THE CONTRIBUTION OF SESEMAT TO SCIENCE TEACHERS' PEDAGOGIC PRACTICES IN SELECTED SECONDARY SCHOOLS IN MBALE DISTRICT

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BY

ROSEBUD BUTEME

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DECLARATION

I, Rosebud Buteme, do hereby declare that this research project titled "*The contribution of SESEMAT in Science Teachers' Pedagogic Practices in Mbale District*" is my original work and has never been submitted to any other University or institution of higher learning for the award of a degree.

Signed:------------------------------- Date 5/12/2019----------------------------

APPROVAL

This dissertation entitled: "The Contribution of SESEMAT to Science Teachers' Pedagogic Practices in Selected Secondary Schools in Mbale District" has been submitted to the Directorate of Research and Graduate Training with our approval as the candidate's university supervisors.

Signed: ---------------------------- Date--05.12.19--

Dr. Leah Namarome Sikoyo

Signed ---------------------------- Date-04/12/19----

Dr. John Sentongo

DEDICATION

This study is dedicated to my beloved children namely; Marvin Earnest Masette, Kevin Gift Kisaka, Levin Mike Kisaka and Crevan Larry Kisaka. They were delighted to see me taking studies like them and never ceased to encourage me.

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LIST OF ABBREVIATIONS AND ACRONYMS

ALEI	Activity, Learner- Centered, Encouragement and Improvisation
CPD	Continuous Professional Development
ESSAPR	Education and Sports Sector Annual Performance Report
FGDs	Focused Group Discussions
INSET	In-Service Training
INSSTEP	In-Service Secondary Teacher Education Project
JICA	Japan International Cooperation Agency
MoES	Ministry of Education & Sports
NCDC	National Curriculum Development Centre
OECD	Organization of Economic Cooperation and Development
RMC	Regional Monitoring Coordinator
RT	Regional Trainer
SAQs	Self Administered questionnaires
SARB	SSEMAT Activity Regional Based
SESEMAT	Secondary Science and Mathematics Teachers Program
TPD	Teacher Professional Development
TRCs	Teachers Resource Centers
UCE	Uganda Certificate of Education
UNCST	Uganda National Council for Science and Technology
UNEB	Uganda National Examinations Board

ABSTRACT

The aim of this study was to examine the contribution of Secondary Science and Mathematics Teachers (SESEMAT) program to science teachers' pedagogic practices in selected secondary schools in Mbale district. It was guided by three research questions namely; how science teachers implement SESEMAT principles in classroom practices, what are science teachers' perceptions of the pedagogical worth of SESEMAT principles and what factors influence science teachers' adoption of SESEMAT Pedagogic principles. The study used a descriptive survey design and employed both qualitative and quantitative approaches of data collection and analysis. The target population was science teachers who had ever attended SESEMAT workshops. A sample of five secondary schools was purposively selected and a total of sixty eight respondents participated in the study. Findings of the study showed that there were limited activities in which learners used the hands-on, minds-on strategy as prescribed by SESEMAT through the ALEI principles. Teachers had little experience with the learner-centered approach to teaching and learning science. Teachers encouraged learners in all lessons observed in this study and they also improvised instructional materials. While teachers' perceptions towards SESEMAT were found to be positive, they were affected by teachers' and students' misconceptions of the SESEMAT approach, and the need to cover the NCDC national curriculum. The study further established that provision of professional support to teachers, support supervision from the SESEMAT team, teachers' positive perceptions of the SESEMAT approach and support from school administration are the factors that promoted adoption of SESEMAT pedagogic principles. On the other hand, time constraints, inadequate instructional materials, large class sizes, inadequate physical infrastructure and teachers' misconceptions of the SESEMAT pedagogic approach constrained teachers' adoption of the prescribed SESEMAT pedagogic principles. The study recommends; integration of ALEI skills in the pre-service teacher education curricula for science, increased provision of science equipment and teaching learning materials, institutionalizing continuous professional development courses for all secondary school teachers, refocusing national examinations to encompass both the content and the skills acquired by learners; Schools should consider organizing school based termly workshops, school administrators need to enhance professional support to the teachers, recruit more science teachers and institutionalize a reward system to motivate teachers and learners who excel in improvisation at school. .

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter introduces the study; the contribution of SESEMAT in science teachers' pedagogic practices in Mbale district. The background of the study is presented from four perspectives i.e. historical, theoretical, conceptual and contextual perspectives. It also presents statement of the problem, objectives of the study, research questions, scope and the significance of the study.

1.1 Historical Perspective

The global call for prioritizing science in this new era, coupled with the dire need for a scientifically literate society, resulted into education reforms in the curriculum (Kariisa 2005). In 1994, the Governments of Uganda and Britain signed a contract to establish the In-Service Secondary Teacher Education Project (INSSTEP) with the goal of boosting the teaching and learning of Sciences (Physics, Chemistry, and Biology), Mathematics and English in Secondary schools using the Teacher Resource Centers (TRCs) as the focal point of achieving this goal. During that time, TRCs were intended to improve the teaching and learning of Sciences, Mathematics, and English Language in Secondary schools. Coordination was done by the Inspectorate, MoES by then, and later passed over to districts for administration and management. However, the TRCs did not live long to serve the intentions of improving the teaching-learning of the mentioned subjects as they were pushed to the home districts' management and administration. The districts were not ready enough to accommodate the TRCs resulting into a halt of their roles and functions. This gave way to another program, Secondary Science and Mathematics Teachers (SESEMAT) a Continuous Professional Development (CPD) program that was introduced in 2005.The aim of SESEMAT is to improve pedagogic practices of science and mathematics teachers in secondary schools at O'level.

SESEMAT program was established by MoES with technical assistance from the Government of Japan, through Japan International Cooperation (JICA) in August 2005 with the aim of improving teachers' pedagogic practices in teaching Science and Mathematics. In June 2010, four pilot regions (Bushenyi, Mukono, Karamoja and Teso) were selected for SESEMAT

Activity Regional Based-Tryout (SARB- Tryout) in order to formulate and implement better regional activities. Each region designed one activity namely; Lesson study, Lesson observation, Popularization of lesson planning and Assessment by testing. After the SARB- Tryout, the four models were expanded to the 27 SESEMAT regions through INSET. SESEMAT, currently the major in-service course for secondary school teachers of science and mathematics, was considered an important avenue through which teachers in the field can be exposed to the rapid changes in technology & science and to innovations in curricula and teaching methods.

SESEMAT emphasizes a practical approach to teaching and learning of science through strengthening teachers' pedagogic practices, thereby helping them to take on the learner-centered, 'hands-on minds-on' approach. The teachers who undertake the course are expected to demonstrate that they are keeping abreast of the new knowledge in their areas of specialization. Consequently, the quality of science students is expected to be high and the level of students' academic achievement bound to rise.

1.2 Theoretical perspective

The research study is based on the constructivist learning theory by Jerome Bruner (1960). The major theme in the theory is that learning is an active process in which learners construct new ideas or concepts based upon their current and past knowledge. The learner selects and transforms information, constructs hypotheses and makes decisions relying on a cognitive structure.

Constructivists emphasize the active role of the learner in constructing new knowledge in relation to previously known ideas and making sense of information. The theory stipulates that learners construct their own knowledge in relation to previously known ideas, which they fit in an encounter they have had to accommodate. In constructivism, the learners find some link between what they are doing in the outside world and some models that they have grasped intellectually. This involves mental reorganization of previously known ideas in order to fit them in the new ideas that are being discovered.

Constructivists believe knowledge is acquired experience through interaction with the world as children build mental schemas. Constructivists point out that children are capable of doing different things at different developmental stages. Bruner (1960) proposes three modes of representation; the enactive representation (0-1 years) which involves encoding action based information and storing it in memory, the iconic representation (1-6 years) in which information is stored in form of images/diagrams which are mental pictures in a child's mind and the symbolic representation (7+ years) in which information is stored in form of codes or symbols. The three stages of cognitive development are integrated and only sequenced as they loosely translate into each other.

Bruner points out that the purpose of education is not to impart knowledge but to facilitate a child's thinking and problem solving skills which can be transferred to a range of situations. The problem solving approach seeks to promote the learners' active role in pedagogical processes where the teacher acts as a facilitator while learners take responsibility of their own learning.

The assumptions of the theory are;

1. A child of any age is capable of understanding complex information through the concept of spiral organization. In this concept, information is structured so that the complex ideas are taught at a simplified level and revisited at a more complex level.
2. The cognitive development of a child is enhanced by the social environment.
3. A child can be helped to learn through scaffolding by adults. (Scaffolding is the helpful structured interaction between an adult and the child).
4. 'Discovery' is a guided process directed towards a specific goal. Learners are expected to be innovators who are self-directed problem -solvers.

The theory informs the study in regard to the idea of 'learning by doing'. This idea is related to the SESEMAT approach to teaching and learning where the individual learners are meant to actively participate in lesson activities and practical science experiments that are 'hands -on' and 'minds-on'. Active learner participation in teaching and learning activities reflects the learner-centered approach that SESEMAT advocates in this study. The teacher structures the learning activities and guides the learners to use prior knowledge to fit new information into pre-existing structures, thereby, invoking the 'simple to complex' notion advocated in the theory.

The theory also informs this study through the idea of 'discovery' learning. Learning through 'discovery' is one of the SESEMAT approach to teaching and learning science subjects. The theory posits that learning is more meaningful if the child is allowed to experiment on his own rather than playing a passive role in which knowledge is transmitted from the teacher to the learner. SESEMAT approach advocates that the teacher should present to learners, materials and situations that allow them to 'discover' new learning. In this case the teacher becomes a facilitator of learning through guiding and stimulating the teaching and learning process. Learners are encouraged to 'discover' as they experiment.

The constructivist theory was adopted because it underscores 'learning by doing' which is the underpinning of the SESEMAT approach. Learners are co- constructors of knowledge. The SESEMAT approach encourages teachers to plan their lesson activities for learners while putting in mind learners' prior knowledge on the topic as they leave room for them to construct new knowledge against the back ground of prior knowledge. The four principles of SESEMAT (ALEI) are hinged on the theory of constructivism.

The strengths of the theory are that the children learn and enjoy learning more when they are actively involved in the teaching and learning process rather than playing a passive role of listening to the teacher transmitting knowledge. Children learn better when they concentrate on thinking and understanding rather than on rote memorization. Constructivism gives learners ownership of what they learn, since learning is based on pupils' questions and explorations and often the students have a hand in designing the teaching and learning materials through improvisation

However, constructivism has a weakness of causing a possible frustration to students because they may not have the ability to form a relationship between the abstract knowledge and what they already know. Despite this, the theory is based on construction of learners' own perspective of the world through individual experiences and schema.

1.3 Conceptual Perspective

Pedagogical practices have been defined as the strategies used by the teacher in the classroom with the intention of ensuring attainment of the teaching-learning objectives as a consequence of pedagogical skills. Therefore teachers' pedagogic skills are reflected in classroom practices which are easily measurable. SESEMAT principles operate in mutuality with the pedagogic practices of teachers as stated above; Activity- based lessons, learner centeredness of lessons, encouragement of learners and improvisation of teaching and learning materials. These principles are geared towards enhancing science teachers' know-how skills. In this study, teacher pedagogical skills mean ability to conduct activity-based lessons, use of learner- centered approach, re-enforcement of learning through encouragement, setting up experiments, showing positive attitude to practical lessons, being innovative and creative and teaching science in relation to everyday life.

Continuous Professional Development (CPD) has been defined as the action taken to maintain, update and grow the knowledge and skills required for a professional role. It is an ongoing commitment, lasting for as long as one remains in one's profession (Institute of Training & Occupational Learning). SESEMAT is a continuous professional development program for in-service science and mathematics teachers; intended to strengthen their teaching and learning skills in order to improve on learners' outputs. Integrating SESEMAT pedagogic principles in science teachers' classroom practices ensures participatory hands- on approaches to science education. All science teachers in Mbale district have attended annual SESESMAT training workshops as a requirement that is overseen by the school administrators.

Villegas- Reimers, (2000), defines Teacher Professional Development (TPD) as the development of a person in his or her professional role. TPD is an important aspect of teacher pedagogic practices because it improves the performance of teachers in the classroom which eventually raises student achievement and learning. Professional development addresses knowledge gaps in teachers' pedagogic practices as they acquire new skills in pedagogy and content knowledge. This is in tandem with the aspects that SESEMAT underscores i.e. strengthening science teachers' skills and new techniques in pedagogic practice. If teachers lack professional development, then their pedagogic practices will suffer. Consequently, their output in schools shall be affected because competence is central in effective pedagogic practice.

Science teachers, in the context of this study refer to secondary school teachers, who teach the basic science subjects; i.e. Chemistry, Biology and Physics. Though SESEMAT encompasses science and mathematics, this study focused on only the three science subjects; chemistry, physics and biology in which practical science work in the laboratories is done. These subjects have been compulsory since 2005 following the compulsory science policy, which requires all students to offer science at ordinary level. The study focused on science teachers' pedagogic practices in view of SESEMAT prescriptions; i.e. activity- based lessons, learner-centered approach, encouraging learners and improvising learning materials. SESEMAT program underscores sciences so as to create scientifically literate communities.

1.4 Contextual Perspective

In Uganda, there are a number of studies that have been carried out in regard to science and mathematics subjects at O' level since the implementation of SESEMAT program. The Education and Sports Sector Annual Performance Report (ESSAPR-2012/2013), notes that MoES, trained science and mathematics teachers in Uganda with emphasis on learner-centered approaches and a total of 5,663 teachers underwent the second and third cycle of SESEMAT training. Though improvement in quality of the outcomes was registered, there is an indication that the traditional teaching and learning methodologies still persist. This can be justified by the low quality of the outcomes at O' level. Though the overall students' pass rate is high, scores in the three science subjects are still low.

In Mbale district, the status of the three science subjects in the selected schools in UNEB results 2017 shows that half of the science students are still facing challenges in the subjects in question (chemistry, physics and biology). According to the 2017 UCE results, the failure rates in these subjects in all the selected schools ranged as follows: chemistry; 50.9% to 62.1%, Physics; 19% to 83.2%; Biology; 29% to 76% .Whereas there was an increase in the pass rate of science subjects, the high failure rate is an indicator that teaching and learning of the science subjects is still lacking.

Teacher professional development enhances development of effective teacher pedagogical practices. Knowledge gaps are addressed and the acquired skills reinforced as teachers practice what they teach (Kagoda & Ezati, 2014) SESEMAT program is intended to strengthen teachers' pedagogical practices by addressing such areas as hands-on, minds-on activities and positive attitude to enhance quality teaching and learning of science and mathematics in Secondary schools. The program equips teachers with pedagogical knowledge, so that the teachers in turn, improve the learners' performance by practicing the ideals of SESEMAT pedagogical approach; i.e. being innovative in lesson presentation, presenting lessons in varied and interesting ways, active learner participation, dealing with students' questions and mis-conceptions and reinforcing learning at each step. Though there have been reports of improved perceptions towards the teaching and learning of science subjects, students' performance is yet to reach satisfactory levels of improvement.

In Eastern Uganda, in a study carried out in Jinja district, SESEMAT program had great impact on improving teachers' and learners' attitude towards science education (Komakech & Osuu, 2013). However, the status of SESEMAT as a CPD has not been investigated in Mbale district and its role on the pedagogical practices of teachers is yet to be known; yet science teachers' pedagogical knowledge has been reported to be low in Uganda (Eraut, 2009, Uganda Options Paper, 2000, Science First, 2010, Education &Performance Report, 2012/2013). This may imply that the teaching and learning of science subjects and mathematics in the district has remained largely theoretical since 2005, when SESEMAT program was instituted. The teacher may have remained the dispenser of knowledge and the learners, restricted to a passive role. It is against this background that the proposed study is to take place in Mbale district in Eastern Uganda, to investigate the role of the SESEMAT in enhancing the pedagogical practices of science teachers at O' level in Mbale district.

1.5 Problem Statement

SESEMAT CPD program aims to strengthen science teachers' teaching ability at secondary level. In SESEMAT training sessions, teachers are helped to develop deeper thinking about the best ways of handling teaching and learning with in the classroom through use of Activity-filled lessons that are Learner-centered, Encourage learners and learning materials are improvised (ALEI- pedagogic principles). Once teachers have been trained, they should be familiar with the changes in technology and science and to innovations in curricular and teaching methods. The quality of the teachers' pedagogic practices should consequently translate into improvement in students' science performance.

However, the teachers' pedagogic practices still draw a lot of concern among stake holders; illustrating that despite being trained in SESEMAT program, there is a lot desired in their competences. The ESSAPR (2012/2013) reported that a number of the teachers are still unable to prepare science practicals adequately, resulting into low utilization of lab resources. Theoretical teaching and learning of science is still evident; there is no integration of theory with practical work even when instructional materials are available due to teachers' lack of competence to conduct experiments (Kivunja & Sentongo 2016, Sentongo, et.al, 2010). Uganda National Examination Board (UNEB) Statement on Release of 2016 UCE examination results dated 31st January 2017 revealed that the percentage pass levels for all science subjects remain low, with almost 55% of candidates unable to exhibit the minimum required competency to be graded as students still exhibit problems in handling apparatus during practical tests, making and recording observations, tabulating experimental results and interpreting the said results. In Mbale district, UNEB results 2017 show that failure rates in the three science subjects were still high with 50% of the students failing. While there could be several factors that explain science teachers' low pedagogic levels, SESEMAT as a CPD program may not be playing its role as initially purposed, hence, the failure to improve on the teachers' teaching ability. This prompted the researcher to conduct this study.

1.6 Purpose of the study

To investigate the contribution of SESEMAT CPD to science teachers' pedagogic practices in selected secondary schools in Mbale district.

1.7 Objectives

The study was guided by the following objectives:

1. To establish ways in which science teachers implement the pedagogic principles of the SESEMAT CPD program.
2. To establish science teachers' perceptions of the worth of SESEMAT pedagogic principles in enhancing their classroom practices.
3. To analyze factors influencing science teachers' adoption of the SESEMAT pedagogic principles.

1.8 Research Questions

1. How do science teachers implement the SESEMAT pedagogic principles in their classroom practices?

2. What are science teachers' perceptions of the worth of SESEMAT pedagogic principles in enhancing their classroom practices?
3. What factors influence science teachers' adoption of SESEMAT pedagogic principles in their pedagogic practices?

1.9 Scope of the study

The study was conducted in five secondary schools in Mbale district, in Uganda. Three of the selected schools are located in an urban area while two are in a rural area.

One of the selected schools is privately owned while the other four schools are public schools. With regard to content scope, the study focused on how science teachers implement SESEMAT CPD pedagogic principles in the classroom, establishing teachers' perceptions towards the pedagogic worth of SESEMAT principles and analyzing the factors that influence science teachers' adoption of SESEMAT pedagogic principles in classroom practices. Implementation was conceptualized as science lessons that were activity based and hands on teaching and learning, participatory teaching and learning processes, encouragement of the learners, and improvisation of teaching and learning materials. Perceptions were conceptualized as beliefs of individual teachers regarding SESEMAT pedagogic principles visa viz classroom practices.

The study was conducted in 2018 basing on the UNEB results of 2017. This was because 2017 UCE results were released early 2018; which enabled the researcher to select the best performing schools in the year 2017. The selection criterion was against the assumption that science teachers in the said schools used SESEMAT principles in classroom practices; hence the good performance of learners.

1.10 Significance of the study

The study envisaged benefiting the following categories of people and institutions: Study findings shall guide SESEMAT program designers to explore ways of engaging science teachers, as partners in the reform efforts of teaching and learning science subjects. This would improve the quality of the professional development.

Findings of the study would guide SESEMAT program designers and evaluators to re-consider the time stipulated for the SESEMAT CPD learning experiences for science teachers. Although there is no specified amount of time required for effective CPD programs, teachers require sufficient time for exposure so as to dispel any possible fear or doubts regarding the use of SESEMAT pedagogical approach to teach science subjects.

SESEMAT policy makers could be guided to focus their efforts into helping teachers to implement what they learn and overcome the restraints they encounter in school settings. This includes the mounting pressure on teachers to cover the mandatory syllabus.

Findings of the study could encourage science teachers to appreciate and embrace modified instructional practices as a pedagogical base that leads to successful application in real classroom contexts. This is hinged on the view that teacher effectiveness in the class room is enhanced by CPD activities in which new pedagogical knowledge is shared among teachers.

Findings of the study could encourage science teachers to try out the new teaching methods and strategies for the good of their learners. This can be done after the teachers' exposure to 'good practice' lessons in SESEMAT CPD.

Findings could guide SESEMAT program designers to focus on pre-training needs assessment and post- training follow up activities so as to improve on the relevance of SESEMAT program.

1.11 Chapter review

This chapter presented the background of the study; the contribution of SESEMAT in the pedagogic practices of science teachers in Mbale district. The background was presented in four perspectives; historical, theoretical, conceptual and contextual perspectives. It also presented statement of the problem, objectives of the study, research questions, scope and the significance of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviews literature related to the current study according to the following sub-themes; Theoretical Review, the literature related to the study; science teachers' implementation of CPD pedagogic principles in their practices, science teachers' perceptions of the worth of CPD pedagogic principles in enhancing their classroom practices and the factors that influence teachers' adoption of the pedagogical innovations in their practices and the Conceptual Framework

2.1 Theoretical Review

This study is guided by the theory of constructivism as advanced by constructivists such as John Dewey (1938) and Brunner (1960) who argue for an inquiry-based, student-centered education where the role of the teacher is to guide and support students in an active quest for knowledge. Knowledge according to constructivism is acquired experience through interaction with the world, as children build mental schemas. Constructivists point out what children are capable of doing at different developmental stages. Though constructivism was initially based on the work of psychologists such as J. Dewey, whose perspective on science education focused on solving real world problems based in children's experiences, Brunner's theory as a contemporary cognitive scientist is more related to the current study in such a way that it deals with the problem solving skills of learners. The approach seeks to promote the learners' active role in the pedagogic processes through learner involvement.

In Bruner's theory knowledge is assumed to have a specific purpose; that is to aid a learner in adapting to the environment. Bruner's central thesis is that the individual is active, curious, and innovative. The theory covers the three learning areas; cognitive, psychomotor and affective domains. In practice, the teacher should encourage students to 'discover' by themselves and also the teacher should engage learners in an active dialogue- like inquiry approach. The theory advocates active participation of learners in the learning process. The learner is allowed to make mistakes and learn from them.

Kwakman (2002) used the constructivism theory in his study in the Netherlands, in which factors affecting teachers' participation in professional learning activities were investigated. He found that whereas the theory stressed the importance of a large range of professional learning activities to help teachers develop professionally, the frequency to which teachers participated in some activities was disappointing, considering the high value that is attached to them. The range of activities was more restricted in practice, implying that collaborative professional learning activities were not very common in real school organizations. The low participation in many of the professional learning activities indicated that opportunities for teachers to learn remained unused in practice.

2.2 Science teachers' implementation of CPD pedagogic principles in their practices

Quality pedagogic practices are central to the success of educational reform efforts (Park, Lee, Oliver, Cramond, 2006). Many researchers have pointed out, that teachers need to be given extensive time and support, in order to help them modify their instructional practices and beliefs. Chauraya & Brodie, (2017) argument that teachers need more engagement time in learning activities in order for observable ways in teaching to be registered, is consistent with Lai (2011) who points out that one week programs leave teachers unprepared to implement educational reforms. This is because brief training does not help teachers to implement the changes that are expected. Other scholars argue that quality can be achieved through collaborative efforts of teachers in workshops. (Fullan 2001, Leenheer e.tal 2003, Darling -Hammond 2009, Carla & Sherry 2009, Hofman, 2009). These researchers stress the importance of teacher networks as an avenue for provision of opportunities to build the capacity of teachers to engage with each other in the improvement of their practice. They explain that collaboration is most important to professional development as it provides necessary support for learning and provides teachers with feedback. Atay (2007) conducted a study in Istanbul University Turkey, in which sixty two teachers who used English as a foreign language (EFL) were provided with relevant theoretical knowledge with guidance for research, reflection and collaboration and found that the program had a positive impact on their professional development. The growing call for more collaboration in order to stimulate teacher learning, has been emphasized by Jenlink & Kinnucan -Welsch (2000) and Ejuu (2012). This illuminates the need for teachers to interact with peers and form learning cultures in which learning will be enhanced.

However some researchers caution that collaboration can sometimes lead to teachers supporting preservation of the statuesque rather than pursuance of new courses of action in new programs. (Sato & Kleinsasser, 2004, Kwakman 2003, Korthagen, 2009) That collaboration may not automatically lead to learning casts doubts about the effectiveness of teacher education in general and CPDs in particular, as it implies that not all teacher programs lead to ongoing learning opportunities.

UNESCO (2010) is in support of the view that education quality is largely obtained through pedagogical processes in the classroom and that what students achieve is heavily influenced by the knowledge, skills, dispositions and commitment of the teachers in whose care, students are entrusted. Learning to teach is a lifelong process (Atay 2007) In line with the above a classroom teacher's role is central to the effectiveness of education provision, (Kelly 2009, Power and Cohen 2005).These scholars underscore the need to support teachers to be competent. They further highlight the importance of initial courses to prepare teachers, to make this central role a reality in curriculum development and point out that it is even more important that teachers are given adequate opportunities for continuing in-service education.

The views about teaching and learning and the role of the teacher have rapidly shifted from someone transferring knowledge to someone guiding the students (Korthagen 2005, Sikoyo 2007). Atay, (2007) asserts that knowledge transmitted is conceptually and practically far removed from the teaching and learning contexts. More effective teaching can be achieved not by telling students what to think and why but by implementing meaningful activities that challenge every day understanding (Gallardo & Reavey, 2018). This is in line with the constructivists' theory which holds that students learn best through active knowledge construction. Saputro & Santos (2018) argue that equipping students with hard skills is not enough and emphasize the need for students to acquire both soft and hard skills; and integrate both in a new situation..Active learning methods seek to promote learners' active role in the pedagogic processes in which the teacher plays the role of a facilitator. This kind of student learning requires teachers to adopt a new pedagogical approach away from transmitting knowledge. Sikoyo (2010) posits that teachers' adoption of the active learning approaches to teaching and learning is dictated against by factors beyond the pedagogic prescriptions of the official curriculum. Contextual, political and economic factors with in schools and at different education system levels may inhibit teachers' adoption of the active learning approaches. This perspective highlights the need to align teachers' pedagogic prescriptions of the official curricular with the diverse contexts within which teachers work if implementation is to be successful. Kwakman (2002) and Korthagen (2002) suggest that teachers could fulfill their new role by creating stimulating environments and acting as facilitators in students' learning processes. Mutilifa & Kapenda. (2017) investigated the use of learner-centered approaches in improving learners' understanding of acids and bases using two secondary schools in Namibia and found that learner-centered approaches improved high school learners performance in understanding the topic 'Acids and bases' in Physical Science Ordinary level as compared to the teacher- centered approaches.

However, other scholars argue that the active learning approaches could yield better results if amalgamated with the teacher- centered approaches to teaching and learning (Altinyelken 2010, Sikoyo 2010 and Ndebele & Maphosa 2013).This argument is against the background that teaching in most African countries is theoretical and characterized by knowledge transmission (teacher-centered) and therefore typical of teachers' experiences. Therefore integrating what the teachers already know with new knowledge may be rewarding in effect.

Sikoyo (2010) cautions that active learning approaches require relaxing the power relations between the teacher and the learners as well as among the learners themselves. This implies that if a teacher has strong control over the pedagogic processes; as is typical of the teacher-centered approaches, the use of active learning approaches such as group work, practical experiments and small group discussions may not yield the expected results because active participation of learners is constrained. Fatimah Mulya Sari (2018) resonates with the view above and posits that passive learners make slower progress. The scholar suggests that letting learners take risks and allowing them to learn from error are beneficial strategies for improving learning. These views illuminate the need for preparation of teachers for specific challenges of adopting active learning approaches and gaining awareness of the conditions necessary for promoting student engagement in lesson activities. This also insinuates the fact that teachers' pre- and in-service experiences shape their commitment to implement the prescribed active learning approaches. If this is the case then integrating the teacher-centered and the learner- centered approaches may be the solution of slowly changing the 'established' social order in which teachers are in control and learners expected to be obedient to an environment in which active learner participation in lesson activities is emphasized.

Korthagen (2009) notes that the potential to influence teachers' practices lies in giving professional development to teachers that is based on specific pedagogies. The scholar points out that the teachers face severe problems trying to 'survive' the classroom and implement little of what they learn during their professional preparation. Literature on implementation of active learning approaches indicates that teachers' pedagogical practices are not congruent with CPD interventions. (Allybokus, 2015; Sikoyo, 2007; Mtitu 2014; Schweisfurth, 2011). Altinyelken, (2010) conducted a study in which primary school teachers used the learner-centered approach and the thematic curriculum in Uganda; and found that teachers' pedagogic practices in the classroom context, varied from the accounts of what they regarded as learner-centered pedagogy. This finding is consistent with other studies in Uganda and sub-Saharan Africa. (Schweisfurth, 2011; Sikoyo, 2010; Vavrus, et al., 2011). Dole et al (2016) argue that changing teachers' pedagogic practices is difficult especially as the practices are hinged on their pre-service teaching and learning experience.

Chauraya & Brodie (2017) argue that teachers shift their practices during a professional intervention but only half of them sustain their shifts after the intervention. In line with the above Sakkoulis, Asimaki & Vergidis (2017) note that in-service training does not arm teachers with concepts and practices that allow them to advance to successful realizations in the communicative context of the school classroom. However, Schweisfurth (2011) expounds that teachers are more likely to feign intention and success even when they are unable or unwilling to implement a prescribed policy; in circumstances where they are expected to obey authorities. He attributes this conduct to the cultural aspect in which distance between authorities and teachers' and teachers and learners, is expected to be 'appropriate' and locally deemed respectful. This implies that the implementation of learner-centered approaches as advocated in the curricular starts from changing not only the perceptions of teachers towards the problem solving approaches but also their teacher -learner cultural roles. It is also possible that teachers do not wholly grasp the rationale of the professional development intervention so as to control the direction of the required change or misconceive the pedagogic interventions. Even when teacher professional development is school based the top to down approach does not allow professional knowledge generation (Lai 2011).

Lai (2011) further argues that for successful implementation of a curriculum reform teachers need to develop a stronger ownership of teaching and learning. These arguments illuminate the view that school based CPD may enhance teachers' professional knowledge but that teachers' perspectives have to be considered so as to have contact with their realities. This is because situational, contextual and personal factors can affect teachers' classroom practices (Atay 2007, Sikoyo 2010).

According to Darling- Hammond (2006), effective professional development is school- based and includes both the teachers' and learners' activities. The Federal Democratic Republic of Ethiopia- MoE (2009) Framework concurs with Hammond, that effective CPD needs to be conducted in school settings and be linked to school wide efforts. The Framework points out that professional development is based on classroom practice and deals with subject content and teaching strategies. Therefore, if it is not school-based the alignment of training needs may not follow a clear procedure. Besides, identification of 'expert teachers' to work with colleagues in their own school and other schools becomes easier and more successful if TPD is school-based. They point out that TPD is most effective when the 'expert teacher' remains within the school.

The most effective forms of TPD focus on clearly articulated priorities, provision of on- going school support to classroom teachers, deal with suitable subject matter and instructional strategies, create opportunity for teachers to observe, experience and try out new teaching methods (Organization of Economic Cooperation & Development -OECD, 2005). Hofman, (2000) and Lai (2011) caution that the top to down professional development initiatives may not be effective as teacher involvement is crucial. The issue of involving and identifying what teachers need to learn and developing the learning processes to be used is underscored. Teachers' knowledge and experiences should be valued sources of information. This is because teachers need to see links between what they are learning and their own classrooms. (Sandholtz & Scribner, 2006) The rationale for involving teachers in professional development activities should not be for purposes of teacher buy- in but for their expertise. Teachers should be involved in the selection of topics for professional development and in the making of key decisions (Boardman& Woodruff, 2004) TPD is central to enhancement of teacher pedagogical practices because it directly influences the pedagogic competencies of teachers and consequently, their output. This implies that teacher involvement in professional development activities impacts heavily on the implementation and sustainability of the 'new' teaching approaches.

Although situated learning is the way to go, many teacher educators forget that education knowledge cannot be simply transmitted to teachers so as to improve their actions. (Korthagen 2009). Kwakman (2003) asserts that teachers gain new experiences and ideas by experimenting; which culminates into improvement in their professional practices within the classroom. The importance of CPD programs to practicing teachers cannot be under-estimated.

Research shows that a single workshop is ineffective, inefficient and costly (Darling Hammond e.tal 2004, Darling -Hammond 2005, Schwille, & Dembele, 2007, Gregory 2009) CPDs that take the form of single session development workshops with little follow up are not effective A quality indicator of professional development is teachers practicing a new skill (Gregory 2009). Kwakman (2003) concurs with the above and posits that unlearning routines is the first step in changing practices and improving the quality of teaching. These arguments illuminate the need for CPDs, to be continuous in order for the intended benefits to be realized. It also implies that if teachers are to unlearn their routine practices of teaching and learning, they should be given modeling experiences.

Korthagen (2003) notes that modeling consists of showing the learners what suitable behavior is so that they can imitate it. He indicates that conceptual change strategies consist of; helping a student to reflect on concrete experiences during teaching practice, helping the learner to become aware of the implicit beliefs that play a role in his perceptions in similar situations, examining the disadvantages of that belief to create dissatisfaction, offering an alternative sound theory that is scientific and giving alternative behavior based on that study. The steps that Korthagen (2003) prescribes are in line with the SESEMAT program principles in which teachers are required to change their conceptual strategies in pedagogy, against the background that teachers are facilitators whose role is to create a stimulating environment in students' learning processes and not the sources of knowledge.

Andreia et.al (2011) note that teacher education and professional development are the corner-stones of quality education; whatever the education system, quality can only be achieved if teacher education and professional development are coherently organized across the life course of teachers. Professional growth should be sustained and integrated into school hours. Darling-Hammond e.tal (2005) note that professional development should be continuous and ongoing (Sandholtz & Scribner 2006) and with adequate resources and support for further learning. This indicates that change in educational practice takes time.

Lotter, Harwood & Bonner (2006), examined a professional development program (summer research institute) for high school science teachers in the United States, where they investigated discrepancies between the program goals and the teachers' products and the reasons for these differences. Findings showed that teachers felt especially limited by the time needed to prepare for and teach with the inquiry method. Thus, the teachers believed that they could more easily include inquiry-based practices in their classrooms, but that inclusion was still limited by their need to cover the curriculum. These findings do not indicate that the teachers were involved in designing the program goals and how these goals would be met. This is contrary to professional development needs as advocated by Carla & Sherry, (2009) that making partners of teachers requires not just training but also educating administrators and politicians on new management approaches, relying more on consensus building and negotiating agreement, rather than on attempting to rule teachers by decree. This observation underscores teacher involvement in professional development programs as it answers questions related not only to content and pedagogic knowledge but also time related issues vis- a -vis syllabus coverage.

In a study focused on improving the educational experience of Latino school children in an urban school district through improving the effectiveness of their science teachers, authors recommended that there was need to abandon the existing frameworks for professional development. The frame works were found to be typically prescriptive and developed without involving practicing teachers from participating schools. Their study revealed that even the best intended programs did not meet the needs of all the teachers involved (Carla & Sherry, 2009). This study supports the view that involving teachers in program design increases the possibility of successful implementation and effectiveness of educational programs. This view demands that educational reforms ought to be a promotion of participatory learning for teachers, rather than mechanical implementation or adaptation of rules or reforms decreed from the top.

Findings of the above study revealed that teachers showed dissatisfaction with the top to down approach in the implementation of a new basic curriculum in Paraguay because it did not help them develop new skills. Reformulation of the curriculum resulted into a major realignment of teachers towards the reform. Boyle e.tal (2005) concurs with the findings above and notes that the top to down professional development initiatives are not effective because teachers differ in their specific needs for courses and specific content. There may be no connection between separate teacher courses and there is not enough time to process, actively learn and reflect the content of the course. This illuminates the significance of involving teachers in designing and implementing of CPD programs; through interactive forums, so that appropriate approaches in teaching are embraced. It is therefore important to think of ways to engage the teachers as partners in the reform efforts if professional development is to yield quality (Carla & Sherry 2009)

Lewin and Stuart, (2003) argue that the most powerful way of translating ideas into classroom practice is the kind of training that moves between principles and practice and back to principles. If a professional intervention is successful a teacher's use of the intervention is reinforced (Gregory, 2010). This implies that teachers who practice an acquired intervention skill indirectly engage in active learning, which is a quality indicator of good professional development.

Tyler (1949) theorizes that the real purpose of education is not to have the instructor perform certain activities but to bring about significant changes in the students' pattern of behavior. However, this depends on a good knowledge of pedagogical knowledge which leads to future successful application/use in any field developing interdisciplinary thinking, creativity and managerial qualities (Andreia et al. 2012). This indicates that effectiveness of teachers in the classroom is determined by CPD activities in which new pedagogical knowledge is shared with and among teachers. This knowledge is expected to translate into use of modified instructional approaches such as the use of inquiry based teaching and learning.

Sakkoulis e,tal (2017) cautions that in service activities that are directed at teachers may be haphazard, unconnected and unpredictable in terms of content. This may limit the contribution of CPDs to the teachers' pedagogical knowledge base.

Inquiry-based teaching concerns the pedagogy of inquiry or one's ability to employ inquiry instruction in the classroom. Though it is not the only way to effectively teach science, inquiry based instruction is thought to have a powerful influence on students' science learning, because it exposes them to a type of learning that parallels the work of practicing scientists (Capps, Crawford & Constas, 2012).

Findings from studies on teacher professional development indicate that teachers should also experience scientific inquiry through inquiry workshops. This culminates into improvement of their content and pedagogic knowledge in science i.e. inquiry-based teaching techniques (Park, Lee, Oliver & Cramond, 2006, Akuma and Callaghan 2016). SESEMAT program also advocates a good knowledge of the participatory and problem-solving approach.

Lotter, Harwood & Bonner (2006) caution that there is a possibility though, that teachers can assume that students learn through activities and, therefore, concentrate their discussions on the activities themselves, instead of analyzing how and why the activities help their students learn. Kelly (2009) theorizes that if any proposed pedagogic innovation is to be successful, there must be an attempt to obtain teachers' understanding, support and approval. It must seek to promote change through empirical-rational strategies which attempt to demonstrate the validity and desirability of the proposed change. Recent studies support the findings that change supported by professional development may be most successful when aligned with teachers existing ideas. Tondeur, Forkosh-Baruch, Sikoyo 2010, Prestridge, Albion & Edirisinghe (2016) note that enabling teachers to share their ideas and providing examples of their good practices, facilitates understanding, sharing and negotiating, and consequently transference into local settings.

Reform of science instruction requires the development of teachers who understand and enact best practices in their classrooms (Lotter et al. 2006). Pedagogic practices (i.e. presenting teaching and learning materials and tasks in diverse ways, encouraging students to collaborate with one another when learning new material, giving students feedback on progress and praising them for their effort towards a goal, providing students with opportunity to exercise autonomy and choice in their academic work and connecting school work to students' lives and interests and to life outside of school) reinforces students' active role in classroom practices (Farrington et. al (2012). Across the United States, science teacher quality is a concern because many science teachers feel that they were not prepared with adequate content knowledge or the instructional skills to teach science effectively (Carla & Sherry 2009). Higgins & Spitulnik (2008) recommend extended support to teachers as important because it offers them a chance to ask questions and interact with professional developers and their colleagues outside of workshops, and gives teachers the opportunity to receive feedback on new teaching strategies after using them in their classrooms.

The need for better approaches such as, use of active methods and strategies, relating classroom knowledge to everyday life, adequate lesson preparation and effective lesson delivery when teaching science have been emphasized by Odebode, (2004); Oyodele, (2006), Osuji (2007), (Farrington et. al (2012) and CICE (2013). One can conclude that pedagogically knowledgeable science and mathematics teachers should develop students' curiosity and interest by involving them in the teaching-learning activities, which leave room for innovativeness, experience, reflection, discovery and generalization. This fits in with what SESEMAT program advocates; the teacher is a facilitator and learning is through practice and discovery. However, the question that emerges in the researcher's mind is, can pedagogical knowledge work in isolation with subject content knowledge and teachers' perceptions of the pedagogical worth? In view of this, the researcher wonders what main skills a successful teacher possesses and what actions he performs so as to be rated as pedagogically knowledgeable. Korthagen (2003) questions the description of qualities of good teachers against isolated competences.

The notion that teachers require to move from the traditional teacher-centered approach to the child-centered approach has been underscored by the SESEMAT program. At the INSET of SESEMAT (2009) at Kololo National Training Centre, participatory learning was emphasized in the teaching-learning process. This is in line with the constructivists' learning theory which underscores learning through knowledge co-construction of both teachers and learners.

Fullan (2007) theorizes that there are three components at stake in implementing any new program or policy; the possible use of new or revised materials (instructional materials such as curriculum materials or technologies), the possible use of new teaching approaches (i.e. teaching strategies or activities) and the possible alteration of beliefs (e.g. pedagogical assumptions and theories underlying particular new policies or programs). The three aspects determine the achievement of educational goals. The theorization is noted to be compatible with SESEMAT programme aspirations as it emphasizes the use of new technologies and materials and use of new teaching approaches in implementing a program. Teachers are expected to guide and facilitate students to learn through experience, reflection, generalization and experimentation; an idea that is underscored by SESEMAT program.

SESEMAT approach aims to improve learners' performance through three steps; Step 1(good lesson preparation), which leads to Step 2 (good lesson delivery) consequently leading to the achievement of Step 3 (good lesson learning). UNESCO (2010) Sahlberg (2006), Fullan (2007), Kelly (2009), Power and Cohen (2005) Andreia et al. (2012) & CICE (2013) Korthagen (2003) Korthagen (2009) Kwakman (2003) and Sikoyo (2010) underscore professional development as a means of enhancing pedagogical practices of teachers and the possible ways of implementing CPD programs: but do not show how the main skills are deployed in diverse ways to suit particular education contexts. This is because professional development needs vary from one context to another. Also the literature does not show the length of time required for an effective training session to be implemented. This can be an obstacle to professional development and teacher change as a lot is left implicit.

2.3 Teachers' perceptions of the worth of the CPD pedagogic principles in enhancing classroom practices

Teachers' beliefs are known to influence how teachers respond to professional development (Fullan, 2001). Researchers studying behavior stress that it is important to know what teachers think, what their beliefs are and how they were trained as beliefs teachers hold, with regard to their teaching and learning determine their actions. .

Research shows that teachers tend to opt for traditional teaching methods using lectures, as opposed to the participatory pedagogy (Schweisfurth, 2011) Carla & Sherry (2009), Altinyelken (2010), Sikoyo (2010) and Ndebele & Maphosa (2013).argue that, teachers and administrators are products of a traditional school experience that has not taught, modeled, or supported the principles that standards define. Many teachers use primarily direct instruction, from teacher to learner, because it reflects how they were taught. Direct instruction is teacher- centered and focuses on memorizing content and may have little relevance to the learner (Park et al. 2006, Carla et al, 2009). (Farrington et. al (2012) argues that while research is clear that classroom contexts shape students' mindsets and that certain teacher strategies support these mindsets, it is difficult to know how to change classrooms on a broad scale without further research based in actual classrooms, aimed at helping teachers acquire such strategies. This argument illuminates the necessity of helping teachers to understand the mechanisms by which classroom variables affect students' beliefs about themselves and their schoolwork.

Boardman et al (2004) recommend that teachers must first be able to gain a clear understanding of the instruction practice then find ways to adjust to meet individual classroom needs.

A teacher's competences are determined by his or her beliefs (Knight 2001Schweisfurth, (2011) attributes teachers' lack of skills in participatory pedagogy to the pre-service training which is its self rarely learner-centered and so, does not provide suitable models upon which fledging teachers can base their practice. Schweisfurth (2011) and Sikoyo (2010) argue that teachers' adoption and attitudes towards the problem solving approach is shaped by multiple complex factors ranging from cultural contexts, teachers' own learning experiences pre and in-service training and on- the job experiences. Findings from other studies on teacher learning show that if teachers do not have confidence in their ability to implement a new teaching approach, even if they value the approach and desire to use it, they will rarely try it out (Park et al. 2006)). This may imply that teachers do not perceive with clarity their new role in relation to the use of the participatory pedagogy other factors not withstanding.

Gregory (2009) points out that perceptions and judgments can influence the outcomes of events. Teachers' beliefs are important for understanding and improving educational processes as they influence students' motivation and achievement. (Dehghayedi & Baghari 2018) Sainz et al (2018) conducted a study in which gender differences in motivations leading to young people to pursue highly male dominated Science, Technology and Mathematics (STEM) degrees and careers in Spain; found that women representation in Biomedicine was higher than in physical sciences and engineering. The researcher attributed this finding to stereo typed ability beliefs related to expectations for success among other factors; hence the choice of different career paths. From this argument, one can infer that teachers' preference of the traditional approach is attributed to their expectation for success in student outcomes among other factors. It is also possible that teachers' lack of the kinds of skills and knowledge needed to conform to 'the new' pedagogical model, explains their preference.

Creativity-centered science teaching is an instructional approach that places the focus of science instruction on the development of students' creativity, as well as their conceptual understanding of science. However, in a study where Korean science teachers were studied, they exhibited uneasiness about the educational reform, struggling with how to teach science to improve students' creativity (Yoo & Sohn, 2001). This appeared to mainly result from the fact that teachers themselves had never been taught creativity instruction as learners (Park et al. 2006)

Sato & Kleinsasser (2004) noted that teacher collaboration reinforced existing practices. In their study in which they examined what influenced teachers' beliefs about language teaching and learning, they found that teachers relied more on the second language learning- teaching initial experiences. The beliefs remained constant regardless of age or number of years of teaching experience. This finding was attributed to the formative assessment (AFL) that gave teachers procedures to try out in the classroom without considering what their beliefs about learning were. This finding seems to be in line with Korthagen (2003) who argues that teachers are most likely to be opposed to a new teaching and learning approach owing to the professional self image shaped by the past role models.

As argued by Sainz et al (2018) role models influence beliefs and choices of young people. The scholar found that all students' choices of science, technology and mathematics (STEM) careers were attached to their preference for enjoyment of the (STEM) courses e.g. physical science or mathematics when they were in high school. The study above also revealed that female participants recognized that they lacked specific feminine role models in the male dominated fields. These findings illuminate the negative stereotypes associated with science, technology and mathematics disciplines. The role of these stereo types on beliefs of both teachers and learners cannot be over emphasized. This also highlights the crucial role of 'expert' teachers is in influencing teachers' and even learners' beliefs. This implies that teaching behavior can best be understood if one considers the specific methods and strategies the 'expert' teachers used; which in turn, may account for teachers' beliefs practices and choices. If teachers have developed the belief that teaching is knowledge transmission, then opposition to the participatory approach may follow. Korthagen (2003) argues that the level of environment in which a teacher is working may put serious limits on the teacher's behavior even when the teacher has pedagogical skills and the right beliefs.

Sainz et al (2018) argues that motivational beliefs such as influence of other significant people and social utility values encourage young people to enter science, technology and mathematics fields. In congruence with the above, Farrington et al (2012) asserts that stereo -types about alleged inferiority or indolence can exert a powerful pull on self - perceptions and attitudes towards learning and academic performance. The literature suggests that strong supportive relationships play a critical role in building a foundation of trust. This implies that teachers' play a crucial role in creating classroom contexts that either foster or thwart development of academic mindsets and positive perceptions towards teaching and learning of science subjects. Research shows that provision of positive psychological conditions is very important for building academic mindsets (Farrington et al., 2012).

NCDC (2012) points out that teachers in Uganda find the learner-centered approach to teaching and learning challenging, especially those who have taught for many years. This finding is consistent with Lai (2011) who reported that teachers over forty years had difficulty in adapting to the new concepts as compared to the younger teachers, in a case study he carried out in China. This is because the teachers are inadequately equipped and insecure in their status, which translates into fear of venturing into the unknown where they might not be able to cope with methods unfamiliar to them.

As many researchers have pointed out, extensive time, intensive support, and collaborative efforts are needed to help teachers modify their instructional practices and beliefs (Fullan 2001, Darling -Hammond 2005)

The constructivism theory of learning underlies the learner-centered approach to teaching and learning. For science teachers to use the ideals of the theory they require CPD teacher education programs such as SESEMAT, where demonstrative teaching in science and mathematics lessons is done. The intended outcomes of the CPD program include; increased use of effective instruction and improved student learning; which is the rationale for SESEMAT pedagogic practice. The teachers who attend such CPD programs are expected to adapt well to the changing needs of the profession.

Kelly (2009) theorizes that where a lot of positive effort has gone into promoting the dissemination of a project to the schools, barriers to its implementation exist not only in the failure of teachers to perceive with clarity their new role, but also in absence of conditions appropriate to their being able to acquire such a perception. He concludes that the above condition can be attributed to circumstances such as; the teachers' lack of clarity about the innovation, lack of the kinds of skills and knowledge needed to conform to the new role model, the incompatibility of organization arrangements with the innovation, among others. Providing training to teachers is necessary but not sufficient for successful change that typically involves changes in peoples' awareness knowledge, skills and beliefs or attitudes (Sahlberg, 2004).

Research in science education has demonstrated that teachers' beliefs strongly influence their science teaching and the implementation of alternative forms of practice (Park et al., 2006). However, Higgins & Spitulnik (2008) caution that initiatives to reform schools will flounder if the centrality of teachers' perceptions and beliefs are ignored. Sato & Kleinsasser (2004) contend that change in teachers' beliefs is likely to take place after changes in students' outcomes are evidenced. This implies that among the factors that influence change in teachers' beliefs is the students' out comes. It also implies that teachers' perceptions of the CPD activities are important in determining the effectiveness of the activities in the CPD.

This illuminates the possibility that there are differences among science teachers' skills, knowledge and perceptions concerning pedagogy; depending on how well individual teachers perceive the new role model and whether they have the required skills and knowledge required. This perhaps explains why some teachers feel uncomfortable to use new approaches in teaching science subjects and why some pedagogical approaches such as the theoretical approach is preferred to the practical approach.

Kelly (2009) emphasizes the importance of the manner in which innovations are introduced by pointing out that the mere provision of resources and in-service support for teachers is not enough. Teachers need to become committed to the innovation, promote ideological change, and be able to willingly adapt their methods and approaches to meet the demands of the new work. He further theorizes that attempts to bring about change using power coercive strategies do not yield positive attitudinal change of teachers, instead opposition and hostility in teachers is promoted rather than support.

Fullan, (2007) contends that changes in beliefs are very difficult to attain because they challenge the core values held by individuals regarding the purposes of education. Moreover, beliefs are often not explicit, discussed or understood, but rather are buried at the level of unstated assumptions. Changes in beliefs and understanding are the foundation of achieving lasting reform. John Kotter of Harvard Business School, as quoted by Deutschman (2005) argues; “Behavior change happens mostly by speaking to peoples’ feelings. In highly successful change efforts people find ways to help others see the problems or solutions in ways that influence emotions, not just thought”.

Unlike a program that is accepted by the implementers, one that is imposed on them might not yield the expected results. One wonders whether teachers who under take CPD courses have this element of belief; that the CPD is something that benefits them in strengthening their skills and knowledge.

2.4 Factors influencing teachers’ adoption of CPD pedagogic principles

Many problems associated with existing professional development programs available for science teachers have been identified by various researchers. Among the problems underscored is the duration of professional development experiences Jean Pierre et al (2005), Loucks-Horsley et al (2003), Carla, (2007) Sandholtz, (2002) argue that although there is no specified amount of time required for effective CPD, programs should provide teachers enough time to fully process and address the doubts and misconceptions they have regarding inquiry. Loucks-Horsley et al. (2003) notes that effective professional development opportunities that initiate change require multiple opportunities to learn, practice and interact, as well as actually use the new skills. This implies that programs that are not given sufficient time do not fully address the needs of teachers (Boardman & Woodruff 2004, Carla, 2007)

Garet et al (2001) noted that the total amount of time of a CPD impacts on the success of a program. Sustained time and support for reflection should therefore be considered as a requirement for a systematically developed professional development (Park et al. 2006). That implies that time is an important feature for teachers undertaking CPDs; to enable them practice, reflect on, and revise innovative techniques in a real classroom environment. It has been argued that there are many factors that scale down CPD programs other than duration of the program.

The other factors include social and cultural factors, lack of teachers' technological, pedagogical, and content knowledge (Mishra & Koehler, 2006), inadequate infrastructure, limitations of Internet diffusion, linguistic differences, and geographical separation (Tondeur, 2016)

In a study focused on improving the educational experience of Latino school children in America the researchers concluded that for teachers to change instructional practices and improve the effectiveness of teaching, time and support were major factors to be considered (Carla, 2007). Ezati & Mugimu (2010) support the finding that implementing innovations in CPD workshops is constrained by the timing of the training. In a study in which researchers investigated possibilities and challenges of providing CPD in pedagogy for higher education staff in Africa, it was found that training schedules could not match with the schedules of the staff. Adequate facilitation of the program was not possible as the 'facilitators' or 'trainers' tight schedules could not allow this. This was because the trainers also worked as teachers in their respective schools. (Ezati & Mugimu 2010, Rarieya et al., 2006)

Supporting the effective application of technology to enhance learning and teaching in novel ways may serve as a foundation for successful CPD. Utilizing ICT in novel ways within TPD may also facilitate innovative pedagogical practices that will, in turn, bring into practice innovative teachers who may affect the education system as a whole, thereby leveraging efforts in the field and establishing Professional Development (Tondeur et al., 2016).

In a study where TPD for technology integration was conducted in four countries, i.e. Kenyan secondary schools, Australian schools, Israeli schools and Sri-Lankan pre- service internship, common characteristics that contributed to the success of enhanced application of ICT in education included; provision of resources coupled with effective TPD, engaging teachers in inquiry learning, directing inputs such as software, hardware and training into the education system by using teacher projects, increased likelihood that the resources would be applied to enhance learning in classrooms. (Tondeur et al., 2016)

Valuing teachers' contributions to the profession motivates them to engage more fully. (Sandholtz & Scribner, 2006, Tondeur, 2016). Carla (2007) suggests that discussions with other teachers play a significant role in developing teachers' knowledge and skills. Teachers hold fellow teachers' expertise in higher regard than outside experts whom they see as removed from day to day reality of the classroom (Sandholtz, 2002). The researchers recommend use of strategies that encourage continuing professional communications among teachers. One can infer that using the partnership approach in reform efforts can go a long way to foster effective implementation of CPD programs and realization of intended goals.

Carla (2007) argues that professional development experiences that do not focus on specific needs of teachers involved has been a problem, in that too many experiences are general in nature and have little to do with classroom context. This argument illuminates the fact that effective professional development programs ought to be tailored to suit the needs of the teachers who undertake them and the context within which they work.

Uganda Options Paper (2009) and Uganda National Council for Science and Technology (UNCST 2008) point out that one of the biggest implementation challenges that teachers of science face is having inadequate skills to effectively deliver science using the problem solving approach. Ezati & Mugimu (2010), Sentongo et al (2010) are in support of the view above and indicate that many staff have content knowledge but are challenged with teaching techniques. They point out that training workshops focus more on what in-service staff can do to improve quality but not how they can be supported by management to accomplish their work.

Knight (2001) and Schweisfurth, (2011) assert that 'How to' knowledge grows in practice. Whereas teachers are now hard pressed and expected to embrace lifelong learning, they do not seem to find concrete models upon which they can base their teaching and learning practices. Korthagen, (2003) explains that modeling consists of showing the learners suitable behavior. Teachers face problems trying to implement what they have learnt during training (Power & Cohen 2005, Korthagen, 2009) using a 'one -size -fits all' model (Hofman 2000).This highlights the idea of teacher net- working as vital. It also indicates that before a program is implemented, specific training needs analysis should be done in consideration of teaching styles, school or classroom contexts and experience of the teachers.

African Population and Health Research Center (APHRC 2014) studied the quality of education in two districts in Uganda and found that trained teachers are unable to demonstrate effective pedagogical teaching skills as would be expected. The study however, does not show whether teachers who participate in CPD training workshops also lie in this category of 'trained' teachers.

The researcher wonders whether trained teachers who participate in CPD workshops improve their instructional practices. It is also possible that the teachers do not put into use the new knowledge as integrating it with existing knowledge and practices does not only take time and support but also change in perception towards the new practices.

Garet et al.(2001) reported six characteristics of effective mathematics and science CPD programs on teacher learning following a study he carried out on 1,027 teachers. Among the characteristics were; focusing on content knowledge, providing opportunities for active learning during CPD activities, providing ongoing support and providing an adequate amount of time. These characteristics are in line with the experiential learning theory that emphasizes an active learning environment through experiences.

Carla (2007) points out that in order to change teaching practices, collective participation of groups of teachers from the same school, department, or grade level should be the focus of professional development, as opposed to the participation of individual teachers from many schools. This view is backed by Prestridge & Tondeur, (2015) who argue that enabling teachers to share their ideas and provide examples of their good practices facilitates understanding, sharing and negotiating, and consequently transference into local settings. It is important that teachers are given adequate support which is classroom based in order to enable them obtain any new skills that the innovations require.

Bennell (2004) observes that low teacher motivation in sub-Saharan Africa and Asia is reflected in standards of professional conduct, including serious misbehavior and poor professional performance. In support of this observation, Deutschman (2005) argues that; "If the threat of death does not motivate people who are ill, what on earth is going to motivate teachers to change? The answer has to be engagement with colleagues and with mentors in exploring, refining and improving their practices."

Changing instructional practices takes time and support from all stakeholders in the school (Carla ,2007) .Okhee, Karen, Maerten-Rivera, Lewis, Thornton and LeRoy (2008) conducted a 5-year professional development interventionism study to promote elementary teachers' knowledge, beliefs, and practices in teaching science, English language and mathematics for English Language Learning (ELL) students in urban schools. They found that teachers needed opportunities to develop their own deep and complex understandings of science concepts and recognize how students' misconceptions cause learning difficulties Adrienne (2008) supports the view that competences cannot be acquired without previous acquisition of knowledge. A science teacher must know well not only the science concepts but also the scientific processes (experiments, models and their limits of validity). This implies that teachers should be supported to engage in science inquiry themselves in order to enable them adopt reform oriented instructional practices.

Tondeur, et al (2016) indicate that engaging teachers in learning through inquiry, especially using ICT, is a powerful way to move them from a traditional view of education as transmission of knowledge from the expert teacher to the learner and toward understanding of education as a lifelong process of learning with and from each other.

When teachers participate in inquiry learning around ICT they experience firsthand the style of pedagogy that they are being encouraged to adopt in their classes. In this way TPD can assist teachers to adopt pedagogical forms that are empowered by ICT to engage learners in authentic activity rather than replicating more traditional instructive practices. (Tondeur, et al., 2016)

Teachers in many urban schools feel overwhelmed by the challenges they face while working with large numbers of students with diverse backgrounds and needs. This is coupled with their own lack of successful classroom management skills. (Carla & Sherry, 2009) The role that modeling plays in a classroom context seems to be illuminated indirectly in the argument raised above.

Literature indicates some difficulties involved in implementing initiatives that integrate subject area instruction, such as science, with English language and literacy. Many teachers, assuming that English Learning students (ELL) must acquire English before learning subject matter, are unaware of linguistic influences on student learning and purposefully overlook linguistic differences.(Lee, et al., 2008)

Covering the mandatory curriculum and preparing students to be successful on the high-stakes examination are major concerns for the teachers, which ultimately restricts their implementation of the participatory teaching approach.(Park et al., 2006). Kivunja & Sentongo (2016) posit that administrators in Uganda place considerable emphasis on the need to complete subject syllabi and teachers’ performance is assessed in terms of syllabus coverage. This implies that special efforts should follow CPD programs to help the teachers implement what they learned and overcome the restraints they encounter in school settings.

Sandholtz (2002), Darling-Hammond 2005, Tondeur et al (2016) recommend professional development of teachers that uses a lifelong learning approach, beginning with pre-service teacher education programs, and continuing throughout their professional lifespan.

The literature reviewed shows the need to improve classroom instruction, with continuous professional development as the means to accomplish this. Many researchers have pointed out, that extensive time, intensive support, and collaborative efforts ought to be given to teachers to help them modify their instructional practices and beliefs (Fullan 2001; Loucks-Horsley et al 2003; Korthagen 2003, Korthagen 2009, Gregory 2009, Carla & Sherry 2009, Darling Hammond 2000; World, Bank 2007). Other studies found that successful CPD should be aligned with teachers’ existing ideas. (Sandholtz & Scribner 2006, Tondeur, 2016).

However, the literature does not show how the main pedagogical skills can be deployed in diverse ways to suit particular education contexts. This is in consideration that professional development needs vary from one context to another. Also the literature does not show the length of time required for a CPD session to be effectively implemented. The literature does not show how to help reinforce teaching of instructional methods through activity, what teachers should reflect on in order to change their pedagogic practices. Hence the need to carry out this study, to investigate the role of SESEMAT program in enhancing the pedagogic practices of science teachers, at O’ level, in Mbale district.

2.5 Conceptual Framework

SESEMAT program is conceptualized as effective teaching and learning process. The elements upon which SESEMAT is founded are; Activity-based teaching/learning, Learner -centered teaching, Encouragement and Improvisation abbreviated as ALEI. These four elements are the SESEMAT pedagogic principles that guide the teacher in developing and delivering science lessons effectively. Effective delivery of science lessons translates into enhanced growth of learners in the three domains of learning .i.e. cognitive, psychomotor and affective domains.

The ALEI concept is a paradigm shift that discourages the use of knowledge -based approach, teacher-centered learning, laissez- faire attitude and large scale ‘recipe’ type experiments. It encourages Activity/experiments teaching and learning, learner-centered lessons, encouragement of the learner and improvisation of teaching-learning materials so as to conduct small scale experiments.

The frame work shows that SESEMAT influences teacher pedagogic practices. However, this influence may be modified by extraneous factors such as initial teacher training, school environment and availability of lab resources. Initial teacher training was controlled basing on the teacher’s experience in the field. Availability of lab resources was controlled purposively, so that only schools with labs and lab resources were studied against the background of performance results at U.C.E.

2.6 Chapter review

The chapter reviewed literature related to the study according to the following sub-themes; Theoretical Review, the research questions namely; How Science teachers implement CPD pedagogic principles, Science teachers’ perceptions towards the pedagogic worth of CPD programs and the factors that influence teachers’ adoption of the pedagogic principles in CPD programs and the Conceptual Framework.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter presents the methodology of the study; the contribution of SESEMAT in the pedagogic practices of science teachers in Mbale district. It describes the research design, population, study sample and sampling techniques, the data collection and analysis techniques as well as the procedure that was used in administering the instruments. The chapter also discusses the ethical considerations of the study.

3.1 Research design

Kombo and Tromp (2006) define research design as an arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance of research purpose. The research adopted a descriptive survey design. Mugenda and Mugenda (1999), define descriptive survey as a method of collecting information by interviewing or administering questionnaires to a sample of individuals. The design was cross sectional in data collection from all respondents once and for all to reduce on time and costs that would be involved (Creswell, 2003). This study aimed to investigate the contribution of SESEMAT CPD in science teachers' pedagogic practices in Mbale district. The study used mixed approaches i.e. qualitative and quantitative approaches.

The researcher used the qualitative method because there was need to study the reality from the point of view of the subject being studied (Science teachers). The researcher hoped to understand and capture reality as it was; i.e. without pre-conceived ideas (Sarantakos, 1993). The sample under study was also small enough to allow use of a qualitative approach i.e. 68 respondents. The qualitative approach was used in items that dealt with perceptions towards the pedagogical worth of SESEMAT and the factors that influence adoption of SESEMAT pedagogical approach. Key informant interviews and Focus group discussions were used in the qualitative method.

The Quantitative method was based on the survey conducted in order to collect data about the samples' demographics and pedagogical knowledge levels in SESEMAT ALEI practices, using a Self-Administered Questionnaire (SAQ) and teachers' classroom observation. This was collaborated with the qualitative method in which one- on- one post- lesson interviews with the subject teachers was done. The researcher took a random sample that was used once and for all to check the time and costs that would otherwise be involved. The methods used under the quantitative approach included; self- administered questionnaire and observation.

3.2 Population

The study population consisted of all the thirty six public and private secondary schools in Mbale district. The target population was five secondary schools with science teachers who had ever attended SESEMAT workshops.

3.3 Sample size

A sample of five secondary schools out of the thirty six schools in Mbale district was selected purposively. Selection of the five schools was against the background of performance in UNEB results (February 2016) for being the best performing schools at O' level in the district since priority is given to science subjects in grading of students' performance, besides English and Mathematics. Respondents were also purposively selected.

3.4 Selection of respondents

The table below shows selected respondents from the schools that participated in the study and the criteria used for inclusion. A total of 68 respondents participated in the study.

Table 3.1: Selection of respondents.

Category	**Inclusion criteria**	**Number**
Teachers	Teaching any of the three subjects and having attended any SESEMAT workshop	3 per school
Head teachers	Being the head teacher	1 per school
Regional Trainer (R/T)	SESEMAT technical person at regional level	1
Regional Monitoring Coordinator (RMC)	Key informant	1
Students	S.2 and S.3 classes	10 per school
TOTAL		**68**

Three teachers were selected randomly from the five selected schools, following the three science subjects (chemistry, physics and biology) under SESEMAT. This made a total of fifteen subject teachers. However, of the selected fifteen teachers only eleven participated as respondents in the study. Efforts to get the other four who had the SAQ were futile. The teachers were purposively selected because they are the ones who implement SESEMAT pedagogy at classroom level. They could also give data concerning perceptions and factors that promote or constrain the adoption of SESEMAT approach to teaching and learning of the three science subjects.

Five head teachers from the five selected schools were purposively selected as key informants because they were the supervisors of SESEMAT activities in the schools. The researcher hoped to collect data on the implementation of SESEMAT at school level from the selected head teachers.

A regional trainer was selected purposively as a key informant because she was a technical person in SESEMAT program. Data regarding training, monitoring, organization of training workshops and evaluation could only be gathered from her.

The regional monitoring coordinator was selected purposively as a key respondent because he could furnish the researcher with data concerning administration of SESEMAT at school level and coordination at the regional level. There were seen key informants in all.

Ten students were selected using simple random sampling from senior two and senior three against the background that senior four was up to covering the syllabus while senior one class had barely experienced SESEMAT. The ten students were selected randomly in; five from each class, both boys and girls. The total number of respondents who participated in the study was sixty eight.

3.5 Sampling Techniques

Sampling techniques refer to the procedure used by a researcher to select the required study sample (Kombo & Tromp 2006). Purposive sampling was used to select teacher respondents for the study. This technique was justified as the researcher was interested in only the teachers who taught the science subjects under SESEMAT and had participated in SESEMAT workshops i.e.

chemistry, physics and biology in which practicals are done, in the sampled schools. Gay (1996) suggests this technique is appropriate as it enables the researcher to easily identify subjects that are required in the study during data collection.

The five best performing schools were purposively selected depending on the performance of schools as per the UNEB results of 2017. The criterion of performance of students was used as a proxy for teachers' pedagogical practices in using active learning methods, learner-centered approach, encouragement of learners and use of improvisation through innovation and creativity in a science classroom.

3.6 Data collection methods

The methods used for data collection included; interviews (key informant and teachers' post lesson), observation, Focused Group Discussions (FGDs), and SAQs.

3.6.1 Key informant Interviews

The key informants included the SESEMAT Regional Trainer (RT) and the Regional Monitoring Coordinator (RMC). The interview was used to get information that the researcher believed could only be obtained from the said informants. The interviews were unstructured and in-depth to allow flexibility in the questioning. The researcher sought the approval of respondents to have the interviews audio recorded and open-ended questions were recorded verbatim with the use of audio equipment. The interviewer received the respondents' views with neutrality and interest. The interaction between the interviewer and respondents was friendly, cooperative and respectful. This approach is justified because it allows studying issues in-depth.

The Regional Trainer (R/T) and Regional Monitoring Coordinator (RMC) were purposively selected. The regional trainer was identified as a key respondent to furnish the researcher with information regarding her role; i.e. sensitizing science and mathematics teachers to improve the teaching of science subjects through monitoring and supervision of teachers in class, drawing annual action plan for the region and giving a feed back to the SESEMAT national office

The role of the Regional Monitoring Coordinator (RMC) is to ensure that SESEMAT program is implemented by the teachers in schools, monitoring and evaluating 'good' teaching practices, mobilizing trainers to give over-head support to teachers while conducting science lessons, mobilizing resources and chairing meetings. Five head teachers were selected as respondents. Their role is to; give support supervision to teachers in individual schools, ensure that science teachers attend CPD workshops when called upon, facilitate science teachers to attend workshops by providing transport to them, keep records and monitor attendance of sensitization workshops.

3.6.2 Post lesson interviews

In the after teaching pedagogic practices, areas of special interest were; whether the teachers improvise learning materials in case there is inadequacy, how improvisation enhances teaching and learning and how teaching and learning materials enrich students' experiences. The researcher conducted post- lesson interviews with the teachers whose lessons had been observed. In these interviews teachers explained why individual tasks were not assigned to students. i.e. Inadequate instructional materials and equipment coupled with large class sizes, in limited time. This curtailed assigning tasks to individual students. Post- lesson interviews were also done so as to establish whether there were any follow up strategies by the teachers concerning students who may not have grasped the concepts during the lessons, how best practices are shared in their respective schools and any other actions taken by the teachers in the interest of improving students' learning.

All the observed items were given a description of the activities and strategies carried out by the teachers and how these activities were conducted. The researcher wrote down qualitative comments on what was being done in the teaching and learning process and later, compared them, with what is prescribed by SESEMAT approach to teaching-learning. In this way, the researcher was able to tell the extent to which SESEMAT pedagogic prescriptions have been taken up in the teachers' practices. Four classroom lessons were observed with at least one lesson from each of the subjects.

3.6.3 Lesson Observation

The method aimed to establish how science teachers use participatory methods of teaching and learning and whether they harness the surrounding environment to support their teaching practice. The observation was non-participant in a natural setting i.e Labs and classrooms. The observer remained formal and detached as this was a cross sectional survey in which each lesson was observed once in one hour and twenty minutes. The observer's identity was disclosed and the intention of the research study was made known in order to eliminate reactivity of the subjects (Sarantakos, 1993). The focus of the observation was on the teachers' and learners' activities during the teaching and learning process. The classroom observation guide sought data on two fronts; during the actual teaching and after teaching. During the teaching, the researcher observed science lessons to analyze if they reflect the SESEMAT pedagogic approach i.e. Activity filled lessons, learner-centered teaching and learning, encouragement of the learners and improvisation of learning materials (ALEI Pedagogic Practices)

3.6.4 Focus Group Discussions (FGDs)

The method was used with five groups of students from the five selected schools. The researcher held FGDs with ten students from each school that were randomly selected from S.2 and S. 3 classes. The focus group discussion was done with the selected students as one group. The researcher purposively selected students from the two classes because they were readily available as compared to the S.4 class whose concern was about syllabus completion. The S.2 class was selected because they had a better understanding of SESEMAT lessons following exposure for a longer time than S.1 class. Respondents were assigned numbers 1-10 in each group. The researcher facilitated the discussion by posing questions which were answered by individual respondents. Shared opinions were recorded and later tallied for interpretation and analysis. The students furnished the researcher with information regarding the teaching and learning of science subjects in their schools/classes, their perceptions towards SESEMAT lessons and tests, whether they bring learning materials from home and the effect of such materials on their understanding of science subjects. The researcher guided the discussions so as to obtain information about students' feelings towards the SESEMAT lessons and reasons for such feelings. In this way, she was able to tell the difference SESEMAT had made in students view of science subjects.

3.6.5 Self Administered Questionnaires (SAQs)

The researcher used SAQs to gather data from science teachers in the selected schools. The questions were carefully designed and typed so that respondents were given copies to answer at their convenient time within the time frame of the researcher. The questionnaires were both open-ended and close-ended; thereby enabling the researcher to elicit both qualitative and quantitative data. Pre-coded questions were used in items that the researcher wished to classify such as respondents demographics and working experience. A response scale was formulated and respondents expected were expected to tick one of the words in the spaces provided. The questionnaires were related to the research questions and ultimately covered the research objectives. Questions regarding implementation of SESEMAT, perceptions of teachers towards the program and factors influencing adoption of SESEMAT were suitably answered using this method because the said respondents were the target group of SESEMAT program

3.7 Research instruments

The researcher employed the following data collection instruments; SAQs, the interview guide, FGD guide and the observation checklist. The data collection instruments were chosen because they worked in mutuality with the data collection methods.

3.7.1 Self Administered Questionnaires (SAQs)

A questionnaire is a set of carefully designed, written down, pre- tested questions, which are asked of individual respondents to gather information in research (Enon, 1998).The study employed SAQs to gather data from science teachers. Mugenda and Mugenda (2003), points out that use of questionnaires enables respondents to express themselves freely. Both open ended and closed ended questions were asked. The open-ended questionnaire was ideal for generating personal responses from science teachers as required in the study. The close-ended questionnaires were used for items that were quantifiable such as the respondents' demographics.

Science teachers' questionnaire had four sections. Section A which had four items on demographic data of teachers, section B which captured data on science teachers' implementation of the SESEMAT pedagogic practices, section C had data on science teachers' perceptions towards the pedagogic worth of SESEMAT and section D that had data on factors that influence science teachers' adoption of the pedagogic worth of SESEMAT pedagogy in teaching and learning of science subjects at O' level.

3.7.2 The interview guide

The interview guide was used in administering interviews to key informant persons i.e. the Regional Trainer and the Regional Monitoring Coordinator and the head teachers of the selected schools. Three areas were covered in the interview process against the background of the research questions i.e. the section with questions that elicited data about how science teachers implemented the ALEI pedagogical principles, the section that sought data on teachers' perceptions towards SESEMAT program and the section that derived data about factors that influence teachers' adoption of SESEMAT.

The Regional Trainer responded to questions related to; whether SESEMAT was a worthwhile approach to teaching - learning science, teachers' perceptions towards SESEMAT, effectiveness of policies governing the program, challenges encountered in monitoring the program, how teachers are supported to implement SESEMAT, evaluation activities, use of the cascade model, challenges associated with it and the modification of SARB for improvement.

The RMC responded to questions regarding; monitoring of the program in the region, SARB promotion in the region, challenges in monitoring SARB, effectiveness of the governing policies of SESMAT, how responsive teachers are to changing patterns of teaching -learning science and any improvement opportunities for the program.

Head teachers responded to questions regarding issues such as how they ensure that teachers teach according to SESEMAT prescriptions, submission of SARB school summaries to the RMC, support schools give to science teachers to implement SESEMAT, challenges they encounter in facilitating implementation of SESEMAT program in their schools and recommendations for improvement of SESEMAT implementation at school level. These questions guided the researcher to capture an independent opinion from these respondents about how science teachers implemented the ALEI pedagogical principles.

The questions were rated by the supervisors for suitability. This helped the researcher to test the items for validity. The researcher then piloted the interview guide and the SAQ on a small sample of two head teachers (R/Ts) and three science teachers in two schools outside the study sample. The piloted sample was similar in characteristics with the target population. In this way, the researcher checked the response pattern for consistency as well as reliability. All responses were audio recorded and hand written. The audio recorded data was used later by the researcher to counter- check with the hand written data and the interview guide for teachers.

3.7.3 Focus Group Discussions Guide (FGDs)

The FGD was used to collect data from selected groups of S.2 and S.3 students from the selected schools. This instrument was preferred because the researcher sought to get data from students' experiences about the way they were taught science subjects so as to establish the how science teachers implemented ALEI pedagogical principles. The researcher used simple random sampling to select the student respondents from S2 and S.3 classes .Selected students answered questions regarding; teaching and learning of science subjects namely; the SESEMAT approach, support given to them by subject teachers, teacher involvement in students' discussions, improvisation and use of the teaching -learning materials and their perceptions towards SESEMAT lessons and tests.

The data gathered using the FGDs was triangulated with data collected using other instruments such as the teachers' SAQ, and interviews.

3.7.4 Observation check list

The researcher used the observation check list with a focus on SESEMAT ALEI pedagogic pillars upon which effective teaching and learning is hinged. The researcher looked out for indicators of the four ALEI pedagogic principles in lesson development and delivery of lessons; i.e. Activity-filled lessons in which individual students carried out activities during lesson time. The said activities were expected to cover the three domains; i.e. the cognitive domain (minds-on), the psychomotor (hands- on) and the affective (hearts -on). Use of the learner-centered approach, whose indicators were the teachers' questioning techniques i.e. use of structured and probing questions that enhance students' participation in class and the teachers' ability to harmonize students' ideas. The pedagogic principle of learner encouragement was indicated by the teachers' use of rewards to students who gave correct answers, partially correct answers and/or wrong answers. Improvisation was checked by the teachers' creativity in using learning materials harnessed from the local environment.

Recording during lesson observation was done through writing down the ALEI key words; i.e. Activity- filled lessons, learner-centeredness, encouragement and improvisation (ALEI). Under each of the elements were the three domains coded as C.A.P; C-for cognitive A- for affective, and P- for psychomotor. The teachers' activities were then categorized under each of the elements (ALEI) and the three domains of learning (C.A.P). The codes made recording easier for the researcher as the key words and codes served as a guide for making complete notes after observation. Photos of some aspects observed were taken where necessary. The researcher triangulated the data collected from the observation instrument with data collected using other instruments so as to ensure validity of the findings.

3.8 Quality Control

3.8.1 Validity

Mugenda & Mugenda (2003) define validity as the degree to which results obtained from analysis of the actual data represent the phenomena. The researcher constructed questionnaires and interview guides that conform to the conceptual framework of the study and the study's objectives, through consultation with the supervisors. The relevance, wording and clarity of the questions were evaluated by showing them to the supervisors together with the objectives of the study. They then judged the suitability of the items, discussed them and made appropriate modifications.

Kothari (2003) defines content validity as the degree to which a measuring instrument provides enough content under study. Content validity ensured the instruments, measured what they were intended to measure. To enhance content validity, appropriate and adequate items relevant to the research objectives were included in the self administered questionnaires and the focus group discussions. Two pilot schools, two head teachers and six science teachers were randomly selected to respond to the questionnaires; while ten pupils (selected through use of the simple random technique) participated in the focus group discussions. After one week, the same items were administered to the same respondents and the results were compared to determine the reliability of the instrument.

Triangulation of methods was used to increase the validity of both qualitative and quantitative instruments (Amin, 2005). This was achieved through comparison of findings from different data collection methods and different respondents

3.8.2 Reliability

Reliability of a research instrument concerns the extent to which an instrument yields the same results on repeated trials (Mugenda & Mugenda 2003). The researcher used two pilot schools in which two head teachers, six science teachers and ten pupils in Mbale district participated before the actual data collection. Test retest technique was used to ascertain the reliability of the instrument.

3.9 Data analysis

Data from the field notes provided information that led to the understanding of how SESEMAT pedagogic principles were implemented, the teachers' perceptions towards the worth of the SESEMAT pedagogic principles and the factors that influenced teachers' adoption of the SESEMAT ALEI pedagogic principles.

To track how teachers implement SESEMAT principles in their classroom practices, teachers' responses from the post -observation interviews formed a starting point for analysis. The researcher analyzed the responses of the teachers whose lessons were observed following the research objectives. Under each objective were the ALEI principles. The data was triangulated with the data derived and analyzed from the self -administered questionnaires. Data from classroom observation were analyzed based on the ALEI principles displayed by the teachers. Under each of the ALEI elements were three sub- categories that had letter codes; C.A.P each letter representing the three domains. The teachers' activities were then categorized under each of the elements (ALEI) and the three domains (C.A.P). The key words and codes served as a guide for making complete notes.

Data from the self administered questionnaires, the key informant interviews and the focus group discussions were analyzed based on an interpretation. Small units of responses that could make meaning on their own were identified and later grouped into themes that described them effectively. The data was then grouped and named according to the semantic themes. The relationship between the themes was studied and the patterns in the data described and presented. The patterns identified went through a process of open coding in which number codes focused on the three major categories; implementation, teachers' perceptions and factors for adoption of

SESEMAT. Hence, category 1 was implementation, category 2, perceptions and category 3, was factors for adoption.

The self- administered questionnaires and interview transcripts were read several times as codes were established. The teachers' responses were then coded to the questionnaires just as the interviewees' responses were coded to the interview transcripts. Data from the focus group discussions were also read several times and coded. The patterns and themes that emerged were refined using triangulation of the instruments; i.e. self-administered questionnaires, interviews, focus group discussions and observation.

To analyze teachers' perceptions, responses regarding the use of ALEI pedagogic practices and how these practices have changed science teaching were analyzed so as to gauge the teachers' perceptual stand. Responses to the teachers' questionnaire were compared with responses from the key informant interviews in the target area. The perceptions identified were compared with the patterns that had emerged from the questionnaires and the interviews.

To analyze factors that influence adoption of SESEMAT pedagogy responses from the self administered questionnaire in the target area were analyzed and compared with responses from the interviews and document analysis. The data were then triangulated with the data derived and analyzed from the FGDs and observation.

Descriptive statistics were used to summarize data in form of frequencies and percentages. Data was organized and presented in form of frequency tables and figures. Descriptive statistics involved tabulating data. Data collected was coded and analyzed manually and percentages computed. Findings were reported by use of frequency tables and percentages.

FGD items were analyzed manually on the frequency of shared opinions. Each group had ten respondents from the five selected schools, in the two selected classes of senior two and three; comprising both girls and boys. The respondents were assigned numbers ranging from 1-10. Each response was audio recorded and hand written, and later tallied with responses from other schools. The data was then interpreted and tabulated.

3.10 Research Procedure

The researcher having obtained an introductory letter from the Dean's Office, School of Education, Makerere University, selected two research assistants and explained to them the project. The researcher went to the selected schools and introduced herself. She sought permission from the various authorities such as the head teachers, the directors of studies and heads of departments and the science teachers themselves, as a student carrying out a research, so that it was conducted without any hindrance. Interviews were conducted by the researcher while writing and audio recording were done by the research assistants.

3.11 Ethical considerations

A letter of introduction was obtained from the Dean School of Education attached as appendix F. Copies were given to the five selected secondary schools. The letter had a clear explanation of the intention of the study to the respondents. The researcher explained the major objective of the research as being for study purposes. The researcher sought consent of the respondents before engaging them in any form of discussion or interview. She assured them of the confidentiality of whatever information that was revealed. Neither their names nor the names of their schools were disclosed. Otto and Onen (2005) point out that those respondents have a right to remain anonymous. The respondents reserved the right to withdraw from the project or otherwise.

3.12 Chapter review

This chapter presented the methodology of the study. It also presented the qualitative and quantitative research design that the study employed with the sample of 68 respondents. The participants were purposively sampled. It also presented the instruments used namely; self-administered questionnaire, key informant interview guide, FGD guide, observation check list and document analysis guide. It also showed the procedure of data collection and the administration of the instruments.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Over view

This chapter presents findings that answer the research questions of the study. The findings are reported in the following four sections; background of the respondents, science teachers' implementation of the SESEMAT pedagogic principles to teach science, teachers' perceptions of the worth of SESEMAT pedagogic principles in enhancing their classroom practices and factors that influence teachers' adoption of SESEMAT pedagogic principles in their classroom practices.

4.1 Demographic data of respondents

The demographic characteristics of respondents included; qualification of respondents, their teaching experience, gender and classes they taught.

4.1.1 Highest qualification

The figure below shows the highest qualification of respondent teachers. A total of eleven teachers participated in the study.

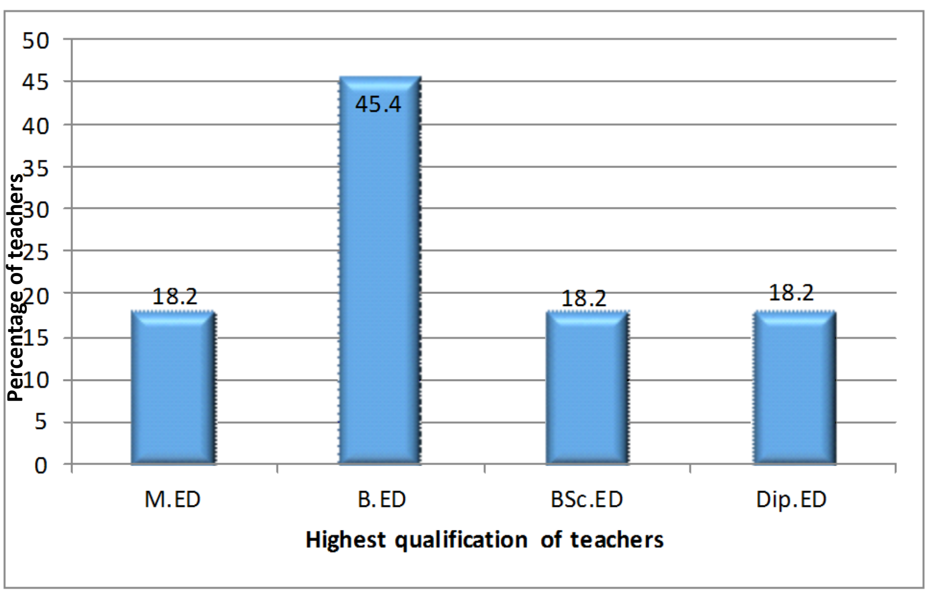

Figure 4.1: showing percentage distribution of teachers by qualifications

Three quarters (63.6%) of the teachers had bachelor's degrees as the highest academic qualification. On the other hand, only 18.2% of the teachers had diplomas as the highest qualification. This implies that all the teachers who participated in the study had the minimum expected qualifications for teaching science at O'level and they had also been exposed to SESEMAT professional development opportunities. The study established that each of the three science subjects under study, had qualified teachers in areas of specialization i.e. four Biology teachers, three physics teachers, two chemistry teachers and two teachers for both biology and chemistry subjects. All the teachers who participated in the study had taught for over six years, as reflected in the figure below.

4.1.2 Experience of respondent teachers

The figure below shows the experience of respondent teachers.

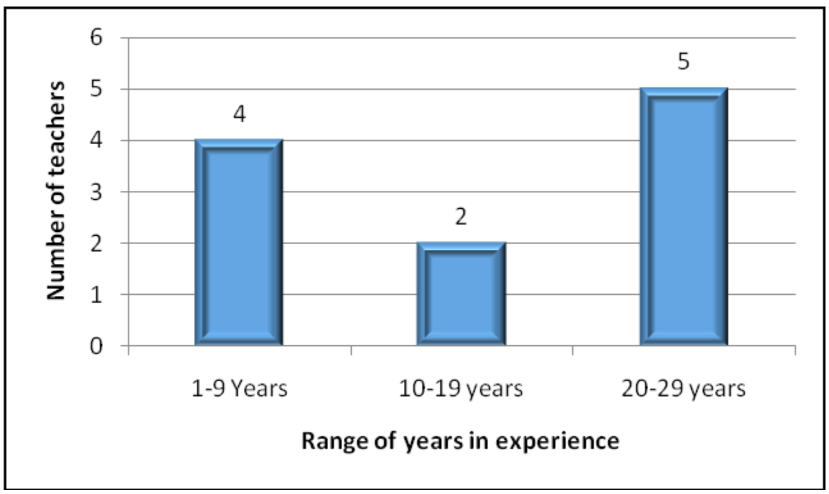

Figure 4.2: Teaching experience of respondent teachers

Four out of the eleven teachers had teaching experience ranging between one to nine years. Two teachers had the experience of between ten to nineteen years while five teachers had the experience of twenty to twenty nine years. This implies that majority (seven out of eleven) teachers that participated in the study had had long exposure to teaching the three science subjects and attended SESEMAT CPD. Teachers' experience compounds their professional competence to teach science. Therefore, they were in a better position to apply SESEMAT pedagogic prescriptions i.e. ALEI principles. Only four of these had the experience of less than ten years. This group also had teaching experience which may have influence in the teaching of science. This implies that the teachers that participated in the study had had long enough professional exposure to teaching science.

4.1.3 Gender of respondent teachers

The figure below shows the distribution of teachers by gender.

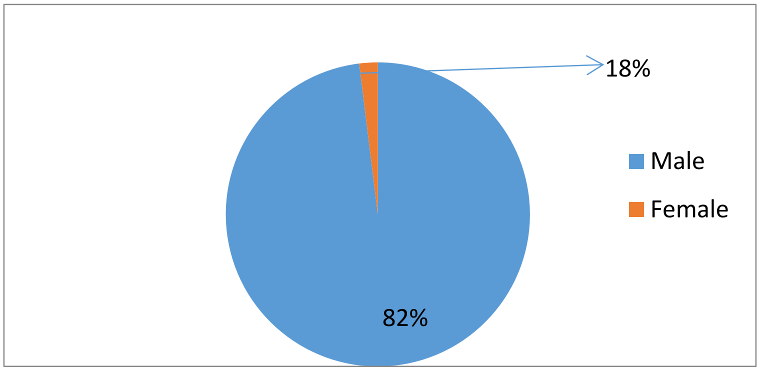

Figure 4.3: Showing gender of respondent teachers

Teachers were asked to indicate their gender. Gender imbalance may influence the students' attitude towards science subjects in such a way that students may interpret one's capability of doing sciences alongside the small or large numbers of the teachers by gender. Nine out of eleven (82%) teachers were male and only two (18%) were female. Teaching of science subjects in Mbale is dominated by male teachers. This imbalance may be attributed to the apathy and stereotypes by society that science is a male domain or for the 'gifted'. This implies that the girl child could be disadvantaged in getting real role models of their gender from whom to emulate.

4.1.4 Distribution of teachers against classes taught

The figure below shows the percentage distribution of respondent teachers and classes taught

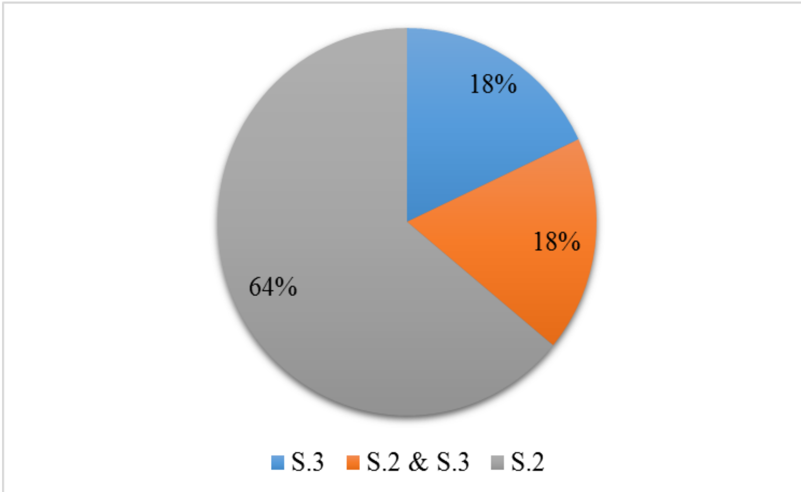

Figure 4.4: Distribution of teachers against classes taught

Out of the eleven teachers who participated in the study seven were S.2 teachers; two were S.3 teachers while two teachers taught both classes. The fact that S.2 teachers were the majority participants in the study as compared to the S. 3 teachers may imply that S. 2 teachers may have had confidence in their ability to use the SESEMAT pedagogic approach at that level. Findings from studies on teacher learning show that if teachers do not have confidence in their ability to implement a new teaching approach, even if they value the approach and desire to use it, they will rarely try it out (Park et al. 2006). Senior one and Senior four teachers were not selected for the study against the background that senior one students had barely experienced SESEMAT while Senior four was a candidate class whose focus was on NCDC syllabus coverage.

4.2 Teachers' implementation of the SESEMAT pedagogic principles

The first research question sought to establish how the selected teachers implemented the SESEMAT pedagogic principles in their classroom practices. In order to answer this research question, the researcher used classroom observation check list, teachers' self-administered questionnaires (SAQs) students' focus group discussions guide (FGDs) and key informant interviews.

Findings presented below indicate how teachers apply the SESEMAT (ALEI) principles in teaching and learning classroom practices.

SESEMAT Continuous Professional Development (CPD) is hinged on four pedagogic principles; Activity, Learner-centered teaching and learning, Encouragement and Improvisation (ALEI). According to SESEMAT CPD, there is no good or bad teacher; therefore all teachers keep improving. Good lesson planning and implementation as prescribed by SESEMAT leads to efficient delivery of the lesson in which the teacher prepares activities for learners, involves them in the lesson through use of the learner-centered approach, encourages them to explore and discover and improvises where teaching and learning materials are inadequate or unavailable. SESEMAT pedagogic prescriptions are expected to culminate into effective teaching and learning of science subjects.

The study found that the selected science teachers had adopted the SESEMAT ALEI pedagogic principles and they used them in their classrooms to some extent. All observed lessons were interspersed with activities in which selected students took part. Learner-centered teaching and learning was evidenced in three of the four lessons observed as learners co-constructed knowledge and got involved in the teaching- learning processes. All teachers who were observed encouraged their learners through reinforcement of learning and improvisation was reflected in all the science lessons observed. However findings showed that not all learners were engaged in the pedagogic processes due to classroom contextual factors such as extremely large classes, inadequate supplies and equipment for hands-on activities, albeit improvisation. Learner-centered teaching and learning was not wholly implemented as some teachers reverted to the teacher centered approach to teaching and learning. Teachers still relied heavily on what schools provided as teaching and learning materials.

Below are two case studies of biology lessons observed in two different schools; vignette X illustrates the use of the ALEI principles in the classroom. While vignette Y shows the classroom practices that still rely heavily on knowledge transmission from the teacher to the learners.

Date: 20th June 2017

School: Large, mixed day urban government aided school.

Class: Senior two

Venue: The laboratory

Number of pupils: Eighty nine students

Duration of the lesson: Eighty minutes

Organization of the class: The biology teacher stood in front of the class facing students. Between the teacher and the students was a long high table on which the teaching and learning materials were laid. Students stood around similar tables arranged in four columns.

Teacher: Male with twenty three years' experience.

Topic: Flowering plants; written on the chalkboard

Lesson

The teacher started the lesson with a quick recap of the previous lesson; non flowering plants. He then asked the students to mention the products that plants give and state the importance of the fruits, seeds and flowers. He asked students how fruits can be identified. A student (girl) said, 'with the help of scars.' The teacher introduced the fruits brought for the lesson. He cautioned students not to eat anything from the lab. He instructed students to close their books.

The teacher asked students to identify the major types of fruits. Student (boy) mentions 'simple fruits'. Other students still put up their hands; the teacher chooses one at a time and they each mention the answers as; succulent fruits, dry dehiscent and dry indehiscent fruits. Teacher asked students why the fruits are called dry dehiscent. Student (boy) says; 'because they break along two lines of weakness. Another student (boy) says; 'because they have two scars'. The teacher asked one student to show the rest of the class the lines of weakness. A student (girl) does. Teacher asked students to differentiate the fruits according to the scars. He singles out a student who does it. Teacher asks the class to clap for him.

Teacher asked students to give examples and characteristics of dry dehiscent fruits. Students picked at random mention; fruits that cannot open by themselves, such as black jack and sun flower. Teacher distributes specimen (black jack) to all students.

Another type of fruits; dry indehiscent fruits, is mentioned. Examples are given by students. Teacher asks them whether the specimen is a fruit or a seed. One student says 'a seed' and the teacher says 'no, that is a good trial but the answer is not correct. 'He gives another student opportunity to answer. The student says 'fruit'. The teacher tells them that the fruit is called 'samara'. The students repeat after him. The teacher tells the students that when the fruits are dry they split along the lines of weakness. Teacher distributed another type of fruits; bean pods. One student identified the lines of weakness. The teacher asked her to demonstrate the splitting along the lines of weakness. Teacher proceeded to show the class other types of fruits; i.e. follicles e.g. cassia pod.

Teacher introduced succulent fruits to excited students. He asked a student (girl) to define succulent fruits. Student said 'fruits with a fresh and dehiscent scar' Teacher showed fruits mixed up and asks other three students to identify the succulent fruits only. Students identify mangoes, avocados, bananas and oranges. Teacher showed them the three layers that one of the succulent fruits (mango) has. Students mention the names of the three layers on the succulent fruits; epicarp, mesocarp, and endocarp. The teacher showed them another fruit (orange) and asked four students to cut them into two, using knives as other students watched. The lesson ended as the teacher was getting another fruit (banana) to be cut.

Figure 4.5: Vignette X-Best practice lesson

Date: 18th June 2017

School: Large, mixed day, urban government aided school.

Class: Senior two

Venue: The classroom

Number of pupils: Eighty three students

Duration of the lesson: Eighty minutes

Organization of the class: The biology teacher stood in front of the class facing students. On the teacher's table was equipment and apparatus that were going to be used in the science experiments. The students were sitting at their desks.

Teacher: Male with twenty one years' experience.

Topic: Test for reducing sugars (written on the blackboard)

Lesson

The teacher instructed the students to sit in groups of eight. He cautioned the students not to taste anything using the tongue. He then asked the students the name of the reagent that was going to be used to test the reducing sugars. The students kept quiet. The teacher told them that it was called Benedict's solution. The teacher showed them a solution in a test tube and asked them what color it was. The class chorused 'Blue'. The teacher told them that the reagent is used to test sugar in fruits. Teacher explained that 'reagents are simple solutions kept in the what? In the lab. In the what?' Students chorused; 'In the lab' Teacher reminded them that the reagent is the Benedict's solution.

He said, 'today we want to find out if we put chemicals in this fruit solution and test, to see if it is a reducing sugar' 'We test by putting a little dro…what? Drops. Then we boil. You will see reaction taking pace. You will see by obser,,, what? Observation. By what?' The students reply in chorus; 'Observation.' Teacher asked students; 'who knows the name of this apparatus?' Students keep quiet. Teacher said 'it is a test tube rack.'

Teacher distributes racks to the eight groups then he said; 'We are going to use our food sample in a beaker. We shall also use a match box. A what?' Students chorus; 'a match box' The teacher told the students that they were going to light a Bunsen burner. 'After we are going to make some obser…what?' Students chorused 'Observation'.

Teacher instructed students to test and draw conclusions from the observation made. He told the students that they were going to observe four color changes which they would write down in tabulated columns. The teacher told representative students to go the front of the class and get the food substance solution as he lit the Bunsen burner. The teacher had labeled Benedict's solution as 'A' and the food sample as 'B' He showed them how much of each solution they could get. He then instructed them on how to hold the test tubes with papers as fire tongs were not there so as to heat the solution. The representative students watched the color changes and reported to the teacher. The teacher showed the rest of the students how to record the results.

The scheduled time for the lesson ended as the teacher was guiding students on another activity in which they were going to test for starch, using the iodine solution. The students carried out the experiment hurriedly as they were supposed to attend another lesson. Eight students were selected to wash the test tubes in a basin placed outside the classroom.

Figure 4.6: Vignette Y- Teacher centered lesson

In regard to application of ALEI Pedagogic principles the selected teachers implemented the SESEMAT ALEI pedagogic principles in their classrooms at varied levels as elaborated in the following subsections.

4.2.1 Activity based lessons /Practical Science work

All lessons observed had practical activities in which students took part. For example, in vignette X, learners' activities included; classification of fruits according to characteristics i.e. Simple fruits, dry dehiscent, dehiscent and indehiscent; selection and identification of succulent fruits, cutting a berry fruit (an orange), transversely and a banana longitudinally, and splitting legumes (beans & cashew nuts) along lines of weakness. The other three lessons i.e. S2 biology, S3 chemistry and S2 physics lessons had similar practical activities tailored to suit particular lesson topics. Activities such as measuring food samples, iodine solution, heating the solutions, and observing and recording color changes during two experiments intended to test for reducing sugars in fruits and test for starch in a food sample are a typical reflection of the activity principle in use. In the physics lesson, learners' activities included grouping levers into the first, second and third classes and demonstrating a see-saw using a ruler and a wedge. While in the chemistry lesson, learners' activities included measuring sugar using a spatula, pouring water in the test tubes, noting the number of spatula end-fuls, stirring the solution to dissolve it, and measuring and reporting the volume of the solvent formed, recording and reporting the results. Extract 1 from vignette X, shown below illustrates how activities were interspersed in the lesson and how the teacher involved the learners in the teaching and learning process.

Lesson extract 1; shows how Mr. Lusala from Matinyi S.S, senior two, Biology class used activities and involved learners in the teaching learning process.

> T: Can we have a volunteer to show us the two scars which are the lines of weakness?
>
> (*One student goes to the front and picks a bean pod which she shows the class and demonstrates how the bean pod breaks along the lines of weakness*.)
>
> T: Very good. Alright I want two students to come to the front and differentiate the fruits according to the scars. (*Two students go to the front of the class and pick legumes i.e. cashew nuts and follicles -cassia pod*.)
>
> T: (*showing the class a mixed arrangement of fruits*) I now want four students to come and identify only the succulent fruits from the fruits on the teacher's table. (*Four*

students; one girl and three boys go to the front and pick out a mango, an orange, a green banana and an avocado amidst a lot of excitement from the class.)

T: Alright class we are moving to the next step; each of these four students is going to cut the fruit into two. Ready? The rest of us be attentive and watch what happens.

The activity pedagogic principle was reflected in all the lessons that were observed to a great extent, although not all learners were able to participate as prescribed by the SESEMAT activity principle.

4.2.2 Learner-centered teaching and learning

Among the SESEMAT pedagogic principles is the learner-centered teaching and learning. Rather than have the teacher transmit knowledge to the learners, teachers are expected to facilitate the teaching and learning process by involving learners in construction of knowledge.

Learner-centered teaching and learning as one of the ALEI principles is premised on the view that when learners are actively engaged in constructing knowledge they experience deep and meaningful learning. According to SESEMAT principles, lessons are learner -centered when learners co-construct knowledge through being involved in the teaching- learning processes, the teacher facilitates learners to learn through 'discovery' by giving them questions that are searching/ probing or structured. The learner takes responsibility of his own learning as the teacher guides and facilitates him.

The study found out that two teachers out of the four, who were observed in classroom, used the learner-centered approach in their lessons. Learner centered pedagogy was evidenced in two lessons that were observed i.e. Matinyi S.S (vignette X) and Bunyasi High School. The classes and lessons observed were S .2 biology class and the other was the S .3 chemistry lesson. In these lessons the teachers actively engaged learners in knowledge construction through use of practical science experiments conducted in groups. Teachers asked learners probing or structured questions that encouraged explanation rather than guesswork.

Lesson extract 2; shows how Mr. Makombe from Bunyasi High School, S. 3 Chemistry class used the learner-centered approach to teach the mole concept. In his lesson, the teacher grouped students into nine groups of ten. He then distributed test tubes, spatulas, and sugar to each group. Having done this, the teacher went back to the front and instructed the learners thus;

> T: I want each group to get water in a cup and go back to your seat. (*Representative students go to the front to get water*) Now, I want you to measure sugar using a spatula. Each group has to determine the number of spoons that you will put in the water. The amount of water determines the number of spoons/ spatula end-fuls of sugar (*Student representatives scoop sugar from the papers on which the teacher had put it and pour it in the test tubes; using the spatula end-fuls. Some students scoop up to five spatula end-fuls while others make six depending on the water levels in the test tubes*) Do not test the sugar at all.
>
> T: Now one student from each group should come for water at the front. (*Representative students go for the water which they carry in plastic cups*.) Pour the water in the test tubes and stir the solution sing the spatula. (*Student representatives pour the water in the test tubes and stir the solution as the teacher goes around guiding different groups)*
>
> T: Each group measure the volume of the solvent and record the result. What are we going to use to measure the volume of the solvent?
>
> S: (Girl) A measuring cylinder.
>
> (*Students measure the volume and record the results)*
>
> T: How do we read the number of spatula endfuls you got? I expect two values recorded by each group.
>
> S: (Boy) (*reading*); 6 spoons, 200 cm of water. (*Different groups read their results which vary slightly*)
>
> T: Good. Now we are going to record. (*Teacher writing on the chalk board*) You say; there are 6 spatula endfuls of sugar which got dissolved in 200 cm^3 of H_2O

In lesson extract 2 above, the teacher acts as a facilitator by guiding learners to measure the sugar and the water in the correct amounts, read the number of spatula endfuls, measure the volume of the solvent and record the results correctly in their groups. Learners take responsibility of their learning as the teacher involves them in the teaching -learning activities. SESEMAT emphasizes the teacher's role as a facilitator so that learners' ideas are tapped into through co- construction of knowledge by actively participating in the pedagogic processes. Students taking charge of their learning was also reflected elsewhere in a biology lesson in which learners cut succulent fruits to see the three layers (epicarp, endocarp and mesocarp) and also opened legumes along the lines of weakness.

In lesson extract 3 below the teacher uses the learner-centered pedagogic principle through the questioning technique. In the lesson, the teacher shares the teaching and learning time with the learners as he poses structured questions that encourage learners to express themselves freely and even question the logic in their own answers.

Lesson extract 3; Mr. Lusala from Matinyi S.S, senior two Biology class used the questioning technique to teach about flowering plants.

T: Mention the products that plants give. (*Picks students to answer at random*)

S: (girl) Plants give us fruits, flowers and seeds.

T: Good. What is the importance of fruits?

S: (boy) Fruits give us vitamins and food.

T: (boy) Correct. How can we identify fruits?

S: (boy) with the help of scars.

T: Now we are going to identify the major types of fruits. I want three major categories.

S: picked at random; (*succulent fruits, dry dehiscent fruits and dry indehiscent fruits*)

The teacher also acts as a facilitator by guiding learners to discover on their own rather than spoon feeding them

SESEMAT emphasizes the teacher's role as a facilitator so that learners' ideas are tapped into.

Analysis of the teacher's and learners' pedagogic interactions showed that the teacher recognized the features underlying the SESEMAT learner-centered pedagogic prescriptions i.e. Teacher is a facilitator, learner is responsible for own learning, co-construction of knowledge, and learning through ‘discovery’ .

4.2.3 Encouragement

Encouragement is another pillar prescribed by the SESEMAT ALEI principles for teaching science subjects. Teachers are required to encourage students by giving them opportunity to participate in the teaching- learning activities, allowing learners to ask questions during and after lessons, listening to learners’ questions and guiding them to figure out answers, giving encouraging remarks to learners who participate in answering the teacher’s or other learners’ questions, giving rewards such as clapping for learners who give correct answers, thanking those who attempt but give incorrect answers and catering for all learners both the slow and fast learners in disregard of gender. This is one of the SESEMAT pedagogic principles intended to improve learners’ performance in science subjects.

Students’ poor performance in science subjects has been partly attributed to the negative perceptions towards science subjects, of both teachers and students, that sciences are difficult. SESEMAT pedagogic concepts are intended to change the laissez-faire attitude to encouragement so as to demystify the pre- SESEMAT condition where sciences were taught and learnt without enjoyment.

The study found that all teachers who were observed encouraged their learners through reinforcement of learning. For example, teachers encouraged students who answered questions correctly with remarks such as “thank you” “good” “very good,” which encouraged learners to actively participate in the lessons. Meanwhile, those who did not give correct answers were encouraged with words such as; “another trial?” “Thank you but that is not correct”. Teachers also encouraged learners to participate in the activities during lessons by urging female students to answer. In another class (physics) students clapped for their friend who gave a correct answer to a puzzling question. A student who is encouraged by the teacher will most likely be inspired to answer the next questions as compared to one who will be ignored or rebuked for the wrong answer given.

4.2.4 Improvisation

This is one of the SESEMAT ALEI pedagogic principles that underscore creativity and innovation. Improvisation of teaching -learning materials occurs in situations where the teaching- learning materials are inadequate owing to factors such as large class sizes or where the learning materials are too expensive or simply not there. It is therefore up to the teachers' creativity to obtain learning materials from the local environment instead of waiting for the manufactured ones. In lesson extract 3 above for instance, the teacher explained that knives were not supposed to be used in classrooms; but due to lack of surgical blades he had to use knives to cut the fruits. In another biology lesson, the teacher illustrated to students how to fold a paper and use it to hold a test tube in substitute for fire tongs; he also used a jerry can full of water and a basin placed outside the classroom as a water point in place of a sink and tap; while another teacher used a jerry can and a basin as water points with plastic cups for carrying water to different work tables in place of taps and sinks in a chemistry lesson. In these lessons the sinks and taps had been completely out of use for a long time. Were the teachers to wait for the schools to repair sinks and taps, such lessons would never have been conducted but for improvisation. These resources were used with other materials provided by the school labs such as chemicals and the measuring cylinders.

While two teachers of biology explained that they depended on what the schools provided, improvisation was reflected in all the science lessons observed. In an item from the teachers' SAQ in which teachers respond to the question; how improvisation has improved on the teaching and learning of science subjects' eight out of the eleven teachers indicated that more practical experiments and lesson activities were now possible because teachers were no longer entirely relying on what the schools provided.

In a post-lesson interview Mr. Makombe the chemistry teacher from Bunyasi High school commented;

> SESEMAT has taught us to improvise I tell you. For example now, this is the fourth practical that I have conducted this term without waiting for the school to secure the learning materials. In this practical, you can see the sinks are rusted and the taps broke down long ago. But we decided to use a single jerry can of water instead of the sinks, and the cups in place of taps.

Mr. Lusala the teacher of biology in Matinyi S.S. said; “The improvised materials are from within the school compound most of the time. Now like the leaves and legumes I just went to the school garden”

The comments above are consistent with the teachers’ responses in the questionnaire relating to, ways in which improvisation has improved teaching and learning of the three science subjects.

Findings of the study question indicate that teachers have to some extent adopted SESEMAT approach as evidenced in their use of the principle of improvisation. According to what was observed in the classrooms, learners were actively involved in the pedagogic processes through participation in lesson activities and experiments. The teachers were also in position to encourage their learners and improvise teaching and learning materials where there was inadequacy.

4.3 Science teachers’ perceptions of the pedagogic worth of SESEMAT approach

This study question sought to find out teachers’ perceptions of SESEMAT pedagogic approach. Positive or negative perceptions were deduced from the teachers’ responses in the SAQs and post lesson interviews in addition to class room practices vis-a-vis the ALEI principles. Relevant selected items were used to this effect.

All the teachers whose lessons were observed were later interviewed for purposes of finding out their views on the worth of ALEI principles during teaching and learning processes. Majority of the teachers explained that the SESEMAT approach to teaching and learning science had helped them to improve on the skill of developing hands-on, minds-on activities for effective teaching and learning of the three science subjects. Teachers also reported improvement in the skill of learner-centered teaching and learning, encouragement of all learners, irrespective of their capabilities and gender and development of improvisation skills.

In response to how SESEMAT ALEI principles had helped teachers to improve the skill of developing hands-on minds-on activities for effective teaching and learning, majority of the teachers (ten out of the eleven teachers) felt that they had improved in this skill after attending SESEMAT program workshops and tried out the ALEI pedagogy. Six teachers commented that after attending SESEMAT workshops, they could now prepare lesson activities in which to engage all learners; which has culminated into easy interpretation and understanding of the abstract concepts. Four teachers explained that before attending SESEMAT workshops, they had found challenges in tapping the learners' potential but after the workshops they could now design hands-on, minds-on activities in which all learners participate.

The interview held with teachers revealed that their perceptions towards SESEMAT approach to teaching and learning were positive. For instance, Mr Gudoi, a teacher of Physics from Nafungo S.S commented;

> I strongly feel SESEMAT CPD has greatly enhanced the teaching and learning of science subjects not only in performance but also in terms of promoting a healthy perception of sciences among both teachers and students. I never imagined how effective group work activities could be, until I attended SESEMAT workshops and saw how even inadequate materials can be used in very large classes like ours. Improvisation is another novel resource to teachers and students; thanks to SESEMAT. Somehow though not all learners touch the materials they all see what goes on.

Nine out of eleven teachers reported that they had improved in the skill of involving learners in the teaching and learning process after exposure to the SESEMAT ALEI principles in workshops.

Mr. Makombe who teaches chemistry in Bunyasi High school explained;

> Actually it was very difficult to teach passive students. They could not even put up their hands to respond to a question. It meant that the teacher had to do everything and at the end of the lesson, the teacher is exhausted yet he does not achieve much. Now it is different. Students are actively involved and this helps in the understanding of the subject.

Mr. Gudoi, a teacher of Physics in Nafungo S.S commented;

> When a student hears and sees he retains; but when he hears, sees and does, hands-on activities, he retains everything. For instance students found it very easy to classify the levers into the three classes by looking out at where the load, the pivot and the effort were. If I had just explained this without showing them where the load was, when using a spade or wheel barrow, their understanding would not be as good. Also when they go back home and use a spade, a wheelbarrow, a hammer or a pair of scissors, they would be revising physics not to forget but to remember.

Teachers encouraged learners during lessons; which was an indicator of positive perceptions. Majority teachers reported that SESEMAT workshops helped them improve in their teaching practices. Seven out of the eleven teachers explained that they could give rewards of quality words such as ‘good’ ‘excellent’ ‘try again’ and hand clapping for students who gave correct or partially correct answers. Three teachers said that after attending SESEMAT they realized that the weak and shy students needed encouragement more than their counterparts. One teacher commented; “even involving learners in activities is in itself a way of encouraging students. I find this very convenient and rewarding.”

Majority teachers (ten out of eleven) reported improvement in improvisation skills. One teacher said; “SESEMAT has helped me and I believe other teachers too, not to rely on what the school provides so as to conduct a practical lesson or prepare lesson activities. I have now learnt to improvise.”

Another teacher said; “After attending the SESEMAT workshops, we have learnt how to improvise but the number of students is too big”

The teachers argued that improvisation encouraged them to conduct practical science activities with locally available materials which the students are familiar with. Not all the responses were to the effect that SESEMAT program had helped teachers to improve on their skill of improvisation. The implication of this is that some teachers recognize that SESEMAT ALEI pedagogical principles are instrumental in enhancing teaching and learning of science while some may not have appreciated the worth of the ALEI approach to teaching science subjects.

For instance, one biology teacher from Kibukwa S.S pointed out that though improvisation was a good idea, it was not possible for teachers to improvise materials for individual students to manipulate them, considering the large classes. He observed; “Where would all those materials come from?”

Regarding use of practical activities in lessons and involving learners, two male teachers of Physics and Chemistry from Kibukwa S.S and Nabukhuya S.S explained that though involving students in activities relieves the teacher from doing everything on his own; which can be both stressing and exhausting, SESEMAT lessons consumed a lot of time in terms of using the learner-centered principle that required engaging students in problem solving pedagogic processes and waiting for them to ‘discover’ concepts on their own. They therefore did not find ALEI as rewarding as they had anticipated more so in real classroom contexts. These teachers also reported that preparing hands-on activities for lessons and actual teaching of such lessons is time consuming yet they were under pressure to cover the NCDC syllabus. Some teachers (three out of the eleven) maintained that it was not possible for them to adhere to ALEI principles while teaching as this was laborious in terms of organizing elaborate practical science activities, improvising the instructional materials and ensuring that learners got actively involved in the teaching and learning processes.

Nine out of the eleven teachers reported that students had adopted a more positive outlook towards science subjects and they were interested in what they learnt. Students' change in attitude towards science subjects has served as a motivation to the science teachers who argue that the students' potential is fully realized as they are engaged in 'research' discussions and lesson activities. Consequently, teachers strive to organize science practical experiments and activities in which learners participate.

The SESEMAT Regional Trainer commented; "There is a change in attitude of both teachers and learners. They are very positive. In spite of the numbers, many teachers struggle to ensure students do practicals in the laboratory".

This change in perception of SESEMAT pedagogic approach appears to have come about because of students' constant exposure to practical work in science lessons, coupled with the familiar learning materials harnessed from the local environment. The positive perception of both teachers and learners may also be explained by their direct experiences of the benefits of learning and teaching science using the ALEI principles promoted by SESEMAT.

On the other hand, there seemed to be a misconception of the SESEMAT pedagogic approach by both the teachers and the students. For example, in response to the item about students' attitude towards SESEMAT approach, two teachers out of eleven explained that students perceived SESEMAT was irrelevant and too wide because it included topics already covered at primary school level and so they did not like it. This was a misconception as SESEMAT is a pedagogic approach and yet students perceive it as a syllabus running side by side with the NCDC syllabus. The SESEMAT 'syllabus' according to them has many topics ranging from primary school to secondary school. The teachers too, seemed to have misconceived the SESEMAT pedagogic approach as evidenced in the arguments for the need to cover the NCDC syllabus. Teachers explain that there is urgency to prepare learners for UNEB exams which are based on the NCDC syllabus. All of them shared the belief that it was important to teach in line with NCDC syllabus and adhere to the national examination demands. Teachers also think that the SESEMAT approach is another curriculum within the NCDC curriculum. Consistent with the above the SESEMAT Regional Monitoring Coordinator explained; “Science teachers appear to have a misconception of SESEMAT because they tend to think that SESEMAT is another curriculum within the traditional one. They don’t want to implement what they are trained”.

All teachers explained that activities gave learners opportunities to interact with scientific phenomena. They argued that when students see, touch and feel instructional materials their understanding of scientific concepts is enhanced. Teachers also reasoned that learner involvement in pedagogic activities/practical experiments highly motivated and interested them in what they learnt.

Teachers also explained that when students engage in activities that are hands-on, their memory is enhanced as learning by doing helps them to ‘discover’ on their own and consequently retain the knowledge better compared to when teachers give direct instruction. In SESEMAT pedagogic approach, activities are central in science lessons.

Analysis of the teachers’ post -lesson interviews showed that teachers appreciated the ALEI pedagogic principles as useful in enhancing the pedagogic processes and strove to use them in the classroom context.

On the whole the researcher found that teachers had positive perceptions towards SESEMAT pedagogic principles but they were limited by other contextual factors such as time, inadequate instructional material, limited experience in the SESEMAT pedagogic principles and misconception of the SESEMAT pedagogic approach. Details of the findings are presented below.

4.4 Factors influencing teachers’ adoption of SESEMAT pedagogic principles in their classroom practice

The researcher sought to find out what influences teachers’ adoption of the SESEMAT principles in teacher’s day to day teaching of science subjects in the study schools. Data for this research question was derived from the teachers’ SAQ, observation and interviews. Factors that influence teachers' adoption of the SESEMAT principles were categorized into two; those that promoted and those that constrained the adoption of SESEMAT principles. Among the factors promoting adoption of SESEMAT was; organization of SESEMAT workshops, follow up supervision support, teachers' positive perceptions towards SESEMAT approach, students improved outlook towards science subjects and encouraging the use of improvised teaching and learning materials. The factors that hampered teachers' adoption of SESEMAT approach include; time constraint, inadequate teaching and learning materials, large class sizes, inadequate infrastructure and teachers' misconception of the SESEMAT approach to teaching and learning.

4.4.1 Factors that promote teachers' adoption of the SESEMAT pedagogic principles

The factors that promote the selected teachers' adoption of SESEMAT pedagogic principles include; organization of SESEMAT workshops, follow- up support supervision, teachers' positive perceptions towards the SESEMAT approach and support from school administrators

4.4.1.1 Continuous professional workshops

The study findings show that the major factor that promoted the selected teachers' adoption of the SESEMAT pedagogic approach was the professional support that is given through workshops. Two weeks residency continuous professional development workshops are organized annually for teachers during school holidays. In the workshops, teachers are exposed to selected activities in which the ALEI pedagogic principles are demonstrated by national and /or regional trainers. Teachers put the good teaching practices in classroom contexts. It can therefore be presumed that the more workshops a teacher attends the more pedagogically equipped the teacher is, considering that the focus of the workshops is to improve on the teachers' ability to teach effectively. Classroom observation showed that teachers were able to arrange activities for their students, involve learners in the teaching and learning process encourage learners both the gifted and the slow learners across both genders to some extent. The training seems to have impacted on the teachers' pedagogical skills as evidenced in their concretization of the ALEI principles in the classroom context.

4.4.1.2 Follow- up support supervision

Another factor that has promoted teachers' adoption of SESEMAT is the follow up supervision accorded to teachers from the SESEMAT team. Selected items from the teachers' SAQ indicated that all the teachers in this study had been observed in class by technical personnel such as the national trainers and regional trainers. The majority had also been given feedback after supervision. This finding was collaborated by the data from the teachers' interviews in which the said teachers indicated that they were given feedback after supervision. This implied that the teachers' pedagogic practices kept changing due to the technical support given to them at school and classroom levels

4.4.1.3 Teachers' positive perceptions towards SESEMAT approach

The study found that the positive perceptions that teachers had influenced the adoption of the SESEMAT approach in the selected schools. Teachers' accounts of what they considered as the benefits ALEI principles indicated that their beliefs had influenced their practices. SAQs and interview data show that teachers' adoption of the SESEMAT ALEI principles in their teaching practices had made teaching and learning of science subjects more interesting and less exhausting as compared to the pre- ALEI conditions. Teaching and learning of science subjects had also become enjoyable with increased learner involvement. The following interview extracts illustrate teachers' perceptions of the ALEI approach:

Teacher Lusala, Biology Matinyi S.S;

> As long as a teacher follows the three steps that SESEMAT prescribes; (Good lesson planning, good lesson delivery and good lesson learning) science teaching is not just interesting to teach but also very easy to learn. In fact that is what ALEI is all about; before you involve learners in the lesson, you ought to have planned and prepared the activities in which the learners will be engaged. Before you improvise you should know through preparation that the learning materials are not enough and during delivery of the lesson, encouragement of learners follows automatically as they use hands- on strategy. Science is exciting to teach these days.

Teacher Makombe of Bunyasi High school opined;

> I think that SESEMAT approach has made sciences easier to teach and learn. Unlike in the past where teachers used talk and chalk methods, things are different now. There is no more stress about how to teach a certain topic or whether the learners will understand. We do it together; the teacher and the students. When the results of a given experiment

> are accurate and uniform it leaves a feeling of excitement in both the teacher and the learners in two ways; the teacher will have self evaluated himself and the learners will have concluded that they too can do the correct thing. That in itself encourages even the slow learners

Teacher Wanyama, Biology S.2 Kibukwa S.S;

> Science subjects are now easy to teach and learn, interesting and less stressful. I don't have to do everything on my own

Teachers also reported that they had benefited from using the SESEMAT approach in regard to personal learning accruing from the workshops that they had attended. Two teachers who responded to the SAQ indicated that they could now use group work as a strategy to teach large classes. This was not possible before SESEMAT program.

These findings indicate that teachers' adoption of the SESEMAT approach has been enhanced by the teachers' positive perceptions of the approach. SESEMAT approach has simplified the teaching and learning of science subjects through adequate lesson preparation which culminates into improved lesson delivery and learning.

4.4.1.4 Support from school administrators

The other factor that promotes the implementation of SESEMAT pedagogic principles is school support. Whereas improvisation of instructional materials through the teacher's creativity and ability to harness teaching and learning materials from the local environment has been emphasized, constraints like big class sizes and time were factored in the teachers' attempt to improvise . Teachers' and students' accounts in this study indicate that the teaching and learning of science has been influenced by what the schools offered as equipment and learning materials. Teachers' explained that schools supported them to implement ALEI in classroom contexts by providing the most essential chemicals and apparatus in laboratories. Seven out of the eleven teachers from the selected schools pointed out that their school administrators were now more willing and ready to provide consumables/ perishables such as rats, toads, weeds and flowers, upon teachers' requisitions. They explained that departmental plans and budgets were made in advance by departmental heads instead of school block annual budgets. What the teachers said was consistent with what the students indicated. Apart from students from one school (Nafungo

S.S), students from the rest of the selected schools explained that they were never asked to bring instructional materials from home to supplement where there was inadequacy.

4.4.2 Factors that constrained teachers' adoption of the SESEMAT approach

The findings show that adoption of SESEMAT pedagogic principles by the teachers was constrained by time for planning and teaching, inadequate teaching and learning materials, large class sizes, inadequate infrastructure and teachers' misconceptions of the SESEMAT pedagogic principles.

4.4.2.1 Time

The study found that time constraint heavily influenced teachers' adoption of SESEMAT pedagogic approach. All the eleven teachers agreed that the biggest challenge to the adoption of the SESEMAT ALEI pedagogic principles was time. One of the pedagogic prescriptions of SESEMAT is that learners should be given opportunity to actively engage in practical science activities as the teacher facilitates learning. This pedagogical prescription was daunting as all the science classes had large class sizes of not less than eighty students per class. Some classes had more than one hundred students. Whereas SESEMAT pedagogic approach prescribes 'hands-on , minds-on' activities for individual learners and involvement of learners in the teaching-learning process, the time available for all these processes is the same eighty minutes for a double lesson and forty minutes for a single lesson. Teachers explained that as a result of the little time scheduled for the lessons, it was not possible for them to engage all learners in the learning activities. This compelled the teachers to use group work strategy for the practical activities but still the groups were too big for each learner to undertake the practical work individually. The researcher's observation confirmed this constraint.

The teachers also argued that SESEMAT lessons required substantial time to prepare practical science activities and instructional materials for learners. Indeed the researchers' observation of practical science lessons showed that teachers needed time not only to supervise the group activities but also to provide individual attention to learners.

One of the tenets of SESEMAT pedagogy is to guide learners to 'discover' and co-construct knowledge in practical science activities. All the teachers in this study reported that SESEMAT lessons were time consuming. They explained that teachers were required to ask high order thinking (HOT) questions and wait for students to 'discover', a process they perceived to be time consuming yet they were operating under a strict time schedule. This view was consistent with data from the head teachers' interviews. The head teacher of one of Bunyasi High School in an interview explained the constraint of time in saying;

> It is true; SESEMAT lessons are not straight forward. The approach emphasizes discovery, where a teacher has to use various strategies while waiting for the students to "discover". Even the children don't like it. They feel you are wasting their time. It is really time consuming; yet we have the syllabus to cover.

From the comments above it can be deduced that time was a real challenge to the teachers and constrained their adoption of SESEMAT approach in their practice.

4.4.2.2 Inadequate teaching and learning materials

Availability of teaching and learning materials was another factor that influenced teachers' adoption of SESEMAT pedagogical principles in their daily teaching. SESEMAT prescribes 'hands -on', 'minds -on' and 'hearts- on' teaching and learning to enhance learners' understanding and interest in science subjects. However, of the four lessons observed in the selected schools, equipment and instructional materials were far from adequate and yet activity based lessons can only be possible where these requirements are in place. Another teacher argued that even when SESEMAT encourages creativity and improvisation; it was a tall order for him to improvise materials for classes of one hundred plus students. This implies that teachers may leave out lessons that require such activities or even use the teacher- centered approach instead. One head teacher from a private school lamented; "Resources and chemicals are usually given to government schools; private schools are normally locked out, yet the students are not private".

The foregoing comment suggests that inadequate teaching- learning materials affected both private schools and government schools, constraining teachers' efforts to adopt the pedagogic principles of SESEMAT effectively.

4.4.2.3 Large class sizes

The study also found that all the science classes were too big, with numbers ranging from 78 to 115 students which constrained the effective adoption of SESEMAT pedagogic principles in daily practices of teachers. This surge in numbers of students could be attributed to the 2005 compulsory sciences policy in which science subjects were made compulsory. The SESEMAT approach to teaching and learning emphasizes individual learner involvement in lesson activities However teachers explain that not all learners can be involved in lesson activities because the teacher pupil ratio is too high. As a result, the teaching-learning materials are heavily impacted upon leading to majority students being observers rather than active participants.

The researcher confirmed the teachers' claim through lesson observation. In three of the lessons observed, (a chemistry lesson &two biology lessons) activities were done in groups of eight to eleven students. There were about nine to ten groups per class. Whereas every individual learner was supposed to touch the teaching-learning materials and manipulate the equipment, only representatives of the groups were observed conducting the practical activities such as measurements of food samples, iodine solution and the Benedict's solution in one biology lesson; in which the class was testing for sugar and starch. Similarly, in a chemistry lesson, only representative students measured the volume of water, the spatula endfuls of sugar, and mixed the solution. In the physics lesson only selected students went to the front to demonstrate for the rest of the class how the pulley system works. This was the biggest class that the researcher observed; with one hundred and ten students present.

The teachers encouraged the groups and not the individual participants. Regarding improvisation the researcher observed that the teachers tried hard to use the locally available materials such as knives, papers, bottle opener and a human hand among others. On the whole, the findings show that the large numbers of students constrained the available instructional materials and influenced.

4.4.2.4 Inadequate physical infrastructure

Teachers reported inadequate infrastructure to support hands-on learning approaches as a major constraint. Teachers explained that owing to the increase in numbers of students doing science subjects at that level, (following the compulsory science policy) there were serious challenges of teaching and learning space. This was coupled with very old equipment in the laboratories, some of which like sinks and taps had long broken down or simply not functional. The available space was still not sufficient. This constrained the adoption of SESEMAT approach in many ways.

The post lesson interview extracts below illustrate the views above:

Mr. Wanyama from Kibukwa S.S

> When sciences were made compulsory, we had no idea that this could heavily impact on the available lab equipment so badly. If you look at this lab, the working space was meant for a maximum of forty students but as we speak this class is more than double that number. The space is still the same.

Similarly, Mr.Gudoi a physics teacher from Nafungo SS commented;

> This school is very concerned about students damaging the lab equipment and resources such as the science kits and the few available stools. I think the problem is space. If we had like one hundred and twenty stools in this lab, a teacher conducting a science practical would be comfortable; but as you realize there is not enough space for that number of stools. Monitoring and facilitation of teaching and learning becomes very challenging with students standing around work tables. Of course the teacher cannot see all that they do.

The teachers' views captured above illuminate the notion that implementation of SESEMAT principles is constrained by the large class sizes which translates into inadequate teaching and learning materials among other factors.

4.4.2.5 Teachers' misconceptions of the SESEMAT pedagogic approach

The study found that teachers had misconceived the SESEMAT pedagogic approach to be another curriculum within the NCDC curriculum. This greatly constrained the adoption of the approach as majority teachers (eight out of the eleven selected teachers) kept referring to the SESEMAT approach as the 'SESEMAT curriculum.' Descriptions of the SESEMAT approach such as; too simplistic, too wide, time consuming, irrelevant and unrealistic, kept cropping up both in the post lesson interviews and the teachers' SAQs. Teachers argued that if they were to complete the NCDC syllabus as required by their schools then the 'SESEMAT curriculum' would have to be shelved as the topics in the SESEMAT curriculum included topics covered in primary school. This misconception impedes adoption of the SESEMAT approach to teaching and learning science subjects.

Teachers seemed to have also misconceived the rationale for classroom supervision. Whereas classroom supervision is meant to support the teachers in grounding themselves in the use of the SESEMAT ALEI principles, the regional trainer's remark illuminates teachers a possible misconception of the SESEMAT supervision rationale; i.e. to improve teachers' pedagogic practices in teaching Science. It seemed that teachers fear to be supervised because they think that the supervision is fault finding and this also tells on their misconceptions of the SESEMAT approach as indicated elsewhere in the presentation. Teachers are expected to use the ALEI approach most of the time but if they 'run away' from classroom supervision or 'quickly prepare' to be supervised then a lot is left desired. The regional trainer's remark confirms the misconception; "Some teachers run away from us. When you enter a school, teachers disappear. They fear us. If not, you go to class somebody gives a test, if not he dictates notes. Never the less, some quickly prepare and teach.

4.5 Chapter review

This chapter presented findings that answered the research questions of the study. The findings were reported in four sections; demographics of the respondents, how teachers implemented the SESEMAT pedagogic principles to teach science, teachers' perceptions of SESEMAT and factors that influence teachers' adoption of SESEMAT pedagogic principles in their classroom practices.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.0 Over view

This research was designed to study the role of SESEMAT in the pedagogic practices of science teachers at O'level in Mbale district. The objectives of the study were; to establish how science teachers implement the SESEMAT pedagogic principles in their classroom practice, to establish science teachers' perceptions of the worth of SESEMAT pedagogic principles in enhancing their classroom practices and to analyze factors influencing science teachers' adoption of the SESEMAT pedagogic principles. The chapter is divided into four subsections. Subsection one deals with the discussion of the research findings, sub section two presents the conclusions from the findings, subsection three deals with recommendations based on the findings of the study while subsection four deals with the suggestions for further research.

5.1 Discussion

5.1.1 Teachers' implementation of the SESEMAT pedagogic principles

Analysis and discussion of how science teachers implement SESEMAT pedagogic approach in science classrooms has been done against the background of the four ALEI principles as discussed below.

5.1.1.1 Activity principle

Findings on the theme teachers' implementation of the SESEMAT pedagogic principles show that SESEMAT is being implemented in secondary schools at O' level, to some extent. SESEMAT is hinged on four pedagogic principles; Activity, Learner-centered, Encouragement and Improvisation (ALEI). These principles embrace values of teaching/learning that are activity focused. These are meaningful hands-on (manipulation), minds-on (intellectual thinking, reasoning) and hearts-on (those that stir up the learners' interest/feeling about the subject) activities. The rationale is that human beings are more likely to remember what they see and touch more than what they are told.

Experiments and activities enhance learning by promoting curiosity and interest (Korthagen, 2005 Altinyelken, 2010; Sikoyo 2007; Sikoyo, 2010; Mtitu, 2014, Saputro & Santos, 2018). Findings of the current study are consistent with the views of the scholars above as observation showed that all lessons had activities that elicited learners' interest, knowledge and competence. The activities also reflected everyday knowledge fused with systematized knowledge; flowing from known to unknown. Mutilifa & Kapenda (2017) also found that active teaching and learning- methods such as group discussions, practicals and experiments and lesson activities are more effective methods than the traditional methods such as the lecture method, in improving students' understanding. This study finding resonated with the constructivism theory in which knowledge is structured in ways that make it easy and interesting for the learner.

In contradiction, Lotter, Harwood & Bonner (2006) caution that there is a possibility that teachers can assume that students learn through activities and, so, concentrate their discussions on the activities themselves, instead of analyzing how and why the activities help their students learn. This forecasts the necessity of obtaining teachers' understanding of the problem solving approaches before enacting them in classrooms. The role of CPD programs therefore cannot be over exaggerated.

However, Sentongo et al (2010) noted that in Uganda, classroom practice still dwell heavily on content and facts though policy documents emphasize practical teaching. This finding was in agreement with Sikoyo (2010), who concluded that teachers' pedagogic practices were not consistent with the problem solving approach. The current study findings resonate with the findings of the above scholars as depicted from the way some teachers reverted to the knowledge transmission approaches.

5.1.1.2 Learner-centered pedagogy

The study also found that whereas some teachers could use the learner-centered approach to teach, other teachers could not easily use it because they were not familiar with it. This could be attributed to the little experience they may have had in the use of the learner-centered approach as teaching in most African countries is theoretical and characterized by knowledge transmission (Altinyelkin 2010). This study finding was consistent with other research reports that indicated that teachers needed extended experience in the use of the said pedagogy. (Schwille, J. &

Dembele, M 2007, Gallardo & Reavey, 2018). Lai (2011) reported that one week programs left teachers unprepared to implement reform. These views were evidenced in the study when teachers attempted to use the learner-centered approach in their classes and instead, ended up using the teacher centered approach. For instance one biology teacher who used the questioning technique asked students, teacher-led questions instead of prying/ probing type of questions. It was evident from observation that these teachers did not realize that they had reverted to the teacher- centered approach as their learners kept chorusing one-word answers after the teachers. This finding is consistent with Chauraya & Brodie (2017) who reported that teachers shifted their practices during the intervention but only half of them sustained their shifts after the intervention. Sakkoulis, Asimaki & Vergidis (2017) posit that in-service training does not arm teachers with concepts and practices that allow them to advance to successful realizations in the communicative context of the school classroom. Thus to "survive the classroom" teachers feign intention and success even when they are unable to implement a prescribed policy (Schweisfurth, 2011).

Findings of the current study concur with reports of other scholars regarding teachers' pedagogical knowledge in using the learner- centered approach elsewhere. It seems true that teachers may have content knowledge but lack pedagogical skills to conform to participatory pedagogy. Garet, e.tal, (2001) Kelly, (2009), Ezati & Mugimu, (2010), NCDC, (2012) report that a teacher's observation of a new strategy promotes transfer to classroom application. This implies that even if teachers were accorded extended time for experience, they would still need to be given modeling support in real school and classroom contexts in order to bolster pedagogic skills.

The study also found that although teachers were able to set up and guide learners in doing hands-on activities in groups, along with cautions of what might go wrong and how to respond to such situations, the majority students didn't have the opportunity to touch the specimens and apparatus during the experiments. The groups were far too big (8-10 students per group) and many for a single teacher to effectively cater for individual learners. Most of the students were on- lookers as only one or two manipulated the given specimens. These findings concur with those of other studies on the implementation of learner-centered approach in real classroom contexts (Fullan 2001, Korthagen 2003, Darling-Hammond 2005).

Kivunja & Sentongo (2016) expound that over-crowding in science classes impacts negatively on the teaching of science subjects because sciences, by nature, require that students are given the opportunity not only to cover the theoretical aspects but also to complete the practical components. The scholars argue that when students work in large groups they do not have sufficient opportunity for the hands-on practical experience; which limits their understanding and appreciation of the links between theoretical concepts and the practical applications. Sikoyo (2007) findings are congruent with the above. The researcher posits that teachers' application of learner centered pedagogy was more effective in small class sizes as such classes enabled teachers to address individual learners' needs.

Whereas SESEMAT stresses hands-on, minds-on and hearts-on activities for individual students, this research has shown that the rate at which learners access and manipulate equipment and learning materials during experiments is disappointing; considering the high value attached to hands-on minds-on activities.

Theory also stresses that learning is not a matter of transferring ideas from one that is knowledgeable to one who is not (Lai 2011, Atay 2007, Slonimsky & Brodie 2007, Korthagen, 2009). Instead, it is perceived as a personal, reflective, and transformative process where ideas, experiences, and points of view are integrated and knowledge is created. The constructivism theory underscores the need for teachers to acknowledge learners as participants and potential generators of knowledge. Teachers are expected to elicit learners' views by allowing learners to express themselves and accept their contributions. What the study revealed high lights a gap in the implementation of SESEMAT to some extent. The constructivism learning theory stresses the necessity of hands-on activities that provide a foundation for knowledge construction.

5.1.1.3 Encouragement

The study findings revealed that the selected teachers encouraged their learners in various ways. Observation showed that teachers asked both the girls and the boys to participate in the lesson activities, thanked every learner who answered a question and gave rewards such as clapping hands for extreme performance. This was in consistence with Farrington et al (2012 who posits that such pedagogic practices, reinforce students' active role in classroom practices. Students are given feedback on their progress and this encourages them to play an active role in class. This was also in line with what SESEMAT program prescribes. Sainz et.al (2018) argues that motivational beliefs such as influence of other significant people and social utility values encourage young people to do sciences. Findings showed that the teachers' roles included among others praising students who responded to questions, urging both girls and boys to participate in lesson activities, giving rewards to excellent students and giving feedback.

These findings imply that the teachers recognized the purpose of encouraging learners during teaching and learning. This was consistent with what they had reported earlier that their role was to guide and facilitate learning. Research shows that provision of positive psychological conditions is very important for building positive academic mindsets (Farrington et.al 2012). Research literature on role models is in line with the view above (Sainz et al 2018). Teachers seemed to have stamped out the negative stereo- types associated with science subjects. This finding is in line with SESEMAT approach which underscores encouragement of all learners irrespective of their capabilities.

5.1.1.4 Improvisation

Improvisation was a prominent factor among teachers as they felt that the SESEMAT approach had had a lot of impact on the frequency of preparation of practical experiments and 'hands-on', 'minds-on' activities. All the teachers who participated in the study acknowledged that through improvisation, they were able to carry out practical science experiments/ activities with locally available materials. However, there was a contradiction in the teachers' interviews in which three teachers indicated that they depended on what their schools provided because the classes were far too big to enable improvisation of any sort. The students' accounts also confirmed what the teachers had reported; except for students from one school, the rest of the students were never asked to bring any learning materials from home.

This was in contradiction with Akuma and Callaghan (2016) who argue that science educators do not have to produce the science education equipment they need all by themselves. The scholars suggest that teachers can be assisted by learners to harness materials for improvisation as they work collaboratively. Learner involvement in providing raw materials for improvisation enhances their problem solving skills. This recommendation seems to fit in well with the current study finding in which two teachers' accounts revealed that improvisation of learning materials was not possible because of the extremely large classes. Teachers' accounts confirm that learners were minimally involved in bringing materials from home for use during practical experiments in class.

Penuel & Gallagher (2009) posit that improvised teaching and learning materials are seldom used in many ill-equipped science classrooms in secondary schools because teachers lack creativity. This is attributed to the fact that science teachers find it difficult to think as designers. This argument sharply contradicts with the findings of the current study that showed that teachers improvised as much as they could across all lessons observed. This result shows that many science teachers may be facing challenges relating to the production or use of improvised materials not because of lack of creativity but because of other contextual challenges such as large class sizes, time for creating or designing materials, funding the production of improvised science education equipment in school or lack of motivation for them to put effort into improving learning activities through use of creativity to achieve learning goals.

Educators may need to be provided with incentives to motivate them as well as compensate them for the additional time they employ in the production of their own science education equipment (Kariisa 2015, Akuma and Callaghan 2016). Research literature shows that science teachers have been urged to improvise learning materials in ill-equipped classrooms to facilitate practical science work. Some scholars recommend that valuing teachers' contributions to the profession motivates them to engage more fully (Sandholtz & Scribner, 2006, Tondeur, 2016, Akuma and Callaghan 2016).

Yoo & Sohn, (2001) in a study involving Korean science teachers reported that the teachers exhibited uneasiness about the educational reform and struggled with how to teach science to improve students' creativity. Mishra and Koehler (2006), posit that pedagogical knowledge encompasses knowledge of processes or practices useful in motivating learners and implementing practical work. In view of promoting such learning teachers ought to have experienced the pedagogy themselves. This seems to be consistent with Park et al. (2006) who indicates that teachers need to be taught creativity instruction as much as their learners are. The role of the SESEMAT workshops is illuminated.

The study found that teachers implement the SESEMAT ALEI principles to some extent, as evidenced in data gathered and triangulated from classroom observation, interviews, FGDs and teachers' SAQS. The learners were involved in lesson activities and the teachers strove to be facilitators rather than the knowledge transmitters. This is congruent with the constructivism theory and SESEMAT program prescriptions.

5.1.2 Teachers' perceptions of the worth of SESEMAT pedagogic principles

The teachers' perceptions were analyzed and discussed in relation to the pedagogic benefits of SESEMAT ALEI principles in enhancing science teachers' classroom practices. Teachers' perceptions were deduced from what they said in regard to the SESEMAT ALEI pedagogy. Among the benefits of ALEI were; the use of the participatory teaching and learning strategies such use of the learner-centered approach to teach and learn, encouragement of all learners irrespective of their gender or capability and use of improvised teaching and learning materials.

Teachers perceived the ALEI principles as very rewarding to the teaching and learning of science subjects in terms of involving learners in the pedagogic processes. Teachers' accounts about the direct benefit of learner involvement in lesson activities were that teaching science subjects had become a lot easier, enjoyable and less stressful to both teachers and learners. Two teachers explained that prior to the introduction of the SESEMAT approach, teachers did a lot before, during and after the lessons; i.e. prepared for the lesson, taught passive, uninterested and fearful students who regarded sciences as subjects for the 'gifted'. This finding is consistent with Sikoyo (2007) whose study revealed that teachers perceived the problem solving approach as beneficial in enhancing learners' conceptual understanding and retention of knowledge and skills to new situations in life. The scholar argued that teachers' application of learner centred pedagogy was more effective in small class sizes as such classes enabled teachers to address individual learners' needs.

According to the findings of the current study, teachers acknowledged that involving learners in lesson activities has changed not only the learners' beliefs about sciences but also demystified science. Majority teachers (eight out of eleven) indicated that the use of ALEI has relieved them of the 'one man knows- it- all- show' and they no longer leave their classrooms exhausted. This finding is consistent with Kwakman (2002) and Korthagen (2002) who posit that teachers could fulfill their new role by creating stimulating environments and acting as facilitators in students' learning processes. The lesson activities cannot be over emphasized.

In contradiction with the views above, Lotter, Harwood & Bonner (2006) caution that teachers can concentrate their discussions on lesson activities themselves, instead of analyzing how and why the activities help their students learn. It is worth noting therefore that unless a teacher has clarity about the innovation and the kinds of skills and knowledge needed to conform to the new role model (Kelly 2009, Sahlberg, 2004) implementation of alternative forms of practice will flounder (Park et al., 2006).

The study found that teachers who participated in the study appreciated the use of the learner-centered approach to teach and learn science subjects. Observation showed that teachers used strategies such as group work and the questioning technique during experiments that were conducted in chemistry, physics and biology. This principle yielded results on two fronts; learners co -constructed knowledge and took responsibility of their own learning. This is in tandem with Bruner (1960) who theorizes that the purpose of education is to develop a child's thinking and problem solving skills through the problem solving approach so as to promote the learners' active role in the pedagogical processes. The teacher acts as a facilitator while learners take responsibility of their own learning. Active learner participation in teaching and learning activities and practical science experiments reflect the learner-centered approach that SESEMAT program advocates.

The study also found that teachers hailed the principle of improvisation in the teaching and learning processes. Teachers explained that improvisation had enabled them to conduct experiments more frequently and fairly comfortably.

To some extent, teachers' perceptions of the worth of SESEMAT ALEI pedagogic principles were found to be positive; as evidenced in their classroom practices and accounts. This finding was consistent with the findings of Komakech & Osuu (2013) who reported that SESEMAT program had great impact on improving teachers' and learners' attitude towards science education. SESEMAT program seems to have impacted on teachers' beliefs positively.

Dehghayedi & Bagheri (2018) posit that teachers' beliefs, practices and attitudes influence students' motivation and achievement. While Sato & Kleinsasser (2004) expound that change in teachers' beliefs is likely to take place after changes in students' outcomes are evidenced. Teachers' accounts elsewhere in this study reveal that the students' outcomes in terms of perceptions towards science subjects and participation in lesson activities had improved. This could have a positive bearing on the teachers' beliefs towards the worth of SESEMAT CPD programme.

However, a discrepancy is revealed regarding teachers' perceptions and their practices among other things. Much as teachers' arguments pointed to change in perceptions towards ALEI principles, observation showed that some teachers had reverted to the traditional knowledge transmission approach in which learners were minimally involved. Many researchers argue that teachers shift their practices during a professional intervention but drop the shifts in real classroom contexts (Schweisfurth 2011, Altinyelkin 2010, Chauraya & Brodie 2017). In regard to the literature finding above, Sikoyo (2010) posits that in developing countries among which is Uganda, teachers' implementation of the problem solving approach is influenced by factors such as the level of control they have over pedagogic resources; e.g. the demographic characteristics of the class, availability of the instructional materials, external mandates in relation to syllabus coverage and national exams. This implies that teachers' adoption of a new approach is not regulated by the pedagogic prescription but rather by the contextual, political and economic factors prevalent at the time of the intervention. This explains the teachers contradictory behavior highlighted above. The current study findings are congruent with the notion above.

Power & Cohen (2005) argue that changing routine takes time but providing teachers with examples of good practices could facilitate understanding, sharing and negotiating, and transference into local settings (Tondeur et al., 2016)

This requires time for exposure. Knight (2001) is in contradiction with this view and asserts that 'How to' knowledge grows in practice. This implies that the more teachers practice ALEI principles in teaching and learning science subjects the more they will perfect their pedagogic skills.

The current study findings also indicate that though teachers hailed the SESEMAT pedagogic approach, some of them seemed not to have perceived it with clarity. This was deduced from their comments regarding the pressure from their schools to cover the syllabus. Some teachers perceived SESEMAT as a syllabus; hence, the descriptions of the SESEMAT approach as 'SESEMAT lessons', 'SESEMAT exams' and /or 'SESEMAT curriculum.' This misconception illuminated a negative perception that the teachers and students had towards SESEMAT ALEI approach to teaching and learning.

Teachers' accounts revealed that SESEMAT approach is tedious to use and therefore they needed some motivational incentives and rewards if they were to uphold the SESEMAT approach practices. This argument is in line with Kariisa (2015) who suggests that teachers' perceptions could improve if teachers were motivated by the school administration through being given allowances. On the whole perceptions of the teachers towards SESEMAT ALEI principles were found to be positive to some extent as teachers believed that the teaching and learning of science subjects had been enhanced.

5.1.3 Factors that influence teachers' adoption of SESEMAT Pedagogic Principles in their classroom practices

Factors that influence teachers' adoption of the SESEMAT ALEI principles have been analyzed and discussed in two subsections: those that promote adoption and those that constrain the adoption of ALEI.

5.1.3.1 Factors that promote adoption of SESEMAT ALEI principles

Findings on professional development workshops indicate that training workshops play a crucial role in influencing teachers' adoption of SESEMAT approach. Teacher expertise can be achieved through participation in varied professional activities (Sandholtz 2002, Kwakman 2002) report that teachers' adoption of a new pedagogy is influenced by a supportive school culture; both from management and collegial levels.Findings of other scholars resonate with the finding above; (Sandholtz 2002 , Sandholtz 2006 and kwakman 2002, Sikoyo 2007, Sikoyo 2010.)

Else where in this study, teachers reported that SESEMAT continuous professional development trainings provided them with opportunities to engage in modelling activities from which they acquired knowledge and skills in teaching and learning using the problem solving approach. This greatly influenced their perceptions of the pedagogic approach. This finding is consistent with findings of other studies that underscore CPD training as an important factor in enhancing teachers' pedagogic practices and influencing their perceptions. (Sikoyo, 2010; Nzilano, 2014).

That SESEMAT CPD workshops have a significant influence on the science teachers' practices and perceptions seems to be true, as evidenced in their responses about aspects of the problem solving approach vis-à-vis SESEMAT principles; for instance conducting activity- based lessons and the use of improvised teaching and learning materials seemed to have been 'new'strategies of teaching and learning science ; acquired from CPD training workshops. The teachers' conceptualization and application of SESEMAT principles seemed to have been enhanced to a certain extent. This argument is consistent with the findings of other studies on implementation of learner centred pedagogy (Sikoyo, 2007, Sikoyo, 2010, Carla et.al 2009).

The annual SESEMAT workshops given to teachers are meant to build confidence in their ability to use the SESEMAT teaching approach. Teachers are exposed to multiple opportunities in which they collaborate and interact with other teachers, experience modeling of new instructional strategies, practice new strategies with students, and are allowed time to reflect upon the experiences.

The study established that follow up supervision also influenced teachers' adoption of SESEMAT pedagogic approach. This is consistent with the view that single session professional development workshops which have little follow up are not effective as teachers are left unprepared to implement reform (Lai 2011, Gregory, 2009). This underscores the necessity of follow-up supervision. Boardman (2004) expounds that teachers are more likely to use new information when they receive feedback and support during implementation of a new pedagogic approach. This could be true because teachers, like their learners, need to be encouraged. Practicing a newly acquired skill in an active teaching and learning environment indicates quality professional development (Gregory, 2009), while changing pedagogic practices, involves changing awareness, knowledge, skills and beliefs or attitudes (Sahlberg, 2004).

Study findings however revealed that some teachers reverted to the knowledge transmission approach even after attending the SESEMAT workshops and being given technical support through follow up supervision. This contradiction could be attributed to the teachers' misconception about the SESEMAT pedagogic approach; i.e. that SESEMAT is another curriculum within the NCDC curriculum and that content/ syllabus coverage comes before learners' understanding of content. Hence the little perceived impact on the pedagogical practices of teachers.

Further contradiction to the finding about support supervision was the fact that teachers in the field seemed to to fear and shun classroom supervision. Technical support is expected to be given under supervision and monitoring that is school and classroom based. That is why the SESEMAT Activity School Based program was instituted (SARB). However, the SESEMAT regional trainer reported that the idea of supervision is not appreciated by the science teachers. That teachers literally run away from supervision or give tests and dictate notes is a far cry from the realization of the intended goals of the SESEMAT program. There is a possible misconception of the SESEMAT supervision rationale; i.e. to improve teachers' pedagogic practices in teaching Science.

The study found that support from school administrators plays a big role in helping teachers to implement the SESEMAT approach to teaching science subjects. Teachers' and students' accounts in the study indicate that the teaching and learning of science has been largely influenced by what the schools offer as equipment and learning materials. Teachers' explanation that schools supported them to implement ALEI in classroom contexts by providing the most essential chemicals and apparatus in laboratories is consistent with Sandholtz & Scribner (2006) who note that teachers should be given adequate resources and support for further learning Teachers explained that teaching and learning materials that are not readily available or hazardous such as reagents were provided by the schools. They pointed out that their school administrators were providing consumables/ perishables upon teachers' requisitioning.

The study found that teachers' positive perceptions of SESEMAT pedagogic approach also promoted the adoption SESEMAT principles in classroom contexts. Sikoyo (2010) argues that continuous professional development programmes enable teachers to acquire knowledge, attitudes and skills to practice the problem solving approach in their subjects of specialization. Teachers' accounts were consistent with the notion above.

5.1.3.2 Factors that constrain the teachers' adoption of SESEMAT ALEI

There are a number of factors that have been analyzed and discussed as constraining the teachers' adoption of the SESEMAT ALEI principles in real classroom contexts.

Among the factors that constrain teachers' adoption of the SESEMAT pedagogic principles in their classroom practices is time. This factor can be looked at in three perspectives; teachers' scheduled time on the time tables that is fixed (one hour and twenty minutes), teachers' time (outside the school timetable) for preparing lesson activities and science practical experiments and teachers' time for attending the SESEMAT workshops.

Much as teachers are encouraged to use the SESEMAT pedagogic principles to teach the three science subjects, the time scheduled on the timetables does not enable them to apply the SESEMAT prescribed individual learner hands-on, minds-on strategy. This is due to the high teacher- pupil ratio that does not enable teachers to give opportunity to individual learners or even deal with individual differences among learners. This is exacerbated by the pressure to complete the syllabus. The study finding is consistent with Carla, (2007), Sikoyo (2007) Sikoyo (2010) and Sentongo et.al (2010) who note that in order for teachers to change instructional practices and improve the effectiveness of teaching, time and support were major factors to be considered. Teachers' accounts also point to the fact that the scheduled time could not enable them to use the ALEI principles in science classes effectively; considering that hands -on activities were encouraged as much as the use of learner-centered approach in which the discovery strategy is underscored.

In another perspective, time for preparation of lesson activities and science practical experiments was reported as challenging to the subject teachers. In their explanations teachers pointed out that though they had benefited in using the SESEMAT approach to teach science through the use of ALEI, they could not use the approach consistently. Teachers argued that it would take a lot of time for them to improvise learning materials for individual students in classes of one hundred. It would still take much more time for the subject teacher to facilitate learning through encouraging and involving individual learners in the teaching and learning process. This is exacerbated with the pressure from their schools to cover the mandatory curriculum and prepare students to be successful on the high-stakes examination. This ultimately restricts teachers' implementation of the new teaching approach (Park e.tal 2006). Boardman e.tal (2004) note that teachers spend large amounts of instructional time trying to align their teaching to test objectives as they prepare students to take the test. It is therefore prudent that special efforts should be instituted for following up the program to help the teachers implement what they learn and overcome the restraints they encounter in school settings.

The study also found that teachers' time for attending workshops was inadequate and constrained the adoption of SESEMAT pedagogic principles. Ezati & Mugimu (2010) are of the view that implementing innovations in CPD workshops is constrained by the timing of training workshops. SESEMAT workshops are usually programmed for second term during holidays and last for a maximum of two weeks. This finding sharply contradicts with findings from other researchers such as Gregory (2009) & Darling- Hammond (2005) who argue that opportunities for professional development need to be integrated into school hours. That implies that time is an important feature for teachers undertaking CPDs. Many recent research findings emphasize the need for teachers to be given extensive time and support, in order to help them modify their instructional practices and beliefs (Sandholtz, 2002, Fullan 2001; Loucks-Horsley et al, Carla & Sherry, 2009 Carla 2007, Garet, 2001). Garet et al. (2001) reported that the total amount of time of a CPD impacts on the success of a program. In the same vein, Loucks- Horsley et al. (2003), Carla, (2007) Sikoyo (2007) and Sikoyo (2010) argue that programs should provide teachers enough time to fully process and address the doubts and misconceptions they have.

One of the study findings about factors that inhibit teachers' adoption of SESEMAT ALEI principles is the teachers' misconceptions of the SESEMAT pedagogic approach. Majority teachers (eight out of the eleven selected teachers) kept referring to the SESEMAT approach as the 'SESEMAT curriculum.' Descriptions of the SESEMAT approach such as; too simplistic, too wide, time consuming, irrelevant and unrealistic, are attributed to the teachers' misconceptions that SESEMAT is a curriculum running side by side with the NCDC syllabus. Teachers argued that they were pressured by their schools to complete the NCDC syllabus. They also explained that topics in the 'SESEMAT curriculum' included those that were covered in primary school and so they were irrelevant to the secondary NCDC curriculum. This misconception was found to impede adoption of the SESEMAT approach to teaching and learning science subjects. In relation to this finding, a number of studies have illuminated a possible misconception that teachers can have when using the problem-solving approach. Lotter, Harwood & Bonner 2006, Sikoyo 2010, and Mtitu 2014). In this study, teachers misconceived what SESEMAT approach was and also reverted to the use of the teacher-centered approach with the belief that they were using the problem solving approach. It can therefore be argued that adoption of CPD pedagogic principles occurs in situations where teachers have clarity of the intended pedagogic innovation; other factors held constant.

The large class sizes as a constraint has scaled down the adoption of the SESEMAT pedagogic principles in the teaching and learning of science subjects. This factor goes hand in hand with the inadequate teaching and learning materials and science equipment. The current study found out that no matter how hard teachers tried to achieve their set objectives against the prescribed ALEI practices, achieving them is a tall order because the class sizes are too large, ranging between eighty and one hundred plus learners per class. Consequently, teachers are not able to involve all learners in the lesson activities due to inadequacy of the available teaching and learning materials, against too many students and in very limited class time.

Teachers reported that the classes were too big for them to effectively teach using SESEMAT approach. Classroom observation showed that all classes had eighty to one hundred students. This constrained the adoption of ALEI principles. The big classes were difficult to control during group work hands-on activities. Students' participation was limited to representatives who also took turns to manipulate the specimens and equipment. Supervision of students' activities was extremely difficult as the groups were not just large but many for one facilitator given the limited time of one hour and twenty minutes. This constrained the adoption of ALEI by both teachers and students. Improvisation for instance was very challenging because of the large class sizes teachers managed. These findings resonate with findings of Dole, et al (2016), Mtitu (2014), Sentongo et al (2010) who reported that large classes made it difficult for teachers to organize, supervise and manage classes.

Schweisfurth (2011) found that teachers with more training and less crowded classrooms more often believed that students should be asked questions and become more active participants in class. This finding illuminates the intersection of training, resources, teacher beliefs and the lived teacher realities in the classroom context. This implies that the adoption of SESEMAT ALEI principles ought to be looked at in more than one perspective. Sikoyo (2007), Sikoyo (2010)

Schweisfurth (2011) concluded that pedagogic practice in Uganda is far more regulated by contextual material, political and economic factors within particular schools than by the pedagogic prescriptions of the official curriculum. Hence teachers' adoption of innovative pedagogies is constrained

Teachers also reported that they were challenged with the available space both in laboratories and the classrooms. They explained that due to limited laboratory space, many practical lessons were conducted in classrooms. This condition was made worse by the physical equipment such as sinks and taps that had broken down. Data derived from observation was consistent with the teachers' report. Research findings from other studies resonated with the this finding; (Sentongo et al., 2010, Kivunja & Sentongo, 2016).

Inadequate instructional materials were another factor that constrained teachers' adoption of SESEMAT approach to teach and learn sciences subjects. Findings revealed that instructional materials were inadequate. Teachers reported that instructional materials that were required to facilitate hands-on experiences in the different subjects were not adequate enough to enable successful adoption of ALEI principles in classrooms. Although teachers tried to improvise in cases where the ideal was not or when there was inadequacy, the instructional materials constrained implementation of SESEMAT approach. The researcher confirmed this through classroom observation data. Other research findings have similar findings (Sikoyo 2010, Mtitu, 2014; Schweisfurth, 2011).

5.2 Conclusions

The conclusions below were drawn from the discussion following the three themes of the study; science teachers' implementation of SESEMAT pedagogic principles, teachers' perceptions of the worth of SESEMAT pedagogic principles in their classroom practices and Factors influencing teachers' adoption of SESEMAT pedagogic principles.

Findings of the study revealed that science teachers were implementing the SESEMAT ALEI principles in their classroom practices. Teachers prepared teaching –learning activities in which learners were involved, the learner- centered approach was used to some extent, all teachers encouraged their learners and improvisation was done to some extent. However, the practical science activities (hands-on minds-on activities) were either conducted by students in groups and not individual hands -on activities as prescribed by the SESEMAT pedagogic approach.

Findings from this study also indicate that overall teachers' perceptions of SESEMAT ALEI principles are positive. However the study established that some teachers have misconceived the SESEMAT pedagogic approach to be 'an independent curriculum' separate from the NCDC curriculum. These misconceptions have impacted negatively on both the students' and the teachers' perceptions of the SESEMAT program.

Overall the findings show that adoption of the SESEMAT principles is influenced by both factors that promote and constrain teachers' adoption. The professional support, follow up support supervision, teachers' positive perceptions of SESEMAT approach and feedback given to teachers were found to promote the teachers' adoption of the SESEMAT approach.

On the other hand, time factor, large class sizes, and inadequate instructional equipment and supplies teachers' and students' misconception of the SESEMAT approach were found to constrain teachers' efforts to adopt the pedagogic practices prescribed by SESEMAT.

5.3 Recommendations

In view of the research findings, the following recommendations are made:

Teacher training institutions could consider integrating ALEI skills in the pre-service curricula of science teachers in order to give them sufficient exposure in the learner-centered pedagogy.

MoES could increase on the provision of science equipment and instruments like Bunsen burners, spatulas, fire tongs, racks and surgical blades to schools that implement SESEMAT approach much as improvisation is instrumental.

MoES could consider institutionalizing continuous professional development courses for all secondary teachers, so as to foster conceptualization of the learner -centered approach. UNEB could consider the focus of national examinations to encompass not only the content covered at O'level but also the skills acquired by learners; even if students do not make it to higher levels.

Schools could consider organizing school based Termly workshops facilitated by the SESEMAT regional trainers as a follow up to the Annual SESEMAT workshops. This could ground the teachers in the pedagogic approach that SESEMAT advocates for teaching science.

The MoES could consider additional recruitment of science teachers to alleviate the negative consequences of large classes.

Schools could institutionalize the reward system as a means of motivating teachers and learners who excel in improvisation at school level which could promote innovation and creativity.

5.4 Suggestions for further research

Research could be done in the following areas;

A similar study could be replicated to a larger sample in this region or other regions to elaborate on the results.

There is need to carry out a study that would address other teaching and learning approaches that could be effective in improving students' performance in science subjects in view of the large class sizes and inadequate teaching- learning materials.

A study on factors that hinder implementation of learner-centered strategies in science subjects at O' level could also be done.

REFERENCES

Adrienne K N (2008), *Science Teacher Competences in a Knowledged Based Society*.Retrieved on 4th/June /2016 from Science teacher competences - file:///C:/Users/Dell/AppData/Local/Temp/article_1_1_5.pdf

Allybokus, B. S. (2015). *The implementation of learner-centred teaching in Mauritian state secondary schools: examining teachers' beliefs and classroom practice.* UCL Institute of Education.

Altinyelken, H. K. (2010). *Pedagogical renewal in sub---Saharan Africa: the case of Uganda*. Comparative Education, 46(2), 151-171.

Anderia I and Liliana M (2011*).Pedagogical Competences- The Key to Efficient Education.* International Online Journal of Educational Sciences. Retrieved on 4th June 2016 from file:///C:/Users/Dell/AppData/Local/Temp/IOJES_402.pdf

Amin, E. M. (2005). *Social science research: conception methodology andanalysis.* Kampala: Makerere University Printery

Bennell P., (2004). *Teacher Motivation and Incentives in Sub-Saharan Africa and Asia. Knowledge and Skills for Development*, Brighton. Retrieved on 21st May 2016 from http://www.eldis.org/fulltext/dfidtea.pdf**.**

Boardman, A. G., & Woodruff, A. L. (2004). *Teacher change and "high stakes" assessment: what happens to professional development*? *Teaching and Teacher Education, 20*(6), 545e557.

Boyle, B,.Lamprianou,I,& Boyle, T.(2005). *A longitudinal study of teacher change: What makes professional development effective?* Report of the second year of the study. School effectiveness and school improvements, 16,1-27.

Bruner, J.S. (1960). *The process of Education.* Cambridge, Mass: Harvard University Press.

Camille A. Farrington, Melissa Roderick, Elaine Allensworth, Jenny Nagaoka, Tasha Seneca Keyes, David W. Johnson, and Nicole O. Beechum (2012), *Teaching Adolescents To Become Learners The Role of Non-cognitive Factors in Shaping School Performance: A Critical Literature Review;* University of Chicago.

Carla C. Johnson (2007), *Whole-School Collaborative Sustained Professional Development and Science Teacher Change: Signs of Progress*, Springer. Accessed on 5/02/208 from http://www.jstor.org/stable/43156439.

Carla C. Johnson and Sherry Marx (2009) *Transformative Professional Development: A Model for Urban Science Education Reform,* Springer. Accessed on 5/02/ 2018 from http://www.jstor.org/stable/43156499

Kivunja, C. and Sentongo, J. (2016) Teaching Science in Uganda. In B. Vlaardingerbroek and N.Taylor (Eds) Teacher Quality in Upper Secondary Science Education: International Perspectives. Palgrave Mamillan, New York.

Chauraya Million & Brodie Karin (2017): *Learning in Professional Learning Communities: Shifts in mathematics teachers' practices*, African Journal of Research in Mathematics, Science and Technology Education.

Darling-Hammond, L (2005). *Teaching as a profession: lessons in teacher preparation and professional development.* Phi Delta kappan,87, 237-240.

Darling-Hammond,L, Chung Wei,R, Andree, A.,Richardson,N., and Orphanos,S,. (2009), Professional learning in the learning profession: A status report on teacher development in the United States and Abroad, Dallas, TX: National Staff.

Development Council. Downloaded on 9th August 2018 from WWW.nsdc.org

Derin Atay (2007), *Teacher research for professional development*, Oxford University Press.

Dewey, J. (1938). *Experience and education.* London: Collier Books

Dimitris P. Sakkoulis, Anna Asimaki & Dimitris K. Vergidis(2017); *In-service Training as a Factor in the Formation of the Teacher's Individual Theory of Education, University of Patras,* https://doi.org/10.5539/ies.v11n3p48

Enon, J.C. (1998).*Educational research, statistics and measurement*. Makerere University: Department of Distance Education.

ESSAPR. (2013). *Education and sports sector annual performance report 2012- 2013*. Kampala.

Ezati, B.A and Mugimu, B.C (2010). *Possibilities and Challenges of providing Continuous Professional Development in Pedagogy for Higher Education staff in Africa: A case of*

Makerere University. Comparative and International Higher Education. Retrieved on 22nd May 2016 from www.bipai.org/uganda/education.aspx.

Fatimah Mulya Sari, (2018), *EFL Students' dilemma: Factors determining their talk in the language learning process,* Universitas Teknokrat Indonesia

Fullan,M.(2007) *The New Meaning of Educational Change.* New York: Teachers College Press, Columbia University.

Fullan, M. (2001). *The new meaning of educational change.* New York: Teachers College.

Freedman, J,.(n.d). *A Hope for Change, Alan Deutschman on Change or Die.*

Fru Vitalis Akuma & Ronel Callaghan (2016), *Framework for reducing teaching challenges relating to improvisation of science education equipment and materials in schools,* Eurasia Journal of Mathematics, Science & Technology Education, 2016, 12(10), 2697-2717.

Garet, M. S., Porter, A. C, Desimone, L., Birman, B. F., & Yoon, K. (2001). *What makes professional development effective? Results from a national sample of teachers*. American Educational Research Journal Accessed on 5/02/ 2018 from: http://www.jstor.org/stable/jeductechsoci.19.3.110.

Gregory, A. (2009). Teacher learning on problem-solving teams. Teaching and Teacher Education, 26 (2010) 608e615.

Gregory, A. (2010). Teacher learning on problem- solving teams. *Teaching and Teacher Education, 26* (3), 608e615.

Godfrey Ejuu (2012), *Implementing the early childhood development teacher training framework in Uganda: Gains and challenges, SAGE, Journal of Early Childhood Research 10(3) 282 –293.*

Higgins,T.E, & Spitulnik Michele .W (2008). *Supporting Teachers' Use of Technology in Science Instruction Through Professional Development: A Literature Review* .Journal of Science Education and Technology, 17(5) 511-521.

Hofman, R. H., & Dijkstra, B. J. (2009). Effective teacher professionalization in networks? *Teaching and Teacher Education*, *26*(4), 1031e1040.

Institute of Training & Occupational Learning (n:d,). Retrieved from www.itol.org/wp-content/uploads/2014/06/ITOL-GUIDE-to-CPD.pdf.

Jeanpierre, B., Oberhauser, K., & Freeman, C. (2005). *Characteristics of professional development that effect change in secondary science teachers' classroom practices*. Journal of Research in Science Teaching, 42(6), 668.

Jenlink,P.M,. & Kinnucan-Welsch, K.(2000). *Activity theory and the design of professional learning communities*. Paper presented at the Annual meeting of the American Educational Research Association, New Orleans, USA.

José-Reyes Ruiz-Gallardo & Duncan Reavey (2018): *Learning Science Concepts by Teaching Peers in a Cooperative Environment:* A Longitudinal Study of Preservice Teachers, Journal of the Learning Sciences.

Kagoda, A , Ezati, B . (2014). *Secondary School Teachers' Perception of "Teacher Professional Development"*: A Case Study of Teachers from Five Districts of Uganda. Journal of Teacher Education and Educators.

Kariisa, A. (2015) *Perceptions of secondary school mathematics teachers towards Secondary Science & Mathematics teachers (SESEMAT)programme in Mbarara District, Uganda,* International Journal of Recent Advances in Multidisciplinary Research, 02, 1092e1096.

Kelly, A.V (2009). *The Curriculum, Theory and Practice,* London: SAGE Publications Limited.

Kivunja, C. and Sentongo, J. (2016). Uganda: *The Teaching of Science in Secondary Education*. In Vlaardingerbroek, B. and Taylor, N. (Eds.). *Teacher Quality in Upper Secondary Science Education: International Perspectives,* p. 247-263. New York: Palgrave Macmillan.

Knight, p (2001). A systemic approach to professional development. Learning as practice, *Teaching and Teacher Education,18 (2002) 229e241*.

Kombo, K. D. & Tromp, L. A. D. (2006).*Proposal and thesis writing: An introduction.* Nairobi: Pauline publications Africa.

Korthagen, F. A. J. (2003). In search of the essence of a good teacher: towards a more holistic approach in teacher education. *Teaching and Teacher Education, 20*(2004), 77e 97.

Korthagen, F. A. J. (2009). Situated learning theory and the pedagogy of teacher education: towards and integrative view of teacher behavior and teacher learning. *Teaching and Teacher Education, 26*(1), 98e106.

Kwakman, K. (2002). Factors affecting teacher participation in professional learning activities. *Teaching and Teacher Education, 19*(2), 149e170.

Lee, J. F. K. (2008). A Hong Kong case of lesson study e benefits and concerns. *Teaching and Teacher Education, 24*(5), 1115e1124.

Lewin, K. M. & Stuart, J.S. (2003) Research Teacher Education: New Perspectives on Practice, Performance and Policy. DFID Research Series 49a.

Loucks-Horsley, S., Hewson, Love & Stiles (2003). *Designing professional development for teachers of Mathematics and Science,* 2nd ed., Thousand Oaks, CA: Corwin Press.

Manhong Lai (2011), *Teacher Development under curriculum reform; a case study of a secondary school in Mainland China,* Springer.

Million Chauraya & Karin Brodie (2017*), Learning in Professional Learning Communities: shifts in Mathematics Teachers' Practices,* African journal of Research in Mathematics, Science & Technology Education, 21:3,223-233. https://doi.org/10.1080/0035919X.2017.1350531

Milagros Sainz, Sergi Fa`bregues, Maria Rodo´-de-Za´rate1, Jose´-Luis Martı ´nez-Cantos, Lidia Arroyo, and Marı´a-Jose´ Romano (2018), *Gendered Motivations to Pursue Male-Dominated STEM Careers Among Spanish Young People: A Qualitative Study,* Journal of Career Development 1-16, SAGE

Mishra, P., & Koehler, M. J. (2006). *Technological Pedagogical Content Knowledge: A Framework for teacher knowledge.* Teachers College Record, 108, 1017-1054.

Mugenda, O.M &Mugenda, A.G (2003).*Research Methods-Quantitative Qualitative Approaches.* ACT Press: Nairobi-Kenya.

Ministry of Education, Federal Democratic Republic of Ethiopia (2009). *Continuous professional development for primary & secondary teachers, Leaders and Supervisors in Ethiopia.* Retrieved on 23rd/05/2016 from *Ethiopia- info.moe.gov.et/cpdocs/fwk.pdf.*

Mtitu, E. A. (2014). *Learner-centred teaching in Tanzania: Geography teachers' perceptions and experiences.*

Ndebele, C., & Maphosa, C. (2013). *Promoting Active Learning in Large Class University Teaching: Prospects and Challenges.* J Soc Sci, 35(3), 251-262.

NCDC (2012). *A Competence-Based Teaching and Learning Approach in the O'level Curriculum in Uganda*, Kampala.

OECD. (2005). *Teachers matter. Attracting, developing and retaining effective teachers*. Paris: OECD.

Okhee Lee, Karen Adamson, Jaime Maerten-Rivera, Scott Lewis, Constance Thornton & Kathryn LeRoy (2008), *Teachers' Perspectives on a Professional Development Intervention to Improve Science Instruction Among English Language Learners.* Journal of Science Teacher Education, 19, 1 (2008), 41-67.

Otto Y.W.&Onen, D. (2005)A *general guide to writing Research proposal and report*. Kampala: Options press.

Odebode, N. (2004). *Students Attitude to Mathematics Worries Government. Lagos:* The Punch.

Osuji, L. I. (2007). The *Role of Mathematics in Technical Training*. (A term Paper presented to the Department of Science and Technical Education) Rivers State University of Science and Technology, Port Harcourt, Nigeria.

Oyodele,A (2006) *FG and UNESCO Partner To Revamp Science and Technology Education. Lagos:* The Punch.

Park.S,. Lee, S. Oliver, J.S. & Cramond, B (2006). *Changes in Korean Science Teachers' Perceptions of Creativity and Science Teaching After Participating in an Overseas Professional Development Program.* Journal of Science Teacher Education 17(1), 37-64.

Power and Cohen (2005) Powel L & Cohen J (2005) *Competency-Based Education Training Delivery:* Unpublished paper.

Prestridge, S., & Tondeur, J. (2015). *Exploring elements that support teachers' engagement in online professional development*. Education Sciences, 5(3), 199-219

Rarieya, J., & Tukahirwa, F. (2006).*Continuing professional development and the relevance Of the IED model in East Africa.* InI.Farah & B. Jaworski (Eds.), Partnerships in educational development (pp. 119-130). Oxford: Symposium Books. eCommons@AKU. Retrieved on 4th./June/2016 from *ecommons.aku.edu/cgi/viewcontent.cgi?article=1006&context=book_chapters*.

Republic of Uganda, (undated).*The Education and Sports Sector Annual Performance Report FY 2012/2013*, Kampala.

Sahlberg, P,.(2004), *Teaching and globalization: Research Journal of Managing Global Transitions*, 2(1), 65-83.

Sahlberg,P (2006) *Education reform for raising economic competitiveness.* Journal of Educational Change.

Sandholtz, J. H. (2002). In-service training or professional development: contrasting opportunities in a school/university partnership. *Teaching and Teacher Education, 18*(7), 815e830.

Sandholtz, J. H., & Scribner, S. B. (2006). The paradox of administrative control in fostering teacher professional development. *Teaching and Teacher Education, 22* (8), 1104e1117.

Sato.K,& Kleinsasser Robert C (2004).Beliefs,practices,and interactions of teachers in a japanese high school English department, Teaching and Teacher Education 20(2004) 797e816.

Sentongo, J. , Ntale, M. & Kyeyune, R. (2010) Uganda. In B. Risch (Ed) Teaching Chemistry Around the World, Waxmann Verlag GmbH.

Schwille, J. &Dembele, M. (2007).*Global Perspectives on Teacher Learning: Improving policy and practice.* Paris, UNESCO.

Schweisfurth, M. (2011). *Learner-centred education in developing country contexts: From solution to problem?* International Journal of Educational Development, 31(5), 425-432.

Sikoyo, L. (2010). *Contextual challenges of implementing learner---centered pedagogy: the case of the problem---solving approach in Uganda*. Cambridge Journal of Education, 40(3), 247263.

Sikoyo, L. N. (2007). *Primary teachers' recontextualization of a curriculum innovation in Uganda.* University of Cape Town.

Tyler, R. (1949) *Basic principles of curriculum and instruction.* Chicago, IL: University of Chicago Press.

Tondeur, J, Forkosh-Baruch,A. Prestridge,S. Albion, P. & Edirisinghe, S (2016). *Responding to Challenges in Teacher Professional Development for ICT Integration in Education.* Journal of Educational Technology & Society, 19 (3) 110-120.

Uganda Options Paper (2009) *Secondary Education in Africa Follow-up Programme (SEIA) Technical Workshop in Science and Mathematics*, Tunis.

Vavrus, F., Thomas, M., & Bartlett, L. (2011). *Ensuring quality by attending to inquiry: Learner centered pedagogy in sub-Saharan Africa.* Fundamentals of Teacher Education Development, 4.

Villegas-Reimers, E,. (2003). *Teacher Professional Development: An international Review of the Literature.* UNESCO: IIEP

Yoo, Y., & Sohn, Y. (2001). *A study on the analysis of actual conditions and reform measures in light of applying the 7th national curriculum*. Journal of Science Education Kyungpook National University; 25, 1 1-30.

APPENDICES

Appendix A

Class Observation Checklist

The researcher will take interest in how the teachers teach. This will be after seeking permission from the school authority and obtaining consent of the teacher in question. The researcher shall then carry out a post lesson observation interview for purposes of triangulation of methods.

- Activity filled/based lesson
- Learner-centred teaching-learning
- Encouragement through reinforcement of learning
- Improvisation in lesson presentation
- Dealing with learners' misconceptions and difficulties

Appendix B

Interview guide for Head teachers

- Briefly mention the available in-service courses that you know, for science teachers?
- How many SESEMAT workshops do science teachers attend in a term?
- In your experience how is SESEMAT Activity Regional Based (SARB) implemented in your school?
- As the administrator, how do you ensure that the teachers are actually teaching according to the SESEMAT requirements?
- In your experience how do science teachers perceive SESEMAT in relation to improving the teaching and learning of science subjects?
- In your opinion, would you consider SESEMAT a worthwhile approach to teaching and learning of science?
- How often is the SARB school summary submitted to the Regional Monitoring Coordinator (RMC)?
- In your experience which aspects do you consider before SESEMAT lessons are implemented in your school?
- Briefly explain how you address the issues /aspects mentioned above.
- Have you ever attended any sensitization/sharing workshops?
- In your experience how have the sensitization/sharing workshops helped you to implement SESEMAT Program in your school?
- How do you support teachers to ensure that teaching and learning of science is done the SESEMAT way?
- Do you have any recommendations for improving SESEMAT?

Thank you for your cooperation

Appendix C

Interview Guide for Regional Trainer

- Briefly explain what your role is, as a Regional Trainer (R/T).
- What are the intended SESEMAT curriculum characteristics/ principles?
- How do you promote SESEMAT Activity Regional Based (SARB) in your region?
- Briefly explain the monitoring mechanisms for SESEMAT implementation at regional level.
- In your experience what are some of the challenges you encounter in monitoring SARB activities
- How do you address monitoring and follow up challenges?
- In your opinion do you see SARB as a means to enhancing science education?
- In your opinion what is the reality on the ground in terms of SESEMAT implementation at school level?
- In your opinion what are the teachers getting right in terms of perceptions towards SESEMAT pedagogic principles? E.g. do they feel SESEMAT pedagogic principles are realistic, achievable, inapplicable etc.
- How effective are the policies that govern SESEMAT in terms of quality, access and relevance of the program to the science teachers?
- How do you support teachers to ensure that teaching and learning of science is done the SESEMAT way?
- To what extent are science teachers responsive to the changing patterns of teaching and learning science?
- What are the opportunities for change towards improvement?
- Mention any evaluation activities that you carry out at your level.
- Are there any processes that ensure alignment between desired learning outcomes as defined by SESEMAT and evaluation practices?
- In your experience what challenges do you encounter in using the cascading modal?
- In your opinion how can we modify SARB activities for better results?
- Are there any processes that ensure alignment between desired learning outcomes as defined by SESEMAT and evaluation practices?

Thank you for your cooperation

Appendix D

Interview for Regional Monitoring Coordinator

- Briefly explain what your role is, as a Regional Monitoring Coordinator (RMC).
- What are the intended SESEMAT curriculum characteristics/ principles?
- How do you promote SESEMAT Activity Regional Based (SARB) in your region?
- Briefly explain the monitoring mechanisms for SESEMAT implementation at regional level.
- In your experience what are some of the challenges you encounter in monitoring SARB activities in your region?
- How do you address monitoring and follow up challenges?
- In your opinion do you see SARB as a means to enhancing science education?
- In your opinion what is the reality on ground in terms of SESEMAT implementation at regional level?
- In your opinion what are the teachers getting right in terms of perceptions towards SESEMAT pedagogic principles? E.g. do they feel SESEMAT pedagogic principles are realistic, achievable, inapplicable etc.
- How effective are the policies that govern SESEMAT in terms of quality, access and relevance of the program to the science teachers?
- Have you ever participated in sensitization/sharing workshops?
- How do these workshops enhance good practices in science subjects?
- What are the opportunities for change towards improvement?
- Mention any evaluation activities that you carry out at your level.
- Have you participated in sensitization/sharing workshops?
- How do these workshops enhance good practices in science subjects?

Thank you for your cooperation

Appendix E

Focus Group Discussion Guide for students

- Briefly explain how science subjects are taught in your class/school.
- How does use of experiments in science subjects make it easier and interesting for you to learn science subjects?
- Are you sometimes required to bring learning materials from home?
- Give examples of the materials you bring.
- Explain how these materials help you to learn science subjects.
- What kind of support is given to you in class in order to help you perform better in science subjects?
- How do you perceive SESEMAT in terms of helping you understand science subjects better? E.g. do you feel SESEMAT makes science subjects more interesting, simpler/ difficult to understand etc?
- What arrangements are made for you, by science teachers when you fail/or find some questions difficult to answer?

Thank you for your cooperation.

Appendix F

Self administered questionnaire for teachers

Dear science teacher,

I' am a student from Makerere University Kampala, carrying out a research on the program of SESEMAT in Mbale district. The information you give will help improve the teaching and learning of science subjects in the district. Therefore give complete and honest answers. All the responses will be confidential and you shall be acknowledged as having contributed to the research. Please do not write your name or name of the school on the questionnaire.

General information

Please give your responses about the following facts about yourself.

1 .Gender: ☐ Male ☐ Female

2. Teaching subjects ☐ Biology ☐Chemistry ☐ Physics

3. Number of years in teaching ☐ 1-9 ☐10-19 ☐ 20-29 ☐ 30+

4. Highest qualification . M.ed.☐ B.Sc. ☐ B.Ed. ☐ Dip. In Education ☐

☐ Others (Specify) ------------------------------------

Please read through the Instructions carefully before you answer the questions below. For the questions with boxes indicate your response by ticking the appropriate box. Questions with spaces are to be filled with answers in the spaces provided.

1. Which classes do you teach? S.1 ☐ S.2 ☐ S.3 ☐ S.4 ☐

2. In your opinion, what is the main focus of SESEMAT program in terms of teaching and learning? ....

3. Briefly explain how SESEMAT teaching and learning differs from the traditional way of teaching science.

…………………………………………………………………………………………………
…………………………………………………………………………………………………

4a) In your opinion how has SESEMAT approach to teaching science influenced your teaching science?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

b) What are the opportunities for improving SESEMAT pedagogical approach?
....
....

5. In what ways do you see SESEMAT as a means to improve your teaching and learning of sciencesubjects?………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

6 How do your students respond to science subjects when you use the SESEMAT approach to teaching and learning?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

Are there any new responses that your students did not show before the use of SESEMAT approach to teaching and learning?

....
....

7a) What percentage of students has access to teaching and learning resources (e.g. labs, science kits, demonstration resources etc) that help convey SESEMAT concepts? ....

b) In your opinion what effect do teaching and learning resources have on student learning outcomes in science subjects?

....

....

c) How could they be made more effective?

....

....

8. a) How is inquiry used in science subjects?

....

....

b) In your experience how are students involved in the process of improving their own learning of science subjects?

....

....

c) How do you encourage all your learners to participate in the teaching and learning activities?..

....

d) Briefly explain how SESEMAT program has improved on your skill of improvisation …………………………………………………………………………………………… …………………………………………………………………………………………… ………………………………………………………………………………………….

9. Has anyone ever observed you teaching a science lesson?

....

....

(b)If yes, by whom were you observed? (Give title) ……………………………..

c) When was this ? (Year)...

d) How often are you observed while teaching science subjects? (Termly, annually never) ....

10a) In your experience what kind of feedback was provided after lesson observation?... ....

b) In your experience what influences the implementation of SESEMAT lessons?

....
....

11. In your opinion what are the opportunities for change towards improvement in implementation of SESEMAT pedagogic strategies?

....

12. Suggest the kind of professional support you would like to be given as a science teacher…………………………………………………………………………………………… ……………………………………………………………………………………………………

13. How do you rate SESEMAT workshops in improving your ability to teach? ……………………………………………………………………………………………………
……………………………………………………………………………………………………

14a) when did your quality assurance officers (Regional Trainer-R/T and Regional Monitoring Coordinator-RMC) last visit your school

Thank you for your cooperation.

Appendix G

Post lesson interview guide for teachers

Please, I would like you to answer a few questions about the lesson you have just conducted.

1. Briefly explain how you go about improvisation in the event of inadequacy.
2. How has improvisation enhanced the teaching and learning of your subject?
3. In your opinion how do teaching and learning materials make a difference on students' learning experiences (this is in regard to enhanced understanding of your subject)
4. How do you cater for individual differences amongst your learners during lesson activities and other science experiments?
5. Briefly explain the actions you take in the interest of improving students' learning.
6. How are best practices shared among teachers in your school?

Thank you very much

Appendix H

Introductory letter from the Dean School of Education

MAKERERE UNIVERSITY

P. O . Box 7062 Kampala – Uganda
E-mail: deaneduc@educ.mak.ac.ug

Tel: +256 – 414- 540733
Cables: "MAKUNIKA"

COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF EDUCATION
DEAN'S OFFICE

27th April 2017

TO WHOM IT MAY CONCERN

RE: BUTEME ROSEBUD (REG. 2013/HD04/920U)

Ms. Buteme Rosebud is a M.Ed student in the School of Education doing Master of Education in Curriculum Studies. She is proceeding to collect data for her dissertation titled: ***Role of Semat in Enhancing Science Teachers' Competences at O'Level: Mbale District.***

Any assistance rendered to her will be highly appreciated.

Yours Sincerely,

MUK. COLLEGE OF EDUCATION &
EXTERNAL STUDIES
P. O. Box 7062, Kampala, Uganda
27 APR 2017
DEAN
SCHOOL OF EDUCATION

Betty Ezati (PhD)
DEAN.