		Low perfromers (Male)	15.5255*
		Low performers(Female)	1.0192
	High Performers (Female)	High performers (Male)	-2.1029
		Low perfromers (Male)	13.4226*
		Low performers(Female)	-1.0837
	Low perfromers (Male)	High performers (Male)	-15.5255*
		High Performers (Female)	-13.4226*
		Low performers(Female)	-14.5063*
	Low performers(Female)	High performers (Male)	-1.0192
		High Performers (Female)	1.0837
		Low perfromers (Male)	14.5063*

Table 14: Multiple Comparisons

Dependent Variable	(I) Category of school	(J) Category of school	Std. Error	Sig.
AP	High performers (Male)	High Performers (Female)	1.75206	.033
		Low perfromers (Male)	1.77043*	.000
		Low performers(Female)	1.88617*	.000
	High Performers (Female)	High performers (Male)	1.75206	.033
		Low perfromers (Male)	1.79896*	.000
		Low performers(Female)	1.91298*	.000
	Low perfromers (Male)	High performers (Male)	1.77043*	.000
		High Performers (Female)	1.79896*	.000
		Low performers(Female)	1.92982	.716
	Low performers(Female)	High performers (Male)	1.88617*	.000
		High Performers (Female)	1.91298*	.000
		Low perfromers (Male)	1.92982	.716
Test 2	High performers (Male)	High Performers (Female)	1.75405	.628
		Low perfromers (Male)	1.77245*	.000
		Low performers(Female)	1.88832	.949
	High Performers (Female)	High performers (Male)	1.75405	.628
		Low perfromers (Male)	1.80101*	.000
		Low performers(Female)	1.91516	.942
	Low perfromers (Male)	High performers (Male)	1.77245*	.000
		High Performers (Female)	1.80101*	.000
		Low performers(Female)	1.93202*	.000
	Low performers(Female)	High performers (Male)	1.88832	.949
		High Performers (Female)	1.91516	.942
		Low perfromers (Male)	1.93202*	.000

Table 15: Multiple Comparisons

Dependent Variable	(I) Category of school	(J) Category of school	99% Confidence Interval
			Lower Bound
AP	High performers (Male)	High Performers (Female)	-.7044
		Low perfromers (Male)	15.4929*
		Low performers(Female)	17.1687*
	High Performers (Female)	High performers (Male)	-10.2771
		Low perfromers (Male)	10.6171*
		Low performers(Female)	12.2983*
	Low perfromers (Male)	High performers (Male)	-26.5896*
		High Performers (Female)	-21.8927*
		Low performers(Female)	-4.0094
	Low performers(Female)	High performers (Male)	-28.9908*
		High Performers (Female)	-24.2884*
		Low perfromers (Male)	-8.0863
	High performers (Male)	High Performers (Female)	-3.3941
		Low perfromers (Male)	9.9708*
		Low performers(Female)	-4.8986
	High Performers (Female)	High performers (Male)	-7.6000
		Low perfromers (Male)	7.7784*
		Low performers(Female)	-7.0856
Test 2	Low perfromers (Male)	High performers (Male)	-21.0802*
		High Performers (Female)	-19.0667*
		Low performers(Female)	-20.5610*
	Low performers(Female)	High performers (Male)	-6.9370
		High Performers (Female)	-4.9182
		Low perfromers (Male)	8.4515*

Table 16: Multiple Comparisons

Dependent Variable	(I) Category of school	(J) Category of school	99% Confidence Interval
			Upper Bound
AP	High performers (Male)	High Performers (Female)	10.2771
		Low perfromers (Male)	26.5896*
		Low performers(Female)	28.9908*
	High Performers (Female)	High performers (Male)	.7044
		Low perfromers (Male)	21.8927*
		Low performers(Female)	24.2884*
	Low perfromers (Male)	High performers (Male)	-15.4929*
		High Performers (Female)	-10.6171*
		Low performers(Female)	8.0863
	Low performers(Female)	High performers (Male)	-17.1687*
		High Performers (Female)	-12.2983*
		Low perfromers (Male)	4.0094
Test 2	High performers (Male)	High Performers (Female)	7.6000
		Low perfromers (Male)	21.0802*
		Low performers(Female)	6.9370
	High Performers (Female)	High performers (Male)	3.3941
		Low perfromers (Male)	19.0667*
		Low performers(Female)	4.9182
	Low perfromers (Male)	High performers (Male)	-9.9708*
		High Performers (Female)	-7.7784*
		Low performers(Female)	-8.4515*
	Low performers(Female)	High performers (Male)	4.8986
		High Performers (Female)	7.0856
		Low perfromers (Male)	20.5610*

4.3 Summary of Results

Regarding objective 1, the main outcome is that the effect of meta-adjunct mode of questioning appears to depend on whether students are high performers or low performers. The analysis reveals that low-performing students who utilized meta-adjunct questions tend to perform significantly better in comparison to high performers.

Secondly, the effect of meta-adjunct mode of questioning seems not to be dependent on student gender. Even though low-performing girls had a much more significant mean difference, boys too had a positive deviation on test two but slightly smaller than for girls.

Finally, it appears that the effect of meta-adjunct mode of questioning tends to depend on academic performance. Low achieving students tend to gain more from meta-adjunct mode of questioning.

The overall result indicates that meta-adjunct mode of questioning enhances students' academic success. All the four groups of students showed a positive deviation when results of test 2 were compared to results of test 1.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.0 Introduction

Chapter one of the study was mainly concerned with the purpose of the research. It introduced the proposed study by stating and describing the problem of investigation. It concluded by defining some terminologies as they are applicable to the research study. Chapter two purely focused on literature review on meta-adjunct mode of questioning in educational testing. In this chapter it was discovered that meta-adjunct questions can develop students' meta-cognitive abilities. Chapter three described the methodology and design of research study. It also described the population and sample employed to collect the quantitative data. Form three students in secondary schools were used to collect data. The mode of selection was purposive. Chapter four was dedicated to the data analysis using one-way multivariate analysis of variance method and interpretation of results that subsequently led to the findings and recommendations.

This chapter will present the summary of findings from the analysis of research results, conclusion after interpreting results and then recommendations of the findings with identification of proposed areas of future study.

The overall purpose of the study was to determine the effect of meta-adjunct mode of questioning on academic attainment. To accomplish that goal, some smaller objectives had to be addressed. Since learners have dynamic characteristics, the effect of meta-adjunct mode of questioning was tested for learners from different schools-

High performing and low performing, gender, and academic performance. Once this categorization had been done, the study was able to move forward.

5.1 Summary of the Study

5.1.1 Summary of Objective One: To determine if meta-adjunct questioning has an effect on learners of high and low academic achieving students.

Objective one of the study was to determine if meta-adjunct questioning has an effect on learners of high and low academic achieving students. All the assumptions of multivariate analysis of variance were not violated. The main outcome is that meta-adjunct mode of questioning appears to have an effect on high performing and low performing students. However, the analysis reveals that low performing students who utilized meta-adjunct questions tend to perform significantly better in comparison to high performers. It can therefore be said that meta-adjunct mode of questioning works best for low achievers.

5.1.2 Summary of Objective Two: To determine whether the effect of meta-adjunct questioning established in objective one above depends on student gender

Objective two of the study was to determine whether the effect of meta-adjunct questioning established in objective one above depends on student gender. The study utilized students of both gender. Of the participants, some (n=207) were males while the rest (n= 180) were females. The analysis of results showed that both male and female students were significantly affected by meta-adjunct mode of questioning. The effect of meta-adjunct mode of questioning, therefore, seems not to be dependent on

student gender. Even though low performing girls had a much more significant mean difference, boys too had a positive deviation on test two but slightly smaller than for girls. The differences in girls' and boys' mean marks were not significantly wide.

5.1.3 Summary of Objective Three: To determine if the effect of meta-adjunct questioning depended on student performance o teacher-made test

Objective three of the study was to determine if the effect of meta-adjunct questioning depended on student performance o teacher-made test. From the analysis of research results, it appears that students with low grades on teacher made tests benefit more from meta-adjunct questions. This is likely due to the fact that meta-adjunct questions can motivate students to learn. Students with high scores on teacher made tests are already motivated.

The study was triggered by the knowledge that questions well framed can enhance learning and the need to develop Meta cognitive abilities of students through formative assessment. Formative assessment is conducted by the teacher in the course of curriculum delivery. Results from formative assessment are fed into the system to improve instruction. This type of testing can also be used to develop skills such as problem solving and creativity.

5.2 Conclusion

The main aim of the study was to determine the effect of meta-adjunct mode of questioning on academic attainment. To accomplish that goal, some smaller objectives had to be addressed. The results analysis was organized in such a way that it established whether meta-adjunct question depended on the academic performance

of the school, gender and performance on teacher made tests. Conclusions of the study were therefore made within framework of this scope as follows.

First, the study established that meta-adjunct mode of questioning has a greater effect on low achieving students. In literature it was found that meta-adjunct questions are used to motivate student learning. It can therefore be concluded that meta-adjunct questions greatly motivate low performing students. Also, research has established that meta-adjunct questions facilitate recall of information as explained by Rothkopf in the form of "Mathemagenic" hypothesis. This serves to boost memory of the learner. It can also be concluded that since high performing students are already motivated, meta-adjunct questions will have little effect. Secondly, the study established that even though both girls and boys showed improvement on grades, girls had the biggest improvement. The import of this finding is that meta-adjunct questioning has more promise in improving the performance of girls in chemistry. Girls normally have low ability in science subjects and therefore meta-adjunct questions will motivate them. Finally, meta-adjunct questions

The objectives of this study have been met as outlined. The need for meta-adjunct mode of questioning in formative assessment in Hamisi sub-county has been pointed out.

In this chapter a summary of the research project have been given. The findings as well as recommendations for utilizing meta-adjunct mode of questioning have been presented.

Meta-adjunct mode of questioning is very important and contributes to secondary school academic performance. Key components of meta-adjunct questioning are therefore are Boost to memory and improved level of knowledge processing. It is

essential that the above key concepts be understood by classroom teachers who are usually engaged in educational measurement and evaluation.

5.3 Recommendations

The following recommendations are made to assist in the use of meta-adjunct mode of question in formative assessment:

Recommendations for the teacher

- It is recommended that in the course of teaching, teachers should ask specific and clear questions that learners cannot answer with a simple yes or no. Teachers should communicate the question in such a way that the students understand what type of answer is expected.
- It is recommended that teachers should let learners to generate questions of their own in the course of instruction.
- It is also recommended that teachers should use meta-adjunct questions in formative assessment as the technique shows a lot of promise in enhancing academic attainment and development of meta-cognitive abilities.
- When using higher-order question in teaching, it is recommended that the teacher should teach students strategies for drawing inferences.
- It is recommended that low performing girls be taught using a lot of practice on meta-adjunct questions to motivate them to learn.

Recommendations for the teacher trainers

- Teacher training program should have a component of questioning techniques. Educational measurement and evaluation should be given more time as a unit.

- Teacher trainers should train pre-service teachers on how to employ meta-adjunct questions in their instruction
- Teachers should be trained on how to develop a learner's meta-cognitive abilities through questioning.

Recommendations to Curriculum Planners

- It is recommended that rather than just assigning questions at the end of the chapter as activities, these same questions may be more profitable when inserted before or immediately after a specific portion of the reading in text books.

5.4 Further Research

The following suggestions are recommended for further research:

- It is recommended that further research on meta-adjunct questioning be conducted on students in public and private schools.
- Further research has to be made on effectiveness of meta-adjunct mode of questioning urban and rural school students.

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Appendix I: University Introduction Letter

UNIVERSITY OF NAIROBI

FACULTY OF ARTS
DEPARTMENT OF PSYCHOLOGY

Telegrams: Varsity Nairobi
Telephone: 3318262 ext.28439
Telex: 22095

P.O. BOX 30197
NAIROBI
KENYA

July 2, 2015

TO WHOEVER IT MAY CONCERN

RE: MUNYIRI O JAMES – E58/64126/2013

The above named is a student in the Department of Psychology studying Measurement and Evaluation in Education Psychology programme at the University of Nairobi. He is doing a research on ***"Effect of Meta-adjunct Questioning on Academic Attainment"***. The requirement of this course is that the student conducts research and collects data in the field on the topic area.

In order to fulfill this requirement, I would like to re-affirm that the said student is a registered student and is intending to go and carry out field work. Any assistance accorded to him will be highly appreciated.

Should there be any queries do not hesitate to contact the Chair of the Department of Psychology, University of Nairobi.

DEPARTMENT OF PSYCHOLOGY
UNIVERSITY OF NAIROBI

Dr. Luke Odiemo
Chairman,
Department of Psychology

Appendix II: Research Authority

REPUBLIC OF KENYA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
State Department of Education

Telegrams:
Telephone: 0202334766
Email: deo.hamisi@yahoo.com
When replying please quote

SUB-COUNTY EDUCATION OFFICE,
HAMISI SUB-COUNTY,
P.O. BOX 24-50312,
HAMISI.

Ref/HAM/ADM/98/36

21st July, 2015.

To all Principals
Secondary Schools
HAMISI SUB-COUNTY

RE: AUTHORITY FOR RESEARCH: MUNYIRI O. JAMES E58/64126/2013

The above named person is a bonafide student at University of Nairobi, he pursuing a master of Education.

One of the course requirements is to gather data to enable him write a project paper.

This office therefore authorizes him to carry out research in Secondary schools within the sub-county on "Effects of meta- adjunct questioning on academic attainment".

Please accord him the necessary assistance and cooperation to enable him accomplish this assignment successfully.

DISTRICT EDUCATION OFFICER
HAMISI DISTRICT
P. O. Box 24
HAMISI-50312

ALFRED M. GARI
SUB - COUNTY DIRECTOR OF EDUCATION,
HAMISI SUB-COUNTY.

Cc
County Director of Education
Vihiga County
P.O. Box 645
MARAGOLI

Appendix III: Permission to Use A Published Research Instrument

On 6/26/15, Creative Chemistry Admin info@creative-chemistry.org.uk wrote:

Hello James,

You are most welcome to use the document "N-m07-03 Making ammonia – the Haber process- An Inquiry Based Learning" and the worksheet on inquiry based learning in the way you suggest in your letter. As I say on the site" Permission is granted to reproduce the worksheets for personal and educational use only. Commercial copying, hiring, lending is prohibited. You are free to copy and use any of the worksheets in school or at home, but you may not sell them or pass them off as your own work."

Kind regards,

Dr Nigel Saunders,

Harrogate, UK.

Appendix IV: Consent Form for the Respondent

University of Nairobi

Department of Psychology

P.O.BOX 30197-00100

NAIROBI-KENYA

CELL PHONE: 0710968455

EMAIL: james.okou26@gmail.com

DATE:…….

RESEARCH TITLE: THE EFFECT OF META-ADJUNCT QUESTIONING ON ACADEMIC ATTAINMENT

I ……..understand the aim and purpose of the study undertaken by James Okou. I have read the information provided in this research and understand that I will read an expository text and write a test regarding meta-adjunct questioning.

I also understand that my participation is voluntary and I can withdraw from this study any time without any explanation if I wish. I am also assured that there is no risk in participating in this study.

I append my name signature as a show of acceptance to participate.

Name of participant……..

Signature……..

Date……

Appendix V: Text with meta-Adjunct Questions

The learning passage employed in this study was a 644-word passage entitled " Making Ammonia- The Harber Process" . The passage describes an industrial process of preparing ammonia (Harber Process). The passage was not developed by the researcher. It was acquired from *creative chemistry website* with written permission from Dr. Nigel Saunders of Harrogate University, UK. To ensure that participants could determine responses to questions, the passage was modified so that each embedded item was repeated twice in the same paragraph. The modification was accomplished by a careful rewriting of each text segment so that the repetition was integrated into existing content and was not merely "parroting" of the information. Testable material was distributed evenly throughout the passage.

Participants were required to read and answer the questions in italics inserted in the passage. They were instructed hand in the paper only when satisfied that they understood and answered all the questions.

Appendix VI: Text without Meta-Adjunct Questions

The text material without meta-adjunct questions used was a 644-word passage describing an industrial process of preparing ammonia (Harber Process) acquired from *creative chemistry* with written permission from Dr. Nigel Saunders of Harrogate University, UK. This text did not have embedded items. Participants were required to read and comprehend the main points. Later, participants were required to write high-order test items questions test.

Appendix VII: Test 1

Test 1 was a multiple choice test on declarative memory covering Harber process. The test comprised ten items with four choices. The test items were simplistic in nature only requiring recall and recognition of facts regarding industrial preparation of ammonia.

Appendix VII: Test 2

This was a high order questions test referred to by the author as worksheet on inquiry based learning. The test items were open ended. The test had four items. Item one was identical to test one above but in an open-ended format. Item one mainly tested recall and recognition of facts in four questions. Item two required students to interpret a graph about optimum conditions for production of ammonia. These conditions are contained in the prose passage read earlier. Item two tested drawing inferences and extending knowledge from the industrial process presented in appendix V.