

Strategies for promoting active learning in large underfunded Physics classrooms in Kerala, India

By

Ronesh Rajcoomar

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Supervisor: Dr AT Motlhabane

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Student number: **31254896**

I declare that **STRATEGIES FOR PROMOTING ACTIVE LEARNING IN LARGE UNDERFUNDED PHYSICS CLASSROOMS IN KERALA, INDIA** is my work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.



SIGNATURE
(Ronesh Rajcoomar)

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DATE

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Abstract

Large underfunded classrooms are indicative of the situation found in many developing countries. These limitations often lead to the ineffective teacher-centred approach dominating classroom instruction in these countries. The aim of the study was to examine active learning strategies used by teachers in large unfunded Physics classrooms, in Kerala, India.

This study used a qualitative approach utilising a case study method. The data collection process involved mainly unstructured interviews, lesson observations and the analysis of documents.

The results of the study indicate that despite the difficulties faced in India, similar to those faced by other developing countries, the Indian state of Kerala implements and supports active learning rather than the more common teacher-centred approach. The research defines the common forms of active learning in the Physics lessons and critically examines the core elements of the learner-centred teaching approaches. Successes have been found in the implementation of active, collaborative, cooperative and problem-based learning in the large underfunded Physics classes.

The results of the research suggest that teachers need to be highly trained, resourceful, creative, hardworking and sometimes go above and beyond the required duties to make active learning in large underfunded Physics classroom a success.

Key Words: active learning, learner-centred, teacher-centred, Physics, large underfunded classroom, constructivist approach, problem solving, collaborative work, Bloom's Taxonomy, multiple intelligences, zone of proximal development.

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CHAPTER 1

1.1 INTRODUCTION

“Learning is not a spectator sport. Learners do not learn much just by sitting in class listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves.” (Chikering & Gamson, 87:3-7).

Active learning is a teaching method that results in greater learner involvement and knowledge retention (Bonwell & Eison, 1991:1). Learning is a biological mechanism that is foremost about survival. Active learning allows the learner to put into practice what has been learnt for years to come (Chance,2009:24). Active learning significantly improves performances of learners in large classrooms (Hake, 1998:39, Giannola & Green, 2011:5, Settles, 2008 :52) and is a recommended teaching method that works (Felder et al, 2000:27, Hativah, 2000:63 , Kyriacou, 147: 1997) as compared to the teacher centred approach.

Studies show that the three broad areas of successful teaching of large classes involve collaborative activities, encouraging class participation and promoting active learning with associated activities (Nakabugo et al, 2008:87). Active learning significantly improves performances of learners in large classrooms (Hake, 1998:39) and is a recommended teaching method that works (Felder et al, 2000:27). Ideally teachers need to ensure that they base lessons on learners’ knowledge and experiences, actively engaging learners in classroom activities, have learners talking and being active more than listening in class and facilitating learners’ learning by doing and encouraging learners to initiate questions (Barrow et al, 2007:17).

With so much encouragement to shift passive learning environments to active learning environments in large classrooms, educators are faced with the dilemma of managing activities with many learners all at once (French, 2004:13). There is also the difficult task of meeting the learners’ individual needs, providing scaffolding and making learners thinking visible (Bransford, 2000:7). Early work completed by Beeby (1966:72) has suggested that large class instruction is a complex process affected

by numerous factors such as under-resourced teaching and learning conditions that restrict teachers into doing a mediocre job. Recent research conducted by Sikoyo (2010: 247-248) has led to the conclusion that teaching large classes as a learner-centred pedagogy in developing countries has a bleak future unless researchers find strategies to equip educators teaching in those countries with the knowledge and skills required to effectively teach the learner-centred curriculum.

Developing countries have the limitations of resources such as computer interfaces which are an invaluable tool in active learning as well as traditional teaching tools (Cambaliza,2004:89). The world education ranking shows that the first world countries top the rankings for English, Maths and Science leaving most of the developing countries at the bottom of the log tables (Sheperd, 2010). This situation of large under resourced classrooms will perpetuate substandard education in developing countries and will widen the gap between the first world and third world education. This in turn will preserve the unequal power sharing of the global economy (Zhang and Zou,1997:12).

Conversely, the limitation of being a developing country does not seem to apply to India in this aspect. India prides itself on their education system which is creating a scientific academic workforce comparable to those of first world nations. This statement is motivated further by a survey carried out by Cyranoskil et al (2011) which suggests that India has produced around 5,900 science, technology and engineering PhDs. This is ranked as one of the top nations, highly comparable to first world countries ratings (Cyranoskil et al, 2011). An article written by Sabathier and Faith (2008) maintains that India has one of the best space programs in the world. They further state that the Indian space program is roughly comparable to China's program and is second to the United States in terms of technology and space exploration.

According to the respondents of the survey from Redcliff Business group, India is on its way to beating the economic ratings of developed nations such as the United States, Japan, Germany and even the super economic giant China over the next two decades (Bhate, 2009). India is predicted to be top economic superpower by 2030

(Bhate, 2009). All of these successes are due to the strength of the Indian education system.

The Indian state of Kerala has a literacy rate that can be compared to the most advanced regions in the world. Kerala has a per capita income of only \$265 per year and despite such financial challenges it has produced a high literacy rate of 91 per cent (Raman, 2005). This is the highest in India and is comparable to the United States which is approximately 93 per cent (Raman, 2005). Kerala has achieved some of the third world's best rates of life expectancy and literacy, and lowest rates of infant mortality, despite one of the lowest per capita incomes in the world (Franke & Chasin, 1992:139-156).

Subsequently, it may then imply that the underlying reasons that active learning in large classrooms, particularly in developing countries, has not yet been sufficiently researched due to the limitations as stated above. Therefore, this study is designed to identify and analyse the problems faced and strategies used in the implementation of active learning in large classrooms in developing countries with specific reference to the Physics classrooms in Kerala, India. Furthermore, it intends to suggest ways of improving the implementation.

1.2. BACKGROUND INFORMATION

Uganda, South Africa, Namibia and many other developing countries throughout the world have based their educational curriculum on the learner-centred approach of active learning on the notion that they offer an effective alternative to the teacher-centred didactic practices (Cambaliza, 2001 :89-90, O'Sullivan, 2004:585-602). Onwu and Stoffels (2005:89) contend that large underfunded classrooms are a major setback in the implementation of active learning. Annual statistics show that after implementation of Curriculum 2005 (learner-centred curriculum) in South Africa there was a low percentage of African origin learners gaining minimum qualifications to enter science graduate programs. Only an average of 3000 African origin candidates out of 600,000 school leavers gained a pass that allowed them into graduate programs in the tertiary science field (Rollnick 2010:52).

Recent studies outlined by Sikoyo (2010:8) concluded that teachers in large underfunded classrooms felt that active learning was vital for enhancing learners' understanding of scientific concepts. This was achieved if learners actively experienced learning rather than the direct transmission of knowledge from the teacher to the learners. She further states that the learners understood better when they 'observed', 'touched', 'felt', 'heard' and 'smelt' natural objects and phenomena. As established by Gardner's (1991:11-13) research on multiple intelligences, learners have individual styles of learning. For example, some learners learn better when they learn from diagrams, pictures, mind maps etc (visual learners) whilst some learn better when they feel objects, perform role play, do practical investigations etc. (kinaesthetic learners) (Gardner 1991:11-13). Since memory in children is 75% when they practice by doing and 90% when they teach and learn from one another, the intelligences inherent in all individuals such as logical mathematical, visual spatial, verbal linguistic, bodily kinaesthetic, interpersonal and intrapersonal assist in the active learning process when learners are debating, compiling statistics, building models, composing poetry and music etc. (Stix, 2004:5). The active learning environment supports multisensory stimulation, collaborative work and the constructivist approach to learning (Ivers & Pierson, 2003:39).

To reinforce the notion of active learning, Onwu and Stoffels (2005:87) conclude that successes in large classroom environments are achieved when pupils are given learner-based activities in which teacher involvement was minimal. The early theories of Vygotsky (1978:86) suggest that the cognitive development in a learner centred education system lies in the Zone of Proximal Development where the learners are responsible for their own learning and are guided by their more able peers and the teacher. The Vygotskian theory argues that there is a strong connection between a practical activity and the mediation of speech, writing and the individual's intellectual activity (Moll,1990:12). During the active learning process it is acknowledged that learners vary in cognitive tasks during lessons (Black, 1988:23). Bloom's (1956) taxonomy of questioning shows that in order to develop higher order cognitive functions the learner must analyse, synthesise and evaluate information instructed by the objectives of the teacher (Phol, 2000:7-8). However, children can only learn when they are at a required stage of maturation (Vygotsky, 1978, as

cited by Aukrust, 2011:61). Instruction should be constructed to the developmental level of the child (Aukrust, 2011:61) and this is informed by the curriculum document.

The above theory provides suggested evidence that active learning is the most effective way to teach in large classrooms. Learners learn better by perusing personal goals and interests and when they are encouraged to make their own choices about activities (Harmon & Stokes, 2005:118-119). A curriculum that supports this type of learning is a curriculum design that has 'constructive alignment' (Biggs, 2006:347). Biggs defines 'constructive alignment' as a constructivism framework that guides decision making at all stages in the instructional design by objectives that represent high cognitive level. Knuth and Cunningham (1993) argue that the constructivist learning environments live by seven pedagogical goals. They list the goals as providing experience with the knowledge construction process, to appreciate multiple perspectives, embed learning in realistic and relevant contexts, encourage ownership and voice in the learning process, embed learning in a social experience, encourage multiple modes of representation and encourage self-awareness of the knowledge construction process.

In order to achieve excellent teaching and substantial success for all learners in a learner centred environment, caring, competent and qualified staff must be provided to all learners in low-income underfunded schools, (Hammond & Post, 2000:41-42). In addition to this, Valerian(1991 :62-65) suggests that using cheap everyday items such as nails, wood, wire, plastic tubes etc. will be a solution to the implementation of sustainable active learning in underfunded classrooms. Group work can minimise the need for lots of sustainable resources and can create opportunities for interpersonal learning. Teachers in Uganda who taught large classes with limited resources such as textbooks and other instructional materials reported that collaborative group work was an essential strategy in learner centred education (Nakabugo et al, 2008:85-102).

Despite the strong theory and research that supports the learner centred active learning, teachers in Africa, Asia, Europe and America still have problems in its implementation (Ottevanger et al, 2007:16-18) . Ottevanger et al (2007:17) warn that

if there is not sufficient support at the school and classroom level active learning is bound to fail. The prediction of failure stems from large, underfunded high schools in which teachers see 150 or more learners daily, cycling namelessly through the classroom in fragmented forty-five-minute periods which creates alienation because they support neither learning nor teaching (Hammond & Post, 2000:37). Due to large class sizes, many classroom teachers complain that they cannot give learners enough individual attention and they cannot find time to work with other teachers to improve learner achievement (Miles, 2000).

Significant research has emphasised the challenges that teachers experience when teaching large underfunded classes in developing countries. Valerian (1991:3) argues that large classes are one of the hard facts of existence in many developing countries. Recent studies outlined by Onwu and Stoffels (2005:84) suggest that science teachers in large underfunded classrooms face the challenges of classroom management, severe shortage of science laboratory equipment, lack of individual learner attention and difficulty in teaching enquiry science whilst conducting practical laboratory exercises. Valerian (1991:7) adds to this by stating that the constraints are difficult working conditions for the teacher, inadequate material facilities for the pupils, inadequate regulations appropriate to large classes, a shortage of teaching materials and under-qualified teachers. Pupils have the greatest difficulty in establishing interpersonal relations which in turn affects their psychological development and is generally reflected in lack of attention (Valerian, 1991:9).

The recession in 2008-2009 hit developing countries the hardest and countries such as South Africa, Mexico and Ukraine showed a tremendous drop in economic growth (Veric & Islam, 2010:8). Education is the key to facing the challenge posed by the global financial crisis because there can be no solution to unemployment without addressing the issue of education (Muchhala,2012). As continually discussed above, active learning is the solution to the global education problem, however, with it come the problems previously mentioned. Analysing the active learning environment within developing countries which place emphasis on large underfunded classrooms, should provide clues to the solution of the problems faced in the active learning environment.

1.3. STATEMENT OF THE PROBLEM

Large underfunded classrooms, especially in developing countries, struggle to effectively implement active learning.

The merger of practical realities and theoretical complexities tend to fail the binary learner-centred classrooms (Kain, 2002:104). Most teachers consider more than fifty learners in a classroom as a large class, however, developing countries can reach up to 100 or more learners (Nunan & Lamb, 1996:147). Schools in developing countries are moving towards the active learning approach (Cambaliza,2001:89-90, O'Sullivan, 2004:585-602) because research has shown it is the most effective (Campbell & Campbell,2009:74-75, Kyriacou,1997:16, Berry et al,2004:414-415). However, theory does not necessarily materialise into practice (Kridel,2010:248-251, Leyendecker et al, 2008:xiv).

Teachers in developing countries find teaching the learner centred pedagogy challenging because large class environments have an effect on motivation, discipline and the achievement of learners (Byram, 2000:10, Nunan & Lamb, 1997 :147-148). Studies conducted by Ward and Jenkins (1992) as cited by Sana (2010:108) showed that learners in large classes found the environment discomforting, they had the problem of anonymity and passivity which is against the philosophy of passive learning and had a lack of clear direction. Cramped conditions of large classes together with a teaching environment that is underequipped and which has an inflexible schedule, can make a learner centred approach to teaching a mammoth task to implement (Davis & Broadhead, 2007:205). Research undertaken by Eireann (1990) of large underfunded schools has reported high stress levels for staff and for school authorities (as cited by Davis & Broadhead, 2007:205). This caused many teachers to show signs of stress-related illnesses. Seanad (1990) further reported that the impact of worsening class size, the very low level of secondary support services, the discipline crisis and the overcrowded classes have caused this unprecedented pressure and stress on teachers (as cited by Davis & Broadhead, 2007:205).

Blumberg and Weimer (2009:249) argue that learners in the active learning environment find lessons more labour intensive as compared to the more traditional teacher centred approach. They also state learners may not want or may not be able to commit to a challenge and may also resent self-learning because they are teaching each other and not hearing from the expert of the content. Blumberg and Weimer further add that the fear of public failure also threatened progress in an active learning environment. Research conducted by Leyendecker et al (2008:45) in Sub Saharan Africa concluded that teacher's knowledge and practices showed general misunderstandings of the meaning of learner-centred education and led to the ineffective implementation of active learning in those developing regions.

Classroom practices are often constrained by practical considerations, such as learners' expectations and experiences, and by institutional realities such as class size, required grading criteria and instructor training (Kain, 2002:104). Kain (2002:14) states that theoretical implications and some teachers, particularly those new to the role, can find it quite a challenge to align classroom issues, theories of composition and active teaching strategies. Kridel (2010:248) argues that although teachers embrace the learner-centred approach, the teacher-centred curriculum is responsible for a more teacher-centred approach to be observed in classroom practice. He further adds the general classroom culture creates an environment where the teacher is the singular authority, learners are passive and the non-negotiable curricular content is apparent in curriculum and pedagogy. Developing countries have the problems of large classrooms as well as the constraints discussed.

The factors described and argued above provide the elaboration for the problem statement. This dissertation will therefore focus on the possible solutions to the problems that hinder active learning in the large underfunded classroom environment. Through observations and daily experiences, the researcher should become aware of certain trends within schools and may lead to workable solutions.

1.4. RESEARCH QUESTIONS

The following questions are therefore being asked:

Research Question 1:

Does the Kerala Physics curriculum follow the constructivist approach to curriculum design that promotes successful implementation of active learning?

Research Question 2:

What strategies do the Keralan Physics teachers implement to achieve active learning in large underfunded classrooms?

Research Question 3:

How do the strategies used by the Physics teachers in Kerala model the theoretical framework?

1.5. THE AIMS AND THE OBJECTIVES OF THE RESEARCH

The aim of the study is to examine active learning strategies used by teachers in large unfunded Physics classrooms, in Kerala, India.

To achieve the aim of the study and find answers to the research questions in 1.4 the following objectives were formulated.

- a. To analyse the curriculum documents in order to find out whether the Kerala Physics curriculum supports the constructivist approach to curriculum design; therefore supporting active learning.
- b. To investigate teaching and learning in large underfunded classrooms in Kerala to observe techniques used by teachers to overcome the obstacles that impede teachers from achieving successful active learning in large underfunded classrooms.
- c. To find out the opinions of the Physics teachers and their concerns about the teaching in large underfunded classrooms and to discuss workable solutions.
- d. To compare the active learning strategies used by the Physics teachers in Kerala in relation to the modern theoretical framework of teaching and learning.
- e. To analyse and relate the class 12 Physics National Examination results of the research schools to the active learning conducted in the classrooms.

1.6. SIGNIFICANCE OF THE RESEARCH

This investigation into the factors that hinder the implementation of active learning in large underfunded classrooms and to find practical solutions to the problems should be beneficial in the following ways:

- a. The findings should be found to be credible and highly beneficial to schools in developing countries.
- b. The findings could assist Physics teachers with an interest in the implementation of the constructivist approach to learning in large underfunded classrooms.
- c. The findings should have relevance to curriculum development specialists and textbook writers who prepare Physics teaching materials in large underfunded classrooms.

1.7. DELIMITATION OF THE RESEARCH

Primary research was conducted in selected public high schools in the Kannur district of Kerala where learners came from similar socioeconomic backgrounds and attend public high schools with similar resources and infrastructure. Furthermore, the research was limited to secondary school learners and teachers of Physics in the Kannur district. The teachers and learners were in a large underfunded classroom environment that implements active learning which was the focus of the study. These teachers and learners in the Kannur district were interviewed and observed despite the limitations of time and financial constraints. The schools in the Kannur district of Kerala were used in this research because it was a low income region that was poorly developed; a common situation in South Africa. It was possible to travel to the rural schools using a 4 wheel drive vehicle.

1.8. DEFINITION OF TERMS

This research has used certain concepts which need to be defined to clarify their use in this study. The definitions of these terms are theoretical assumptions for the purpose of this study only and may not cover all possible definitions of the concepts.

Active Science Learning: Lantis et al (2000:1) define active learning as a learning paradigm which is holistic, learner-centred and creates an environment to develop critical thinking skills. For the purpose of this study, it implies that science learners' construct scientific knowledge through physical and mental/hands-on and mind activities through active involvement in problem-setting, problem-solving, dialogues and conversations with peers and the educator in rich environments (Shaffer & Kipp 2007 :288).

Large Science Class: For reference of this study, a large science class is the one in which the learners per science educator ratio is very large such that the social and instructional aspects of the classroom environment are affected in such a way that it results in the educator unable to meet individual attention needs of each learner (Donald & Bartel, 2006: 141).

Physics: Holbrow et al(2010:1-2) cite Sir Isaac Newton and Galileo Galilei stating that Physics is characterised by two exceptional ideas. The first being a mathematical description of natural phenomena where simple relationships from complicated behaviour of observed mass can be predicted. Secondly, these predictions can be confirmed by observations and measurements. For the purpose of this study, science refers to the subject of Physics that focuses on investigating physical phenomena through scientific inquiry by applying scientific models, theories and laws in order to explain and predict events in our physical environment (South Africa 2003:9).

Learner: For the purpose of this study a science learner is a grade 9, 10, 11 or 12 learner who is doing Physics as the subject of choice at the high school.

Strategies: In this research the term strategies refers to the methods used by teachers to implement a learner centred approach to education in large underfunded classrooms. Weimer (2012) suggests active learning in large classes is defined by group discussions, student presentations and projects, "learning cycle instruction model" (engagement draws challenging questions, real life application, explanation ,

elaboration of key points etc.), peer led team learning, inquiry-based approaches and problem solving.

Implementation: Laudon and Laudon (2010:13) state that implementation is an approach to problem solving. Studies conducted by Lockheed and Levin (1991: 15-16) conclude that the implementation of active learning causes the shift from a more traditional passive approach in which all knowledge is imparted from teachers and textbooks to an active approach in which the student is responsible for learning. This is informed by the strategies of active learning.

Underfunded Physics classrooms: Vivian et al (2009:9) characterise underfunded classrooms as overcrowded classrooms with out-dated resources and limited resources. With reference to the Physics classroom it implies that there is little or no scientific equipment to perform demonstrations or practicals, no technology to analyse scientific videos or simulations' and overcrowded classrooms.

Constructive alignment: For the purpose of this research constructive alignment is a curriculum that supports active learning (Biggs, 2006:347). Biggs (2006) defines 'constructive alignment' as a constructivism framework that guides decision making at all stages in the instructional design by objectives that represent high cognitive levels.

1.9. CHAPTER SUMMARY

The research focused on the basic problems that accounted for the teachers' difficulties in applying active learning in their day-to-day activities in their Physics class that was large and underequipped. The main purpose of the research was to identify the explicit learning obstacles that impeded the implementation of active learning by Physics teachers and the appropriate strategies that can be employed to overcome these obstacles.

The findings will be significant by highlighting where improvements can be made in the implementation of active learning in developing countries. The participants comprised of learners and teachers in five secondary schools in the Kannur region of Kerala.

Chapter 1 Introduction - This chapter will stir the reader's interest on the topic by providing a brief background of active learning in large underfunded classrooms and its relevance in developing countries. The scope and direction of the research will be discussed. The interpretation of the research question will give the reader a clear idea on how the research will be approached.

Chapter 2 Literature - This chapter will provide a critical and in depth evaluation of scholarly articles, research and books written about active learning in large underfunded classrooms. This will be summarised by citing relevant work by authors and will provide a rundown of what the situation is of active learning in developing countries. The reader should get a clear idea of why research in this field is important.

Chapter 3 Research Methodology - In this chapter the qualitative case study is described. The possible data sources will be interviews with participants, observations of lessons and the analysis of the Physics curriculum. The multi-method approach will provide the triangulation of data. This will lead to the justification of completeness of findings and to confirm validity of data.

Chapter 4 Results and Discussion - The data which is collected by the multi-method methodology will be analysed and qualitatively discussed in this chapter. The reporting will confront the research problem, investigate teaching strategies on active learning in large and underfunded Physics classrooms, and will build towards a conclusion. There will also be reference made to existing knowledge on the research problem. The focus in chapter 3, the research methodology, should convince the reader of the validity, reliability and explanation of the results.

Chapter 5 Recommendations and conclusions - A summary of the research findings will be completed in order to justify any valuable information that has been uncovered. An inductive method of reasoning will be used to conclude the research. If questions have arisen by the research, they will be used as a basis for further research. Evaluation of critical errors will be discussed and recommendations on how to avoid this in further studies will be highlighted.

CHAPTER 2- LITERATURE REVIEW

2.1. THEORIES AND MODELS OF ACTIVE LEARNING IN THE CLASSROOM

2.1.1. INTRODUCTION

This chapter consists of a literature review that critically discusses various accepted theories that promote thinking and learning in an active learning environment. It will focus on currently accepted theories that model active and holistic learning in a differentiated classroom. The literature review is aimed at informing the reader of accepted work conducted by educational theorists that are regarded as essential practice in education globally. The rationale for these theories will be analysed and discussed.

To assist in answering the research questions, the entire literature review centres around the theories of active learning, however, it may not go into details of its practicality of implementation in large underfunded Physics classrooms. This will be covered in the second part of the literature review which covers the analysis of work carried out by other researchers.

There are many theories and models of learning with subtle differences thus making it impossible to be fully comprehensive in coverage. For the purpose of this study, much attention has been paid to multiple intelligences, cognitive learning theories, constructive alignment, constructivism, active learning theories and models and the subsequent learning styles.

2.1.2. TEACHER-CENTRED EDUCATION VERSUS LEARNER-CENTRED EDUCATION

The fundamental difference between teacher-centred education and learner-centred education is that in the teacher-centred approach the teacher passes on what they know and the learner-centred approach the teacher helps the learner to learn (Roberts, 2007:3, Sylvia & Barr, 2011:25, Zellner,2011:11). From this we can conclude that from the teacher-centred approach the teacher is the master of their

subject. They feed information into learners, who are passive, directly whilst in the learner-centred approach the learner, who is active, is guided by a person that is competent about their subject area in order to achieve knowledge (Roberts, 2007:3). The teacher-centred approach assumes gaps in the learner's knowledge whilst in the learner-centred approach the learner realises the gaps in their knowledge for themselves (Wilson and McLellan, 1997:95).

So, what is limited with the teacher-centred approach and what is beneficial about the learner-centred approach? Research conducted by Becker et al (1961), Simpson (1972) and Madison (1978) concluded that learners experiencing the teacher-centred approach felt overloaded with content, lost motivation in their subject, did not see relevance in their study, could not link the theory learnt to the real life application and adopted a surface approach to learning instead of understanding what has been learnt (as cited by Wilson and McLellan, 1997:96). Studies done by De Volder and De Grave (1989) and Coles (1990) found that the learners experiencing the learner-centred approach developed more appropriate ways of studying, found relevance in what they learnt, were more able to remember and apply what they have learnt, enjoyed learning, and built up more interconnections between the things that they learnt (as cited by Wilson and McLellan 1997:96).

Learner-centred education is perceived as more suitable than traditional forms of education when it comes to the development and acquisition of generic competences, personal attributes, job performance and career prospects (Attard, 2010:37). The following is a response made by Malcom (2000:56-62) on the learner-centred science curriculum of South Africa: "Consistent with learner-centred education we will choose a science that learners have tended to remember because they found it useful or interesting, or science that fits interests and the ways that the interests change over time, or the ways their thinking ability grow as they mature". This implies that the learner-centred approach to science learning is the more effective pedagogy.

Positive examples of the shift from teacher-centred education to learner-centred education may however, be counterbalanced by a resistance to a paradigm shift to

learner-centred education, by a large number of learners in countries where the pace of change in teaching and learning has been rather slow across the past few decades, and rapid change is often difficult to implement (Attard, 2010:37). Learner-centred approaches have been strongly criticised for breaking down structure within the lesson and Kirschner *et al.* (2006) argue that the use of the learner centred approaches that use problem-solving in information-rich settings divert our limited working memory resources from learning (as cited by Barrett et al, 2007:12).

2.1.3. CONSTRUCTIVISM AS A PARADIGM FOR TEACHING AND LEARNING IN SCIENCE

“ The most conspicuous psychological influence on curriculum thinking in science since 1980 has been the constructivist view of learning” (Fensham (1992) as cited by Phillips, 2000:161).

Atherton (2011) states that constructivism is the label given to a set of theories about learning which fall somewhere between cognitive and humanistic views. He rationalises his statement by noting that constructivism, particularly in its "social" forms, suggests that the learner is much more actively involved in a joint enterprise with the teacher of creating or constructing new meanings. Atherton (2011) states that constructivism exists in two forms which are, cognitive constructivism and social constructivism. He summarises cognitive constructivism as the method by which the individual learner understands things, in terms of developmental stages and learning styles, and cites Vygotsky's (1968) social constructivism which emphasises how meanings and understandings grow out of social encounters. Social constructivism and cognitive constructivism form the basis of the constructivist theory. Educational constructivism stresses the individual creation of knowledge and construction of concepts (Mathews, 1998:3). Moreover, learners are the makers of meaning and knowledge (Gray, 1995). Gray (1995) states that constructivist teaching fosters critical thinking and creates motivated and independent learners.

Dewey (in Smith, 2001) believed that education must engage with and enlarge experience. This suggests that the learner must experience learning and further emphasises the constructivist theory of the individual's creation of knowledge and

construction of concepts. Smith (2001) further cites Dewey's exploration of thinking and reflection when learners are discussing a problem in Physics.

Though the teacher knows the solution to the problem, the teacher should focus on helping the learner restate their questions in useful ways (Jan & Wilson, 2004:121). Jan and Wilson(2004:121) suggest that teachers should take advantage when a learner finds a solution by convincing the group that this might be a fruitful avenue for them to explore. The teacher should encourage each learner to reflect on and examine his or her current knowledge (Berwick, 2004:12). Furthermore, Absolum (2010 :167) recommends that the plenary creates opportunity for formative assessments where the learners and teacher discuss what they have learnt, and how their observations and experiments helped (or did not help) them to better understand the concept. Absolum (2010:167) further recommends that the teacher should create activities to gauge whether objectives have been met and obtain feedback from the learners . Thinking and reflection is not only confined to the learner; it is also refers to the teacher. The teacher should reflect on the lesson taught and determine whether the lesson was successful and whether concepts have to be revisited (Gall et al, 2008:384-388).

Smith (2001) further discusses Dewey's concern with interaction and environments for learning and provides a continuing framework for practice which stresses the importance of creating a stimulating learning environment. A constructivist classroom according to Gray (1997) is a classroom where learners are actively involved, where the environment is democratic, the activities are interactive and student-centred and the teacher facilitates a process of learning in which learners are encouraged to be responsible and autonomous. The constructivist classroom environment according to Gray (1997) should have a decorated hallway that has learners displays and subject related posters and information. Photographs of learners engaging in fun activities should be displayed as well to reinforce a feeling of ease, showing that they are entering a caring and supportive environment that appreciates their successes. In the classroom itself, Gray (1997) stresses that an abundance of student work should be displayed throughout the room and in some cases the ceiling. This creates some sort of ownership by the learners and makes them responsible for the classroom

environment. Gray justifies this in the lines of the constructivism theory where the learners construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. The displays and models shown in the classroom environment are the reflection of the experiences learnt.

Moreover, the constructivist classroom environment emphasises the notion that the learners are active creators of their own knowledge (Carlton, 2004). In the Physics classroom environment, the classroom should create an impression that the learners are entering a world of science (Jorgensen, 1998:104-120). This implies that the lesson is going to lead to scientific enquiry and bring the microscopic and macroscopic world of science alive. The learners should have a sense of becoming a scientist when they enter the classroom (Tytler, 2010:49) and not have the same sort of emotion as they will have when they enter a language class or a humanities class. The anticipation and excitement should lead to the motivation of the learners.

Piaget viewed the growing child as a solitary explorer discovering the world in a relatively independent manner (in Watts et al,2009:325). He referred to the developing child as a 'little scientist' making and testing hypothesis in order to construct an understanding of the world (in Watts et al,2009:325). Constructivist views of learning in science suggest that learners can only make sense of new situations in terms of their existing understanding (Keogh & Naylor, 1996)

Not everyone agrees that constructivism is a realistic paradigm for teaching and learning. Mathews (2000: 161-192) states that constructivism posed by teaching the content of science is not practical. He feels that it is difficult if knowledge cannot be imparted, and if knowledge must be a matter of personal construction, then how can children approach the knowledge of complex conceptual schemes that have taken the best mind's hundreds of years to build up. Mathews (2000: 161-192) further elaborates that cellular, molecular and atomic realms are out of reach of school laboratories, as is most of the astronomical realm so it is difficult for the learners to construct knowledge from such abstract concepts. Their particular experience of a situation falls short of the experience that scientific investigation requires. Critics say that the constructivist approach to learning dismisses the active role of the teacher or the value of expert knowledge and it devalues grades (EBC, 2004:1).

A major issue in the constructivist theory is that it is a theory of learning and not a theory of teaching, which implies that the elements of effective constructivist teaching is not known (Richardson 2003:1629). Richardson (2003:1635) states that more research is required in the field of constructivist teaching. Research conducted by Brooks and Brooks (1999:18-24) mentions that history constrains the teachers capacity to embrace the central role of the learner in his or her own education. They critique the notion that all learners can and will learn the same material at the same time as restrictive for some learners in their construction of knowledge.

Contrary to the critic's viewpoints, the theory of constructivism in teaching and learning holds its place as a highly effective didactic (Gray,1995). The five central tenets of constructivism as concluded by Brooks & Brooks(1999: 18-24) are:

- Constructivist teachers seek and value learners' points of view. Knowing what learners' think about concepts helps teachers formulate classroom lessons and differentiate instruction on the basis of learners' needs and interests.
- Constructivist teachers structure lessons to challenge learners notions and views of concepts. The implication of this is that all learners no matter what age or background come into class with some sort of experience and knowledge that is essential to the teaching and learning process. When educators permit learners' to construct knowledge that challenges their current notions and views of concepts, learning occurs. Only through asking learners' what they think they know and why they think they know it are we and they able to confront their suppositions.
- Constructivist teachers recognise that learners' must attach relevance to the curriculum. As learners' see relevance in their daily activities, their interest in learning grows.
- Constructivist teachers structure lessons around big ideas, not small bits of information. Exposing learners' to whole concepts first helps them determine the relevant parts as they refine their understandings of the wholes.
- Constructivist teachers assess learners' learning in the context of daily classroom investigations, not as separate events. Learners' demonstrate their knowledge every day in a variety of ways. Defining understanding as only that

which is capable of being measured by paper-and-pencil assessments administered under strict security, perpetuates false and counterproductive myths about academia, intelligence, creativity, accountability and knowledge.

2.1.4. ZONE OF PROXIMAL DEVELOPMENT

“ Actions that the person takes in the future will be informed and shaped by all that that person has experienced and learned in the past.... The world we create today has been informed and shaped by the worlds created previously by our ancestors.” (Davidson at al, 2010:7)

Kail and Cavanaugh (2010:144-145) use the example of a father and his four year old son who are solving a puzzle together to explain the concept of the Zone of Proximal Development (ZPD). The father implements methods of encouragement and sometimes shows the child how to put the pieces together but does not do it himself. ZPD is the difference between what the child can do with assistance and what the child can do alone. Vygotsky developed the ZPD which occurs when learners can complete tasks on their own and the ZPD requires adults or more able peers to provide assistance to learners (Blake and Pope, 2008:59).

In order for teachers to guide learners through the tasks associated with learning a concept, they must understand how cognitive tasks fit into the child's cultural activities (Zeuli,1986:3). These tasks are called scaffolds, which are tasks or levels on which the teacher builds to develop learners' zones of proximal development (Zeuli,1986:3). According to Zeuli(1986:7), instruction should emphasise connections to what the learner already knows in other familiar, everyday contexts. Piaget viewed the emergent of logical thought as mainly a universal process that is in relation to the maturity of the child, which differs from Vygotsky's view of the nature of reasoning and problem solving as being culturally created (in Newman & Newman, 2012:40). So according to Vygotsky the people that are in daily contact with the child have a huge influence in the structure of the child's thinking. Vygotsky argues that a child could not acquire all that is known in cultural knowledge based on just exploration and experimentation without the help of more able adults or peers (in Newman & Newman, 2012:40-41). The implication of the Vygotsky's work is that the child can

promote their own cognitive development in seeking interactions with others (in Newman & Newman, 2012:40-41). This allows the child to become responsible and accountable for their own learning which is the philosophy of learner based active learning.

“What a child can do in collaboration today the child can do independently tomorrow” (Vygotsky as cited in Rieber & Carton,1998:220).

Vygotsky (cited in Rieber& Carton, 1998:220) concludes that difficult scientific concepts become clearer when the learner learns in collaboration with adults or more able peers. Vygotsky further states that scientific concepts restructure and raise spontaneous concepts to a high level forming the learners ZPD.

Klentschy & Thompson (2008:2) believe the goal of every classroom teacher should be for learners to make meaning and develop deep conceptual and procedural scientific understanding from classroom science experiences. However, the complexities of science make it difficult to achieve success in the ZPD because the learner may not be able to learn certain concepts even with help of the teacher (Berk 2006:260). Klentschy & Thompson, (2008:2) state that the breakdown in curriculum alignment (discussed in 2.1.5) and student learning may be a function of poor lesson design and planning or from teachers’ “leap of faith” that the science curriculum materials that they use are aligned.

However, if you have knowledge of what learners already know and can do, you are more likely to engage them in science activities and learning goals that are appropriate for the learner’s ZPD (Goldston & Downey,2012:60-61). Goldston and Downey (2012 :60) state that having awareness of the learners ZPD and creating lessons with the ZPD in mind can guide learners to greater cognitive development. Research conducted by Vygotsky (as cited by Goldston & Downey,2012:60-61) concludes that learners abilities fall into three categories:

- skills that the learner cannot perform,
- skills that the learner might be able to perform with assistance
- skills that the learner can perform.

In a nutshell, research on how learners learn science indicates that the development of deep conceptual understanding in science requires time and can be enhanced through providing support, scaffolding and prompting that guide learners to enhance their scientific reasoning abilities (National Research Council as cited by Klentschy & Thompson, 2008:3). This highlights the practical application of the ZPD in order to achieve conceptual understanding in science. In order to achieve this, Klentschy & Thompson (2008:3) suggest a scaffolded guided inquiry approach for lesson planning in order to provide classroom teachers with a lesson design that guides inquiry. Thus the aim of teachers in applying the learner-centred approach should be two-fold: firstly, using scaffolds that are designed to place the focus of instruction on the actual intended curriculum through the implemented curriculum and secondly, by attaining the development of the learners understanding of the science content described within the standard.

2.1.5. CONSTRUCTIVE ALIGNMENT

A good teaching system aligns teaching method and assessment to the learning activities stated in the objectives, so that all aspects of this system are in accordance with the supporting of appropriate student learning (Biggs, 2003:11).

Theories of teaching and learning focusing on student activity are based on phenomenography and constructivism (Biggs & Tang, 2011:60). Constructivism was discussed in chapter 2.1.3. Phenomenography is the empirical study of the limited number of qualitatively different ways in which various phenomena in, and aspects of the world around us, are experienced, conceptualised, understood and perceived (Prichard & Trowler, 2003: 180). Both are premised on the view that meaning is not imposed or transmitted by direct instruction but it is created by the learners' learning activities and their approaches to learning (Nicholas, 2004: 60).

A course is said to be constructively aligned when (Brabrand, 2007:5):

- the learning objectives are stated clearly,
- the learning objectives are explicitly communicated to the learners,
- the exam's assessment(s) match the learning objectives,
- the teaching form(s) match the learning objectives.

Basically what the teacher wants the learners to know must be supported by how the learners learn and is tested by assessments that reflect on what learners have learnt (Brabrand, 2007:5). An unaligned course for example is when the teacher's intention is to teach the learner to learn how to analyse and compare but sets an examination that measures something else (Brabrand, 2007:5). However, if the teacher has carefully aligned the exam with the learning objectives such that it assesses precisely the ability to analyse and to compare, this ensures that the teacher's intention, the learners activity and the exams assessment are aligned (Brabrand, 2007:5).

“Learners learn what they think they will be tested on... In a poorly aligned system, where the test does not reflect the objectives, this will result in inappropriate surface learning. If those assessment requirements mirror the curriculum, there is no problem.” (Biggs 2003: 140)

“Good teaching is getting most learners to use the higher cognitive level processes that the more academic learners use spontaneously” (Biggs as cited by Brabrand, 2007:4). The overall process of curriculum alignment is built on the framework of curriculum design in which the intending learning outcomes, teaching methods and assessments are interdependent and only by integrating these elements of the curriculum can you achieve optimum learning outcomes (Weyers,2006 :36-39). Moreover, teachers need to reflect on curricula design and be prepared to change and adapt to meet the changing needs of the learners (Weyers,2006:36-39). Related to the constructivist philosophy is the idea that understanding cannot be transmitted from teacher to learner but must be actively constructed by the learner (Weyers,2006 :36).

Weyers (2006:36) states that in order for learners to achieve higher levels of learning outcomes, the teacher needs to mix levels of learning expected from the learner and have some low-level outcomes that deals with basic facts and high-level outcomes that require application and understanding of knowledge. He provides an example of the A-level (grade 12 equivalent) Physics course which requires learners to state fundamental laws but also suggests that the teacher can provide an opportunity to understand and apply the law. Weyers (2006:36) further suggests formative

assessments such as group work, class presentations and homework assignments in order to demonstrate and extrapolate solutions using the core knowledge of the subject. The principle of constructive alignment is practically implemented by the use of a portfolio to assess the extent to which learner felt they had met the unit objectives (Biggs, 2006:360). Furthermore, this forces the learners to reflect on what they wanted from the unit, and how they thought they were going to get it, which in turn puts pressure on the teacher to provide appropriate teaching/learning activities to help them do so (Biggs,2006:360). In this way, all components in the system became aligned to the objectives. In conclusion, work done by Giles (2011:11) found that a curriculum designer must consider:

- What the learner knows about the important construct of the course;
- Develop the purpose of the course;
- Develop teaching strategies that are aligned with goals and objectives;
- Anticipate what learners should know at the end of the course (outcomes) and develop assessment processes that are aligned to teaching strategies.

Moreover, the teacher must focus on what and how the learners learn, convey the learning outcomes that are intended in terms of the subject and learning activity and specify what the learners learn and how they must demonstrate the knowledge.

2.1.6. BLOOM'S TAXONOMY

In the late 1940's and early 1950's, education professor Benjamin Bloom (1913-1999) and a group of colleagues worked to develop a system to identify and organise the process of thinking and learning for the purpose of sharing it with teachers, who could then use the system to help them plan lessons and teach in a more effective way (McDonald & Hershman,2010:172). Acknowledging that thinking and learning behaviours are classified from simplest to most complex, Bloom's Taxonomy provides the tools for critical thinking (Weil & Kincheloe, 2004:77)

Bloom's taxonomy of learning is classified into the following three categories (Mohidin, 2011):

- the affective domain
- the cognitive domain

- the psychomotor domain

The affective domain refers to the learners growth in emotional areas, the cognitive domain refers to the learners mental skills and the psychomotor domain refers to the learners physical skills (Mohidin, 2011).

The affective domain emphasises a feeling, tone, an emotion or a degree of acceptance or rejection (Smith,2007:155). It focuses on developing the learners value and belief in the enquiry process which lends itself to higher-level thinking (Canatu & Warren,2003:71-72, Biddle et al, 1997:780). The affective domain hierarchy moves from receiving to responding and to the top of the hierarchy which is characterising (Mohidin, 2011). Work done by many researchers concluded that elements of the affective domain included in science attitudes are preferences, values, interests, opinions and commitment. In addition to these attitudes to science, some theorists include scientific attitudes such as curiosity, weighing evidence, scepticism, objectivity and suspension of judgements (Yager,1999 :71). The main reason why science teachers should be concerned with science attitudes is that research suggests that there is a strong correlation between the learners achievement and learners feeling to science (Yager,1999 :72).

The cognitive domain was developed by Bloom as an initiative to steer the teaching focus that relied heavily on the recollection of facts towards the development of the learners higher level skills(Price & Nelson,2011:22). The six categories in the taxonomy of the cognitive domain are organised from basic recall of knowledge to more advanced thinking skills such as synthesis and evaluation (Price & Nelson,2011:22). The two applications of Bloom's taxonomy in the classroom is to plan questions that promote various kinds of thinking and to help write the objectives (Price & Nelson,2011:22).

Lakshmi et al (2004 :180-181) break down the cognitive domain in terms of science teaching application. They state that the application of knowledge is to know common terms, definitions, specific facts, methods and procedures, principles theory and structure in science, whereas the comprehension part of the domain requires understanding of facts, interprets charts and graphs, translates verbal material into mathematical formula and justifies procedures and methods. They further state that

application relates to scientific concepts and principles in new situations , laws and theories in practical situations, mathematical problems, constructs charts and graphs and the demonstration of correct usage of a method or procedure. In higher cognitive function of analysis in science, the learner is meant to recognise unstated assumptions, recognises logical fallacies in reasoning, distinguish between facts and inferences, evaluates the relevance of data and writes scientific reports. Synthesis requires the learner to put ideas together to form something new like proposing a plan for an experiment or integrating learning from different areas into a plan to solve a problem. Finally, Lakshmi et al (2004 :180-18) state examples of evaluation where the learner is required to judge the logical consistency of written material, provide a conclusion that is supported by data and judge the value of work by use of internal and external criteria.

However, science assessments are based on exercises and tasks that rely heavily on memorisation and recall, Bloom's basic thinking skills, quite unlike the knowledge and skills that the learner may wish to use later on in life (Abell & Lederman, 2007 : 248). There is relatively little emphasis within the science curriculum on discussion and analysis, Bloom's (1956) higher order thinking skills, of the scientific issues that permeate contemporary life (Abell & Lederman, 2007: 248-249). Vosniadou (2008 :206) argues that lots of concepts in science are more complex than acknowledged and the concepts have no simple core which implies that Bloom's lower order thinking in science can be quite more challenging than previously acknowledged. DiSessa and Sherin (as cited in Vosniadou ,2008 :206) suggest that focus on level descriptives at a sub-conceptual level, has greater reality and variance where the learners construct context specific models of each situation presented to them by using sub-conceptual elements.

The psychomotor domain measures skill performance involving the manipulation of object, tools, supplies or equipment (Tomei,2005:9). Appropriate criteria for outcomes in the psychomotor domain involve accuracy within a certain tolerance limit, speed, degree of excellence or reference to other material outlining the criteria for judgment (Tomei,2005:9). The two prominent competencies in the psychomotor domain are learning approaches and reasoning skills (Fraser et al, 2012:53).

Tsai(1998) found that learners with a constructivist epistemology of science tended

to adopt more meaningful strategies. Windschit and Andre (1998) concluded that learners with more epistemological beliefs seem to have better explorative strategies when given implicit instructions, whereas Hogan (1999) found that learners epistemological perspectives interacted with their sociocognitive engagements in collaborative learning tasks. Waters and Waters (2007) found that high achievers displayed beliefs about learning and knowledge that reflected sense making and relationships (cited by Fraser et al, 2012:55).

Bloom's taxonomy is widely used by teachers throughout the world however, critics of Bloom Taxonomy state that firstly, the taxonomy describes each of the six levels in terms of intellectual processing required of the learners rather than describing the situations to be presented to learners. Secondly, it enables the learner to recognise a higher level question once developed whilst not providing the steps which will be followed (Miller et al, 1978:28). Lorin Anderson, a former student of Bloom revised the taxonomy by changing the category from nouns to verbs by differentiating between higher and lower-thinking in order to help develop analytical skills of the learner (Wasowski,2009:29). Unlike Bloom's original taxonomy, Anderson's revision suggests that there are levels of learning resulting in three levels of questioning which are classified as closed, open ended and the universal theme question (Wasowski, 2009:29-30).

2.1.7. MULTIPLE INTELLIGENCES

"As human beings, we all have a repertoire of skills for solving different kinds of problems" (Gardner, 2006:21).

In the mid 1980's Howard Gardner introduced the theory of multiple intelligences in which he believed human cognitive competence is better described in terms of a set of abilities, talent or mental skills in which he called intelligences (Gardner, 2006:6). Traditional view of intelligence suggested that the general faculty of intelligence is an inborn attribute that does not change with age, training or experience, whereas Gardner suggested that intelligence is biological and psychological and there are certain kinds of intelligences (Gardner, 2006:6). He further emphasised the concept of multiple intelligences and stated that these intelligences ranged from scientific abilities to musical (Gardner, 2006:6). Gardner categorised the intelligences as being

musical, mathematical/logic, bodily kinesthetic, interpersonal, intrapersonal, linguistic and visual spatial (as cited by Adam & Hamm, 2008:93).

Linguistic intelligence is the ability to express oneself orally and in writing (McKenzie, 2005: 12) and can be used to teach and reinforce science concepts by reading, writing, listening, speaking by focusing on activities involving poems, articles, writing assignments and dramatic oral presentation around the area of science (Alvis, 1999: 236).

Kinesthetic intelligence is stimulated by active, physical interaction with one's environment and this can be promoted through fine and gross motor activities found in science labs, role plays and active games.

Whereas musical intelligence is the intelligence that is not exclusively auditory but may include all patterns and has direct inference to mathematics and science (McKenzie, 2005:12).

Gardner suggests that logical-mathematical intelligence encompasses mathematical, science and logic and is essential in testing hypothesis, estimating, interpreting statistics, visually representing data etc. (as cited by Campbell et al, 2004:33)

Visual-spatial intelligence is thinking with images and plays a central role in scientific creativity and communication (Mathewson, 1999: 35). Visual-spatial thinking includes vision whereby the learner uses their eyes to locate, identify, think about the objects and ourselves in the world as well as the formation, inspection, transformation and maintenance of images in the mind's eye in the absence of visual stimulus (Mathewson, 1999: 35).

Interpersonal skills are concerned with the capacity to understand the intentions, motivations and desire to interact with other people (Wilkinson, 2002). Cooperative grouping and collaboration is an extremely useful tool to promote interpersonal thinking and this skill can be utilised in group experiments and other collaborative tasks in science (Wilkinson, 2002).

Intrapersonal skills are how we understand ourselves and our motions, desires, being conscious of who we are, what we want to do and how to react (Durairajan &

Dayal, 2009). According to Durairajan & Dayal (2009) intrapersonal skills in science can be enforced by:

- Allowing the learners to connect science concepts to real life situation;
- Assessing how various principles in science impact on everyday life;
- Having the learners put themselves in the shoes of great scientists by relating to how they felt at that time.

Gardner's multiple intelligence theory concludes that humans have a full range of intelligences, no two individuals are alike and having a strong intelligence does not necessarily mean humans act in an intelligent way (Gardner, 2006:21). However, critics of Gardner's proposal stated that there are more intelligences than Gardner suggested with naturistic and spiritual just being some of them (Gardner, 2006:18). Armstrong (2009:190) stated that there has not been enough critical literature done on multiple intelligences to challenge the idea of multiple intelligence. Added to this criticism there is lack of empirical support to support multiple intelligence (Byrne, 2009:25), the theory of multiple intelligence is not research based (Armstrong,2009:190) and multiple intelligence theory dumbs down the curriculum to make all learners mistakenly believe that they are all smart (Armstrong,2009: 195-197). However, teachers and administrators that are familiar with the critiques of multiple intelligences stated that the theory worked for them (Armstrong,2009:190).

2.1.8. DIFFERENTIATION

"If the curriculum tells us what to teach...differentiation tells us how"
(Tomlinson, 2000: 4).

The basic idea of differentiation in teaching is the acceptance of the fact that pupils have different learning backgrounds and different levels of achievement which means that the teacher should provide individualised learning for all (Piggott 2002:65, Stinger, 2003:8, Thomlinson & Allan, 2000:4). Heacox (2002:7) states that good differentiation means examining how well teachers provide variety and challenge in learning, identifying who among the learners are best served by current lesson plans and modifying those plans when appropriate. She further acknowledges

that many teachers have been using differentiation without even knowing it. Piggott (2002: 65-69) states that differentiation in lessons can be set according to outcomes, learning styles and by tasks.

Differentiation by tasks involves judgement being made about the learners' intelligence and has been most prevalent in schools (Frost, 2010 :171). The most important idea here is that different pupils do different tasks or activities, with the aim of all pupils progressing from their own starting points (Piggott 2002, 66). The teacher may set the whole class a basic task and by observation and intervention develop the task into others that may suit individuals or groups (Stinger, 2003:8). An individual experiment or small group of experiments given to different pupil groups to investigate according to the difficulty of the experiments and the abilities of the pupils based on differentiation is just one of the many situations where task based differentiation may work in science (Piggott 2002, 66-67).

Differentiation by outcome is possible where the whole class teaching or assignments are undertaken where the results vary from group to group or individual to individual and the teacher's skill is in extending those who manage the task easily, while preventing frustration among those who find it difficult (Stinger, 2003:8). The learning objectives need to be simple and clear and the material must be prepared to meet lesson intentions (Mills & Mills, 2002 :74). Care needs to be taken that different expectations do not convey to pupils different senses of personal worth, however, differentiated outcomes tend to occur anyway but may not match the different levels of pupils' ability (Farrell, 1999 :51). Chapman et al (as cited by Frost, 2010 :171-172) have highlighted the risks associated with teachers using the notation of ability as a major determinant for differentiation and argue instead of differentiation by approach to learning which they have termed non-judgemental differentiation. Some of their suggestions in their six stage model are:

- Establishment of prior knowledge;
- Multisensory inputs, activities with differentiation based on multiple intelligences;
- Techniques to support long term memorisation;

- Opportunities for learners to demonstrate new knowledge and understanding and includes reflection and discussion with peers and teachers.

In order to differentiate by learning styles, the teacher needs to understand the four types of learners. Hamilton (2000) describes the four types of learners as:

- visual learners that use words and phrases that evoke visual images and learn by seeing and visualising;
- auditory learners that prefer to have things explained to them verbally rather than reading information;
- kinaesthetic learners who uses all their sensors to engage learning and prefer the hands on approach to solving problems;
- read- write learners who prefer information to be displayed in writing and enjoy reading and writing.

Entwistle (1991) argues that there are compelling messages that come from literature on learning styles(as cited by Heart,1996 :80). These suggest that teachers should:

- take account of learning styles their learners will inevitably exhibit;
- recognise that their learning styles are likely to be reflected in their teaching;
- acknowledging the dangers of allowing one particular approach to teaching to exclude the voice of others.

To accommodate differentiation by learning styles multifaceted activities must be planned and the learning space must be able to allow sound and movement going on together (Northey & Vatterman, 2005:82). Differentiation by multiple intelligences is another way to accommodate learners learning styles and preferences (Conklin & Sorrell, 2010, :27).

However, critical comments on differentiation by teachers include the difficulty of implementation for large classes, time constraints in teaching an exam driven curriculum and incorrect application of differentiation (Tomlinson, 2000: 5). Theories of multiple intelligences, as opposed to general intelligence, and research has indicated that some of the main determinants of pupils examination achievements are class, sex, and ethnicity (Frost, 2010:171).This has challenged the validity of differentiating. Where pupils are used to whole-class activities, change must be

gradual in order not to 'create resentment, jealousy, distraction or obvious streaming within the classroom' (Wellington, 2000: 135).

2.2. PREVIOUS RESEARCH STUDIES

As the global economy brings the consumer markets of the western, industrialised countries to the doorsteps of the labour market in the developing countries, a good education becomes vital to individuals in those labour pools seeking employment and economic advancement (Kaul & Moschovitis, 1999:204). However, schooling in developing countries takes place under conditions that are very different from those in developed countries. At primary level, learners in developed countries are likely to go to schools in modern well-equipped buildings and have a curriculum that is well thought out in scope and sequence with approximately twenty in a class (Kaul & Moschovitis, 1999:204). However, in most developing countries learners are more likely to go to shelter-less schools or have an overcrowded class in a poorly constructed and underequipped building with an inadequate curriculum (Lockheed & Leven, 1991 :20). Good educational attainment may offer the only escape from the long-term cycle of poverty and under-development (Kaul & Moschovitis, 1999:204). This research will attempt to provide positive solutions to the problems faced in providing a good quality education in large classrooms in developing countries, focussing the scope to science education, thus inspiring more research in this area. The following literature review will provide a critically analysed review on previous work conducted by other authors who have also made studies in this area.

2.2.1. THE SITUATION OF TEACHING AND LEARNING SCIENCE IN DEVELOPING COUNTRIES

Many governments of the industrialised countries, international NGOs and agencies of the United Nations have expressed concerns for the deplorable situations in the developing countries, which are mostly preventable; however, the governments of these developing countries are incapable of solving or alleviating the problems (Brown-Acquaye, 2004:11). Developing countries have the notion that only scientific knowledge and exogenous technologies can provide the solution for their problems (Lockheed & Levin, 1991:130, AFREEN, 2011: 3, Riley II, 54:2001).

The citizens, the majority of whom are illiterate in science and technology without any access to good potable water, electricity or to good housing have governments that are bent on importing western technologies and lifestyles (Brown-Acquaye, 2004:11). Agriculture, health, nutrition, population control, environmental management and industrial development are a few of the areas where a wider understanding of science and technology will lead to more informed decision making (Brown-Acquaye, 2004:11). Additionally, when countries invest limited financial resources in science education and the impact is less anticipated it may cause a negative back lash in science education (Ware, 1992:1). Furthermore, Ware (1992:1) cautions a plea for realistic expectations in science education within developing countries because:

- there is not yet a consensus on how to structure courses that will provide quality science education to all learners;
- there is a wide spread lack of understanding of the complexities of implementing successful education reform, in both developed and developing countries;
- no country has ever achieved widespread science literacy; whatever the definition.

Research conducted by Ware (1992:56) concluded that many Sub-Saharan countries may have teachers with only an O-Level (Grade 10-11 UK equivalent) science background with or without some teaching courses. Furthermore, research conducted by Caillods and Postlethwaite (1989:169) showed that in Latin America most primary schools teachers have secondary education. Conversely, in Africa and Asia, although the situation is more variable, most teachers were without teacher training (Caillods and Postlethwaite 1989:169). While there may be some ambiguity about the relationship between teachers' academic background and learners' achievement in developed countries, teacher qualifications do appear to be more closely related to learner achievement in the developing world (Mwamwenda & Mwamwenda, 1989:31-42, Ware, 1992:55). Research carried out by Lockheed & Levin (1991:130) verify this idea by concluding that African learners learn very little at primary school and secondary school level despite the rigorous national exams. The impact of poor performance in science subjects in developing countries such as

Tanzania has led to a shortage of experts such as doctors, engineers, architects and mathematicians although there are many social scientists (AFREEN, 2011: 4-5). For many teachers, large class size is one of the biggest, if not the biggest, challenge facing them in their work (Tod, 2006:1).

Many developing countries have a large teacher/pupil ratio (Caillods & Postlethwaite, 1989:170, Dahar & Faize, 2011:99). Apart from the issue of large class sizes, particularly in developing countries, teachers' salaries have declined in real terms causing them to lead a below average lifestyle unless they take a second job (Caillods & Postlethwaite, 1989:170-171). Furthermore, in certain countries teachers go for months without salary owing to a shortage of funds (Abimbola,1994:59-65). Science teachers who fall in this category cannot reasonably be expected to give of their best to their learners (Abimbola,1994:59-65).

Shulman and Tamirs (as cited by Abimbola,1994:59-65) state three rationales for the use of the laboratory in science teaching:

- The subject matter of science is highly complex and abstract,
- Learners need to participate in enquiry to appreciate the spirit and methods of science
- Practical work is intrinsically interesting to learners.

However, teachers increasingly do not have the necessary teaching aids at their disposal (blackboard, textbooks, library, stock of books available, science laboratory equipment in secondary education, etc.) in developing countries (Caillods & Postlethwaite, 1989:172). Thus, according to Balogun (as cited by Owoeye & Yara, 2011:68) an effective science education programme cannot exist . This is because these essential resources enable the learner to develop problem-solving skills and scientific attitudes (Owoeye & Yara, 2011, 68). Furthermore, schools and classrooms are not always adequate in terms of lighting, ventilation, furniture, sanitary facilities, available drinking water etc. (Caillods & Postlethwaite, 1989:172).

Frequently, science courses in developing countries are imported from Western countries and undergo very little modification in the process (Cobern, 2007:318). Maddock (as cited in Aikenhead & Jegede, 1999:269) states that the major influence

on science education identified by learners in developing countries is their feeling that school science is like a foreign culture to them. Other authors like Aikenhead (1997) and Jegede (1995) believe these feelings stem from fundamental differences between the culture of Western science and their own indigenous science (as cited in Aikenhead & Jegede, 1999:269). Apart from the cultural influence on the science outcome of non-western learners, Baker and Taylor (2007:702) indicate the problem to be one of poor 'fit' between the language, beliefs of many non-western learners, and the cultural meanings embedded in the (western) language of science education. Cobern (2007:319) states that the problem lies in the issues of economics and politics. Moreover, in a compelling cross-cultural study that involved 1635 English-speaking Australian learners and 826 Hindi-speaking Indian learners by Lynch *et al.* (as cited by Baker & Taylor, 2007 :697, have shown that non-western learners are at a cultural disadvantage when studying western science curricula. Akatugba and Wallace (2008:16) provide the following example to reiterate the points:

“While adolescents in western countries use proportional reasoning in everyday activities, such as in the use of road maps, cooking recipes, comparison shopping in price per kilogram, fuel economy, and unit prices, adolescents in many developing countries rarely engage in such activities. In Nigeria, for example, shopping is done mainly by bargain and haggle, while successful cooking is done by mental calculations, tasting, and experience.”

Despite the problems in teaching and learning science in developing countries, modern science will influence a non-western culture as surely as it has influenced western culture (Cobern, 2007:301). Science teachers in non-western cultures serve as a major source of scientific information and they command great respect among their learners as people who know the secrets of the universe (Ogunniyi et al, 1995 :818).

2.2.2. THE CHALLENGES OF IMPLEMENTING ACTIVE LEARNING IN DEVELOPING COUNTRIES

Research conducted in developing countries which was similar to that done in the United States found that little evidence suggests that smaller classes are better than large classes (Whalberg,1991: 29, Hanushek.1995:5, Dahar & Faize, 2011:99). In fact, within the research into large classes, at least two factors have been identified as more important than class size: firstly, the quality of teaching (Obanya et al.) and secondly the kinds of activities used (Kumar, 1992) (as cited by Todd, 2006:3).

Large classes are one of the principal reasons which maintain the traditional teacher-centred approach to learning as ineffective and prevents the implementation of any teamwork that is indicative of the active learning approach (Thanh, 2010:26). However, in most non-western schools the teacher-led pedagogy is favoured (Ogunniyi et al, 1995 :819, Wong, 2003:158).

Authors such as Beeby (1979), who observed Indonesian education, state that the system excludes the cultivation of active individual enquiry, questioning and hypothesising to obtain meaning. The development of personal attitudes or individual techniques at variance from the 'correct' knowledge and methods provided by the teacher are also limited (as cited by Dunbar, 2006 :169). The reason for this is the heteronomous nature of social organisation and strong tradition of oral communication which has created a popular perception that learning in a relationship with a teacher is oral and hierarchical rather than the learner-centred approach (Dunbar, 2006 :168).

In general, the overall picture of Asian learners' approaches to learning tends to be categorised by various researchers as (as cited by Thanh, 2010:24):

- learning by 'rote' rather than by understanding (Ballard & Clanchy, 1994; Burns, 1991; Gow & Kember, 1990; Robertson, Line, Jones & Thomas,2000);
- surface learners rather than deep learners (Ballard & Clanchy, 1994; Burns,1991; Gow & Kember, 1990; Robertson, Line, Jones & Thomas, 2000);
- viewing the teacher and/or text as the definitive source of knowledge (Ballard& Clanchy, 1994; Burns, 1991; Gow & Kember, 1990; Robertson, Line, Jones & Thomas, 2000);

- unwittingly guilty of plagiarism (Robertson, Line, Jones & Thomas, 2000; Watson, 1999);
- passive, quiet and non-participative in class (Adam & Many, 1999; Ballard & Clanchy, 1994; Gow & Kember, 1990; Mullins, Quintrell & Hancock, 1995; Ramsay, Barker & Jones, 1999; Yanhong & Kaye, 1998).

However, work done by various authors as discussed in section 2.1.2 suggests that the learner-centred approach is the more effective pedagogy. In contradiction to this, many cases have shown a contrasting fact that a lot of Asian learners are very successful at western institutions (as cited by Thanh, 2010:24). Teacher-centred education have caused Asian learners to understand information only contained within the text, or supplied by the lecturer (Gow & Kember, 1990, Tang, 1991). However, Asian learners may not involve elaborative processes such as critically analysing the new information or relating it to other subject matter as their western counterparts do who were exposed to active learning in school (as cited by Thanh, 2010:24).

Pham-Minh (1995: 59) states that in order to elevate people's knowledge, training human resources, fostering talent, producing workers with cultural and scientific knowledge, professional skills, creativity and discipline at work, teaching and learning approaches must change to the active learning approach. The teacher-centred approach seems unable to provide learners with such skills Pham-Minh (1995: 59).

Case studies from various Ethiopian districts showed (Barrow, 2007:12):

- learners were generally interactive, with teachers giving the class assignments, monitoring group/individual work, and providing frequent and appropriate feedback;
- learners were enthusiastic and involved in the learning activities. Learners read and copied words and statements from the blackboard, and, overall, they “talked and acted” during the classes more than “sat and listened”;

- learners sat in groups doing assignments and interacted with each other, although the task was often to find the right answers from material that the teacher had presented.

However, it was also clear from observations that (Barrow, 2007:12):

- many teachers have not been fully successful in implementing active learning approaches and in some cases teacher-centred pedagogies still dominate, and even in some classrooms where learners were seated in groups;
- they were generally only interacting with the teacher or with what the teacher had written on the chalk board;
- the cognitive level of the questioning and other learning activities appears to have remained relatively low.

Furthermore, research conducted in Namibia revealed that although some teachers made an effort to implement active learning in their classroom very little success was observed in the critically important areas of cooperative learning, use of higher-order thinking skills, elicitation and questioning, reinforcement and feedback, contextualising knowledge, written work, and effective homework where some form of repetition of information was the observation criterion (Van Graan & Leu, 2006 :3).

Despite these challenges experienced by developing countries in the implementation of active learning, many countries are now exploring new ways of designing their educational system, by advocating for a shift from the traditional ways of learning to a new method of learning, which is active learning (Adedoyin & Shangodoyin, 2010: 161). Botswana educational system has put in place a lot of strategies to improve active learning in schools by focusing on improving materials and physical facilities, teacher qualifications and ability to deal with mixed-ability groupings, curriculum development and learning assessment (Adedoyin & Shangodoyin, 2010: 166).

Studies conducted by Jansen (1999), Chisholm (2000), Leyendecker (2002) and Ottevanger indicated that implementation of learner-centred education in the classroom is problematic in many developing countries even though Sub-Saharan countries have attempted to implement the learner-centred education. The

actual instructional processes were largely far removed from the ideal (as cited in The World Bank, 2008:44). Classroom research completed by Geckler (2000), Ottevanger (2001) and O'Sullivan (2004) suggested that learner-centred education does not fit the vast majority of current African classrooms for a variety of reasons (as cited in The World Bank, 2008:47).

Many authors state the challenges facing adoption of learner-centred pedagogy in many African countries as being (Vavrus et al,2011:11-12):

- without high-quality initial training; teachers largely teaching the learner-centred pedagogy;
- student teachers are not assessed in the use of active learning strategies and are not encouraged to think critically or discuss various ways of teaching content for different contexts, therefore not developing their own pedagogical style;
- tutors are not specifically trained as teacher educators since it is assumed that anyone graduating in education would be capable of teaching at a college;
- the Teacher Training Colleges are not held accountable to schools;
- tutors in Teacher Training Colleges may be experts in academic subjects but not in education whilst some tutors may be experts in education but not in academic subjects;
- the assumption of the learner-centred pedagogy may have certain cultural conflicts;
- teacher's practical concerns about learner-centred pedagogies are not given due consideration;
- teachers often do not have adequate linguistic skills in the medium of instruction to express complex ideas and to ask critical questions;
- the examination system is aligned less with active learning and learner centred pedagogy thereby pushing the teaching practice to be more teacher centred.

2.2.3. TEACHING AND LEARNING OF SCIENCE IN DEVELOPING COUNTRIES

“The acquisition of Western knowledge has been and still is invaluable to all, but on its own, it has been incapable of responding adequately in the face of massive and intensifying disparities, exploitation of pharmacological and other genetic resources, and rapid depletion of the earth’s natural resources”(Hoppers, 2002:8). The world has witnessed a huge scientific and technological explosion in recent decades; but not all societies, especially developing countries, have been equally affected by this process therefore one of the major challenges facing human resources planning is dealing with the uneven level of technological development in different countries (Lewin, 1992:V).

“The focus of science education (in developing countries) has remained on the nature of the disciplines, rather than on the nature and circumstances of the learner” (Ingle & Turner, 1981:358). Many learners in developing countries study science through Western style schools and curricula, resulting in what Baker has termed ‘educational alienation’, which is evidenced by poor grades and slow rates of progression through the curriculum (Baker, 1997:2). They do not readily adopt the assumptions of problem solving and inquiry learning that under-pin much Western educational thinking but spend hours memorising de-contextualised lists, formulae and teacher-directed procedures, completing activities which make little sense but which are seen by learners and teachers as essential to the education process (Baker, 1997:8).

Najike,(2004) and Ryan (2008) conducted studies into how science education in Papua New Guinea has developed in response to Eurocentric education agendas “quasi-Australian” and “neo-colonialism” resulting in a science curriculum that is largely irrelevant to the needs of the learners (as cited by Mckinley & Stewart, 2009:52). Drori (1998, p.62), asks: “How does science education contribute to and expand underdevelopment if it provides education that is not applicable to local needs and it channels the labour forces towards a narrower, rather than wider, range of occupational opportunities”. Drori (1998, p.62) continues, stating that such poor

skills are applicable only for the absorption of transferred technology, rather than for local innovation.”

Research conducted in developing countries by many authors such as Akatugba & Wallace (1996), Baker & Taylor (1995), Dart (1972), George & Glasgow (1988) Jegede (1995) Jegede & Okebukola (1990), Knamiller (1984), Pomeroy (1994) and Swift (1992) has identified problems experienced by learners who have an indigenous “traditional” background and attempt to learn a subject matter grounded in Western culture (as cited by Aikenhead, 1997:224). Ryan (2008) (as cited by Mckinley & Stewart, 2009:52) defines science education as a self-awakening to the neo-colonialism inherent in the Western education imposed on developing countries. He further suggests that Western science educators “ought” to become “cultural mediators” and to “reach out beyond the familiarity and comfort of the “Western worldview”.

To acquire the culture of science, pupils must travel from their everyday life-world to the world of science found in their science classroom however, more often than not, and more pervasive within local cultures in less industrialised or non-western regions of the world, the imported science curriculum from the west taught at school is often shown to be more superior to knowledge within the local culture (Jegede & Aikenhead,1999:3)

Taylor & Cobern (1998) (as cited by Jegede & Aikenhead,1999:3) warn that local cultures are in danger of suffering erosion and loss of integrity as a powerful culture-insensitive science education, operating through the agency of local schools, delegitimises and rapidly displaces traditional ways of knowing, being and valuing. In non-Western countries, the science curriculum itself may be experienced as cultural violence by pupils who strongly believe in their community’s indigenous belief system, whether it be anthropomorphic Africa (Jegede, 1995) or Solomon Island magic (Lowe, 1995) (as cited by Jegede & Aikenhead,1999:9). For example, in Botswana the imported science curriculum from the UK had problems in implementation because of second-language learning problems and a failure to appreciate the cultural context of learning (Prophet, 1990:13).

However, Dzama and Osborne (1999) challenged the idea that opposing worldviews were the main problem in science in developing countries by arguing that the problems that plague indigenous people often plague Western societies as well (cited by Quigley, 2009:79). They concluded that poor performance in science in developing countries is not due to the worldviews of learners in these countries but to the absence of a supportive environment for serious science learning and a lack of scientists as role models for the youth. Furthermore, Prophet (1990:13) states that all developing countries face problems in science teaching in terms of accommodation, equipment and the availability and continuity of specialised teachers. Lewin (1992:V) further states that science education in a large number of countries is still in a critical state because of the following reasons:

- lack of science trained personnel at higher- and middle-levels continue to hamper the socio-economic development of many countries;
- well trained and motivated science teachers have remained in short supply in most countries;
- curriculum reforms have not been implemented as planned either because the necessary resources have not been available or because it takes time for schools and teachers to change their habits and teaching methods;
- more recently, science education seems to have particularly suffered from the economic austerity which has led to a decrease in real terms of the resources allocated to education in a number of countries;
- lack of co-ordination between the numerous administrations and institutions concerned with secondary education, further emphasised by insufficient planning.

In Botswana, the curriculum requires the following in terms of classroom practice during science lessons (Prophet, 1990:16) :

- the learning will be pupil-centred with active participation by the children;
- stress will be placed on the development of observational skills;
- there will be an essential component of practical work involving discovery

methods;

- language and communication skills will be developed.

However, teachers did not follow the above practices because they were unhappy about their teaching and the lack of pupil involvement, arguing that they had to get the pupils through the Junior Certificate examination with limited time to actively implement the curriculum expectations (Prophet, 1990:17).

The present secondary school science programme in Sierra Leone was characterised by (Baimba, 1993:218):

- unfavourable student attitudes towards science;
- low numbers of General Science teachers with subject expertise in Physics and Chemistry;
- a lack of sense of direction in determining goals and objectives;
- inadequate pre-service teacher education preparation;
- limited teacher understanding of recent changes in the thinking about the nature of science and the ways of acquiring scientific knowledge.

Baimba (1993:218) suggests that part of the solution in the curriculum is innovation on building conceptual and application bridges between 'school' science and 'everyday' science and progressing the teaching and learning of science. Institutional development in South Africa was an effort move to develop a corpus of academics and scientists who can act as catalysts and agents of change in order to motivate the process of gradual transformation and emergence of scientific ethos, ethics and practice. While developing a strong committed system of protocols for developing and protecting indigenous knowledge systems, biodiversity and the intellectual property rights of the local people (Hopper, 2002:4). The idea of indigenous knowledge is not just about woven baskets, handicrafts for tourists or traditional dances; rather it is about excavating the technologies behind those practices and artefacts, exploring indigenous technological knowledge in agriculture and management techniques (Dah-Lokonon, 1997), indigenous learning and knowledge transmission systems (Doussou, 1997), architecture, forest resource exploitation, atmospheric and climatological knowledge, medicine and pharmacology and

recreating the potentialities they represent in a context of democratic, equitable participation for communities, national and global development in real time (as cited by Hoppers, 2002:9).

2.2.4. THE STATE OF EDUCATION IN INDIA

“In ancient times, India was a powerhouse of scientific and technological developments and along with China and the Mesopotamian civilization was a beacon of hope for the rest of the world” (Mitter, 2012).

India is home to over a billion people and accounts for more than 15% of the worlds population in which over 40% of its population is aged 15 years and younger and around 70% of its population live in more than half a million villages where the majority of India’s children gain access to elementary education (Little, 2010: VII).

Currently, while Indian institutes of management and technology are world-class and its education system turns out millions of graduates each year especially those skilled in IT and engineering , primary and secondary schools particularly in rural areas, face severe challenges (Lall, 2005:1). In recent times, India has produced approximately 5,900 science, technology and engineering PhDs which compares with the top rated first world countries (Cyranoskil et al 2011). The Indian space program is comparable to China’s program and is second to the United States in terms of technology and space exploration (Sabathier and Faith, 2008).

Despite the success of India’s academic and technological advancements, forty per cent of India’s population still continue to live below the poverty line (Aggarwal, 2000:2). The teacher has been identified as the single most important factor influencing the quality of education by the Indian Education Commission and the National Policy on Education. Consequently, the Government of India, like that of many other developing countries, has been trying to meet the challenge of improving the quality of education by improving teacher quality on several fronts: raising pre-service education requirements, improving teacher training, increasing the diversity of the teaching force and promoting stronger participation by local government and

community organisations (Pandey, 2006:319). Most recently the Right to Education bill, passed in 2009, provides a legal obligation for children to be provided with education up to 14 years of age (Rai, 2011: 636).

Several initiatives have been developed in an attempt to counter the problems faced in the education system (Lall, 2005:3):

- Operation Blackboard (1987–8) aimed to improve the human and physical resources available in primary schools.
- Restructuring and Reorganization of Teacher Education (1987) created a resource for the continuous upgrading of teachers' knowledge and competence.
- Minimum Levels of Learning (1991) laid down levels of achievement at various stages and revised textbooks.
- National Programme for Nutritional Support to Primary Education (1995) provide a cooked meal every day for children in Classes 1–5 of all government, government-aided and local body schools. In some cases, grain was distributed on a monthly basis, subject to a minimum attendance.
- District Primary Education Programme (DPEP) (1993) emphasized decentralized planning and management, improved teaching and learning materials, and school effectiveness.
- Movement to Educate All (2000) aimed to achieve universal primary education by 2010 through microplanning and school-mapping exercises, bridging gender and social gaps.
- Fundamental Right (2001) involved the provision of free and compulsory education, declared to be a basic right for children aged between 6 and 14 years.

The Public Report on Basic Education in 1996 found very poor school infrastructure where (Kingdon, 2007:168):

- 26 per cent of schools did not have a blackboard in every classroom;
- 52 per cent had no playground;
- 59 per cent no drinking water;

- 89 per cent no toilet;
- 59 per cent no maps or charts;
- 75 per cent no toys;
- 77 per cent no library;
- 85 per cent no musical instruments.

The ASER 2005 report found that 66 per cent of primary schools had water (up from 41 per cent in 1996) and 42 per cent had functioning toilets (up from only 11 per cent in 1996), however, the overall infrastructure in schools remained very poor (Kingdon, 2007:168).

India has the world's third largest academic system (Altbach et al, 2009:VI), moreover its recent economic growth rates have generated much optimism about its general social and economic development (Kingdon, 2007:168). However, research done by UNESCO (1998:109) found that India only spent 11.7 billion dollars on education in 1995 which is fairly comparable to China of 15.6 billion dollars. The population of India and China are very comparable. This figure is far less than the money spent on education in more developed regions such as North America and Europe (UNESCO, 1998:109). In 1995 India allocated 8 teachers per thousand populations which is the least in the less developed regions in the world and is much lower than more developed regions such as North America and Europe (UNESCO, 1998:109).

Critics of the Indian educational system argue that schools and colleges in India have a huge deficit of competent teachers and the educational institutions have a pedagogy focusing only on covering the syllabus (Ramanathan, 2006:10, Mitter, 2012). Mitter (2012) further states that the educational system, which has a primary focus of passing examinations and practical onsite training/projects, is a travesty where most of the end products churned out by the education system are unemployable. The schooling curriculum shows no relevance to the learners lives. Despite India producing many child prodigies (e.g. math Olympiad, quiz, scientific competitions international games and sport), it seems to be lost when they grow up (Chatterjee, 2008). Chatterjee (2008) states that the current education system in

India selectively discards talented learners with inquisitiveness and dreams to do something challenging to better their society.

2.2.5. THE SUCCESS OF MASS EDUCATION IN THE INDIAN STATE OF KERALA

Despite the views argued by the critics on the Indian education system, mass education has been a success in the Indian state of Kerala which is not the case in the rest of India (Little, 2010: 24).

An initiative called the Total Literacy Campaign armed with volunteers from the National Service Scheme of the Mahatma Gandhi University in 1988 created total literacy in the city of Kottayam, Kerala in 100 days (Ramanathan, 2006 :15-16). Furthermore, in December 1988 Kerala's Peoples Science Movement organised a mass campaign to create 100% literacy in Ernakulam District, Kerala where people involved sang, played in the streets, met publically, created wall posters and had a massive 5-part jatha (procession) converging on Ernakulam City on 26 January 1989 (Franke and Chasin, 2000:12). The thousands of teachers they mobilised and trained used the participatory and reality-based methods of the great Brazilian educator Paulo Freire to teach 135,000 of Ernakulam's 174,000 illiterates to read, do simple arithmetic, and understand basics of health, sanitation, and inoculation resulted in total literacy in February 1990 and expanded state-wide total literacy to Kerala in 1991 (Franke and Chasin, 2000:12).

To further assist in the success in the education system in Kerala (India Planning Commission, 2008:64):

- the Kerala Education act of 1956 provided free and compulsory education for all children within the period of 10 years and was compelled to provide noon meals, clothing, books and other writing material free of cost;
- while in 1961 the higher secondary schools were free throughout the state;
- currently privately aided institutions and the tertiary education fees are kept at extremely moderate levels.

Moreover, the state of Kerala through the Sarva Shiksha Abhiyan initiative has provided home based support to children with special needs by appointing resource teachers that visit their homes to provide short-time help to individual children and their parents (UNESCO, 2008, 62). Additionally, new programmes called Education Guarantee Schemes and Alternative and Innovative Education are being implemented in Kerala whereby Multigame Learning Centres are available for children in forest areas (UNESCO, 2008, 77).

2.2.6. CONCLUSION

In this chapter the factors that promote thinking and learning in an active learning environment were analysed, conceptualised and described. The theories discussed in this part of the chapter will provide the researcher with insight to critically analyse classroom practices from data gathered during interviews and observations. Lots of research and books have been written about these theories; however, the literature review simply covers the relevant information that is pertinent to the research. Moreover, critics may argue the theories discussed but extensive research has concluded the validity of the theories in effective classroom practice.

In most developing countries the more effective learner-centred approach to learning falls second to the less effective teacher-centred approach (Ogunniyi et al, 1995 :819, Wong, 2003:158). Lack of funds (Brown-Acquaye, 2004:11), inadequately trained teachers (Caillods and Postlethwaite 1989:169), overcrowded classrooms (Tod, 2006:1, Caillods & Postlethwaite, 1989:170, Dahar & Faize, 2011:99) and ineffective curriculum (Lockheed & Leven,1991 :20, Cobern, 2007:318) are some of the major reasons for the ineffectiveness of teaching and learning in developing countries. Together with these problems non-western learners' rebel against the western approach to science teaching which causes the problems faced in schools in developing countries to perpetuate (Baker and Taylor ,2007:702, Akatugba and Wallace, 2008:16). In spite of these problems, India has made tremendous economic (Bhate ,2009), technological (Sabathier and Faith, 2008) and academic (Cyranoskil et al, 2011,Lall, 2005:1) advancement that is comparable to first world countries. The Indian state of Kerala has successfully implemented mass education (Little, 2010:

24). The researcher will examine the teaching and learning situation within Kerala and will attempt to find practical solutions to implement active learning approaches into large underfunded classrooms that can be used by other developing nations in the same situation.

Chapter 3- RESEARCH METHODOLOGY

3.1. INTRODUCTION

The theoretical aspect of the study was highlighted in Chapter Two and the research approach, method, design and data collection strategies employed in the actual study will be presented in this chapter. Two approaches are primarily employed by researchers, namely the qualitative and quantitative approaches. This study used a qualitative approach utilising a case study method.

3.2. RESEARCH APPROACH

Grady(1998:11) states that qualitative research is the general term for case studies, ethnography, educational anthropology and action research qualitative methods. The researcher opted for the qualitative method because the aim of the research was to understand and interpret the teaching and learning situation during the implementation of active learning in large underfunded classrooms. Patton (2002: 40-41) summarises the characteristics of a qualitative research design strategies as:

- studying real-world situations as they unfold naturally;
- openness to adapting flexibility in inquiries as understanding deepens and situation changes;
- cases for study are selected because they are information rich and illuminative.

This research approach has distinct advantages. The qualitative research was conducted under natural settings (Grady,1998:10) therefore the researcher has made no attempt to alter the conditions that were being researched. The research did not require tight control of conditions therefore it lends itself well for schools and action research (Grady,1998:10). It was through this research the researcher aimed to recognise “the pragmatic requirements of educational practitioners for organized reflective inquiry into classroom instruction” (Gabel,1995) with respect to achieving active learning in a crowded underfunded classroom environment. The research methodology allowed the researcher to understand the day to day difficulties faced by teachers and learners in this environment and to observe the strategies used by

teachers whom strived for success during the learner centred approach to teaching and learning.

This qualitative approach was a case study and was therefore relevant and helpful in allowing the researcher to observe first-hand how the teachers and learners make sense of their experiences which are not easily achieved with other methods (Woodside, 2010:IX). As a result, as indicated in 1.7, the researcher sought to conduct a case study within the active learning environment of five schools in the Kannur district of the Indian state of Kerala.

3.3. RESEARCH METHOD

Woodside (2010:1) states that a case study is an inquiry that focuses on describing, predicting and/or controlling the individual whilst Yin (1994:13) adds that a case study is an inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between the phenomenon and context are not clearly evident. As stated in 3.2. the inquiry of this research focused on describing and analyzing the teaching and learning process of active learning in the large underfunded classroom within its real life context.

As Tappen (2011:70) states, a case study design focuses on a single unifying event or situation including both descriptive and analysis of the case within a context that is also described. The researcher employed the case study research method to gather systematic and thorough information, and to use it as a vehicle for in-depth description and analysis in this study. Yin (as cited by Bryman & Buchanan,2009 : 467) positions case study design as a research strategy which can answer “how” and “why” questions. Examinations were made using this research method as to the possibilities of “how” practical strategies could be implemented in order to successfully conduct a learner-centred active learning approach to large underfunded classrooms and “why” many teachers in developing countries are unable to achieve this.

Common sources of evidence in doing a case study are (Green et al, 2006x:116)

- documents

- archival records
- interviews
- direct observations
- participant observations
- physical artifacts.

The researcher collected evidence by:

- analysing curriculum documents and external examination results;
- having open-ended conversations with teachers and administrators;
- observing classroom teaching and learning in the Physics classroom.

3.4. SAMPLING PROCEDURE

Sampling follows a rigorous procedure when selecting units of analysis from a larger population (du Plooy, 2002 :100, Tashakkori & Teddlie, 2003:715). Hartas (2010:67) defines the term population as a group of individuals or organizations that share the same characteristic that is of interest to the study. The researcher used the traditional purposive sampling techniques which involved selecting certain units or cases rather than random selection (Tashakkori & Teddlie, 2003:713). During this research the concern of specifying the researchers sampling procedures is a matter of working out which people from the available population have the most theoretical relevance to the study at hand (Hartas,2010:61). In this research the populations are the individuals involved in the teaching and learning process of active learning in large underfunded classrooms.

According to Tashakkori & Teddlie (2009:186) purposive sampling includes the following characteristic:

- addresses specific purposes related to research questions;
- samples are selected using expert judgments of researches and informants.

The researcher selected cases that were information rich in order to answer the critical questions. The school environment where the active learning process took place was the most information rich. The samples were 5 schools from the economically disadvantaged community of Kannur district in Kerala. These schools were chosen because they had large underfunded classrooms and a learner centred approach to learning. As mentioned in 2.2.6. Kerala has successfully implemented mass education. The teachers, learners and administrators within the active learning environment were the targeted population.

3.5. ENSURING RESEARCH ACCURACY

Reliability and validity with regard to the findings of this research are of great importance. According to Green (2000:80) validity is described as something which actually gives a true representation of what is being researched. Establishing validity of research requires determining the extent to which conclusions effectively represent empirical reality and whether constructs devised by researchers represent or measure the human experience that occur (Brink & Walt, 2006:118). To ensure validity, the researcher was personally involved in every stage of the study especially during the data collection stage which involved close interaction with the participants during interviews and observation of lessons.

In qualitative research authenticity and credibility refer to internal validity (Damon & Holloway, 2011:78). The researcher used the following methods, as suggested by Brink & Walt (2006 :118) to achieve credibility of results of the research :

- remained in the field, Kannur schools, for the maximum duration that was permissible;
- implemented the strategy of triangulation of data gathering by observing lessons, interviewing teachers and analysing the curriculum documents and examination results;
- peer debriefing in which the researcher related the research to a peer, who was an educator, that critically questioned the researchers interpretation, intent and meaning of the research question, methodology and conclusion;
- acknowledged evidence that disconfirmed research goals- negative case analysis.

The authenticity as defined by Brink & Walt (2006:119) has been established by the research being context-rich and meaningful.

Hitchcock and Hughes (1989) state that “Doing participant observation or interviewing one’s peer raises ethical problems that are directly related to the nature of research technique employed. The degree of openness or closure of the nature of the research and its aims is one that directly faces the teacher researcher” (as cited by Cohen et al, 2007:69). Research ethics is focused on what is morally proper or improper when engaging with participants (McMillan and Schumacher, 2010).

The researcher ensured that the participants were well-informed about the purpose of the research and informed consent was obtained from the Principals of the five schools (Seidman, 2006:72-73). The informed consent letter to the Principals and the teachers as well as proxy consent letter for the learners (Appendix 1,3,4 and 5 respectively) made it clear as to how extensively the researcher planned to use the information gathered from the participants and furthermore assured confidentiality.

3.6. DATA COLLECTION PROCESS

3.6.1 ACCESS TO THE KANNUR SCHOOLS

As mentioned in 3.4. when conducting research in schools it is the moral obligation of the researcher to obtain formal permission from the education authorities. The researcher did not reside in the country where the research was to be conducted. This posed a major difficulty. The researcher had to seek the help of a travel agent in order to arranged the informed consent from the relevant authorities. The travel agents sought permission from many schools. Lots of school declined , however, five schools accepted. The school Principals’ corresponded with the travel agent via emails and the times and date of the visitations of school were arranged according to the participants and the researcher’s availability. The travel agent also sent a letter to higher authority (Appendix 5) informing the educational authority of the research.

3.6.2. ENTRY IN THE SCHOOLS

Getting to the schools was very difficult. The roads were poorly constructed. A driver was arranged by the travel agent in order to reach the schools, some of which were in very isolated rural areas. Entry into the schools was very easy and the researcher was welcomed by the school staff and the learners. To prepare the schools for the visits, the Principals were emailed in advance by the travel agents and were made fully aware of the researcher's intentions. The teacher travelled to the different schools on days that were agreed upon by the schools principals. After classroom observations and interviews with the teachers, the researcher thanked them for their willingness and openness and requested their permission to call them should there be a need for clarification and/or further questions regarding the conversations. The researcher also arranged for the schools to provide the summary of the class 12 National Examination results for the 2011/2012 academic year.

3.7. DATA COLLECTION PROCESS

The data in this research was collected to address the critical questions mentioned in 1.4. The data collection process involved mainly unstructured interviews, lesson observations and the analysis of documents.

Naturalistic data is derived from situations which exist independently of the researchers interventions and are useful in this research in order to observe how teachers and learners interact in a large underfunded class environment (Forrester, 2010:64-65). Observation of lessons allowed the researcher to achieve this. The observations involved spending time visiting the 5 schools. Field notes were taken throughout the observation process and focused on what was experienced (Thomas et. al, 2011: 359).

The reason for the use of interviews in this study was to allow the researcher to ask numerous open-ended questions, or open-ended probes where the researcher recorded the responses verbatim (Oppenheim, 2000:81). As stipulated by Oppenheim (2000:81) the open-ended questions allowed the respondents to say exactly what they thought with richness and spontaneity. To collect the data the researcher visited each of the five schools and conducted prolong interviews with

each participant. The field work was done in September 2011. The interviews provided me crucial data used to develop the case studies, which are described in Chapter 4.

The document analysis of the curriculum was used to complete triangulation and was a source of clear, unbiased and tangible records of data (Grady, 1998:24). The curriculum document was analysed in order to provide information on the scope, depth, articulation, progression, continuity of the curriculum and to provide evidence that the curriculum supported active learning. This provided the researcher with insight of what was expected in the academic curriculum before the researcher started the classroom observations and interviews. Furthermore, the researcher requested the class 12 Physics results of the National examination written for the academic year of 2011/2012. This was done a year after the completion of the field work. The examination showed a true reflection of the learners performance because the examination was externally set and assessed.

3.8. INSTRUMENTS USED

3.8.1. SEMI-STRUCTURED INTERVIEWS

An interview is a conversation between two people (Gillham,2000:1) where the researcher is interested in understanding the lived experience and the meaning that is made from the viewpoint of the interviewee (Seidman,2006:9). In this research the researcher used semi-structured interviews. The open-ended questions were asked on the assumption that the participant could answer in a few structured sentences. This method of interviewing was used because the researcher could not predict all possible responses but wanted to keep responses focused upon the research study (Tappen, 2011: 235). These interviews took the form of conversations with the teachers in the staffroom or in the classroom depending on availability.

The interviews intended to explore the teacher's views, ideas, beliefs and attitudes about the teaching and learning approaches to active learning in the large underfunded classrooms. The participating teachers in this study were asked to provide detailed information about their views on the constructivist approach to active learning, continuing professional development and the impact the of large

classroom situations to teaching and learning. However, they were not restricted to these questions but were encouraged to continue in the discussion by providing additional information.

The researcher dressed in a professional manner that blended in a schooling environment and portrayed the following personality traits during interaction with the participants (Kumar,2008:94):

- flexibility by assuming an active or passive role effectively when the situation required it;
- intelligence by eliciting information, evaluating terms of objective of the interview and probing the purpose of clarity;
- emotional awareness by considering the participants emotional needs and not to dominate and challenge participants remarks unnecessarily.

The interviews provided information about the teachers' educational backgrounds, their teaching practices and their involvement in the professional development programs and techniques used to implement practical and theoretical lessons.

The semi-structured interviews allowed the researcher to probe more deeply and explore responses that may have significance to the research study that were not in the original questions.

3.8.2. OBSERVATIONS

Observations in qualitative research generally involves spending a prolonged amount of time in the setting (Thomas et al, 2011:359). The process of the researchers lesson observations was a qualitative data collecting and theory generating activity (Babbie,2010 :296).

The researcher tried to minimize obstruction in the classroom by advising the teacher to explain to the learners that the researcher was there just to observe their lesson for study purposes and was not there to judge them. They were further advised to be themselves and not to be under any pressure. The researcher maximised the time spent in a particular class and hoped that the learners would become accustomed to the researchers presence (Thomas et al, 2011 :359). Before the lesson observations could begin the researcher was shown around the school

and introduced to various classes. During the lunch breaks the researcher had casual conversations with the learners informing them where he is from and a little about his background. Conversations about common sports that South Africa and India had in common such as cricket were discussed and this led to the learners being less intimidated by the researchers presence.

The researcher recorded notes to assist in interpreting the observed events and to assist in answering questions in the data analysis step. The researcher recorded in detail all that was observed to help provide clarity during the data analysis stage.

3.8.3. DOCUMENT ANALYSIS

Content analysis as defined by Markoff (as cited by Klenke, 2008:89) as “ any methodology measurement applied to text for social science purposes”. The researcher views data such as texts, images and expressions that are created to be seen, read, interpreted, and acted on for their meanings (Klenke, 2008: 89).

The researcher chose to analyse the Physics curriculum document. Jackson (as cited by Cowell and Richardson,2002 :114) defines curriculum into two categories:

- those narrowly focused concerns which deal with the development and implementation of specific subjects or topics within a school or a set of schools;
- and those more broadly focused concerns which deal with theoretical issues such as construction of general theories and principles of curriculum development.

However, Pinar (1995) proposed a more relevant definition of curriculum, one in which the point of view is made explicit: “ Curriculum understood as a symbolic representation refer to those institutional and discursive practices, structures, images and experiences that can be identified and analyzed in various ways (as cited by Colwell & Richardson,2002 :117).

The researcher analysed the curriculum document :

- to gain insight of the Physics topics and theories that are taught during the active learning process (Klenke, 2008:89);

- have an idea on what outcomes are expected from the curriculum in order to appreciate the teachers practices during the active learning process;
- to critically examine the effectiveness of the curriculum in order to discuss its relevance to active learning approach ;
- To review whether there is coherence based on knowledge and cognitive structures associated with the Physics syllabus and its scope and integration of curricular contents and knowledge from different subjects (Unwin et al, 2012 : 101).

The researcher also analysed the class 12 Physics national examination results for the academic year of 2011/ 2012. The researcher obtained these results from the five principals of the schools visited. The examination results was analysed to show the correlation of the academic attainment and the active learning approach in large underfunded classrooms as observed by the researcher.

3.9. DATA ANALYSIS

The idea of qualitative data analysis implies some sort of transformation where the researcher collects data, then processes it through analytic procedures into understandable, trustworthy, and even original analysis (Gibbs,2007 :1). Data analysis was carried simultaneously during the data collection step (Polit & Beck, 2008: 507). The data analysis was done after every interview and classroom observation. This allowed the researcher to criticize and analyse events while the information was still fresh in his mind. The analysis of the data collected was deemed to be an active process whereby the data was repeatedly scrutinised carefully and deliberately in search of deeper meaning and understanding (Polit & Beck,2008 : 508). This has enabled the researcher to adjust and modify the data collection process as and when required.

3.10. SUMMARY

The focus of this chapter was to explain the qualitative approach of research and the case study as the key research methods selected for this study. Further explanations were given regarding the research design, schedule and the data collection tools for

this research. Issues pertaining to the presentation, analysis and results obtained from the collected data will be presented in the subsequent chapter.

CHAPTER 4 – DISCUSSION OF RESULTS

4.1 INTRODUCTION

To understand the strategies in implementing active learning in large classrooms, the researcher examined the teaching and learning environment in large underfunded classrooms. In the first part of this chapter the results of the document analysis regarding the curriculum will be discussed. Secondly, the analysis of the interviews conducted will be discussed and finally the analysis of the observation will complete the triangulation of data. To increase validity of the analysis of the raw data collected the researcher was assisted by an objective teacher that was not part of the study

4.2 SECTION A - RESULTS FROM DOCUMENT ANALYSIS

The aim of the document analysis was to find out:

- whether the Indian curriculum is coherent and provides opportunities for active learning;
- whether the active learning approach produces successful academic results.

In order to maintain a coherent and successful curriculum Ornstein and Hunkins (2009: 186-190) state that curriculum design should achieve scope, sequence, continuity, articulation and balance. The researcher analysed the scope, depth, progression, balance, articulation, sequence and inclusion of the Central Board of Secondary Education (CBSE) Physics curriculum document. The researcher analysed the class 12 National Examination results in order to determine the success of the active learning approach in the large underfunded Physics classroom of the researched schools.

4.2.1. SCOPE

The scope of the curriculum refers to the content taught and focuses on the activities selected within the content (Lund & Tannehill, 2010:46). The subject statement provides the basis of the scope of the subject. It acts as a guide to show the depth of the covered syllabus. The scope of the curriculum should prepare learners for lifelong learning, employment and to become responsible and

accountable citizens. At primary science level the Indian curriculum is geared towards developing (CBSE-Secondary, 2011: 120):

- the cognitive, affective and psychomotor domains.
- the spirit of enquiry, creativity, objectivity and aesthetic sensibility.

The above abilities may be limited by the teacher-centred approach but may be more effectively achieved by the active learning approach as discussed in 2.1.2. The scope of the Indian primary science curriculum provides opportunity for the teacher to develop lessons which follow the learner-centred approach lesson by engaging the learners through active learning skills such as development of the “psychomotor domain”, “creativity”, enquiry as well as developing the learner cognitively and kinaesthetically. The Indian curriculum therefore promotes holistic learning through active learning because it encourages the “interconnectedness of the individual’s body, mind, emotions and spirit and draws upon life experiences (Leonard, 2002:85).

Moreover, upper primary stage “demands that plentiful opportunities should be provided to the learners to engage them with the processes of science like observing, recording observations, drawing, tabulation, plotting graphs etc.” (CBSE-Secondary, 2011: 120) whereby activity based learning is supported. Mathematical, visual, kinaesthetic and logical intelligences are reinforced during these activities.

The secondary stage expects abstraction and quantitative reasoning to occupy a more central place in the teaching and learning of science (CBSE-Secondary, 2011: 120). The three sciences are still combined with more complex topics such as Newton’s Laws (CBSE-Secondary, 2011: 123) and The Effects of Electric Current (CBSE-Secondary, 2011: 125) which are both studied in grades nine and ten. Special care was taken to avoid temptation of adding too many concepts that can be comfortably learnt in the given time frame and no attempt has been made to be comprehensive (CBSE-Secondary, 2011: 120). This avoids the reliance on the teacher led approach which is effective in covering lots of theory in a short space of time and favors active learning where scientific enquiry and skill based activities dominates the lessons.

The CBSE curriculum requires a minimum of twenty practical activities a year to compliment the theory taught and in conjunction with the scope of the curriculum help support active learning (CBSE-Secondary, 2011: 121-123, CBSE-Secondary, 2011: 124, CBSE-Secondary, 2011: 126-129). This reinforces the relevance of the theoretical aspect of the course whilst supporting active learning and scientific enquiry.

Due care has also been taken that the senior secondary syllabus was comparable to international standards (CBSE-Senior, 2011: 82). The Physics curriculum extends itself from the secondary curriculum. It shows relevance by exposing learners to “different processes used in Physics-related industrial and technological applications” (CBSE-Senior, 2011: 82) and supports skills based learning by promoting the development of “process-skills and experimental, observational, manipulative, decision making and investigatory skills” as well as “problem solving abilities and creative thinking in learners” (CBSE-Senior, 2011: 82). These skills based outcomes create opportunities for active learning in the classroom.

4.2.2. THE PROGRESSION OF THE INDIAN SCIENCE CURRICULUM

Within the National Curriculum of India there is clear progression from one grade to the next. The Senior Secondary curriculum aims to “strengthen the concepts developed at the secondary stage to provide firm foundation for further learning in the subject” (CBSE-Senior, 2011: 82). For example during the secondary stage of the curriculum the learners cover the section on work, energy and power. Work done by a force, energy, power; kinetic and potential energy; law of conservation of energy are studied at this stage (CBSE-Secondary, 2011: 123). At the senior secondary stage the same concepts progress to “work done by a constant force and a variable force; kinetic energy, work-energy theorem, power, notion of potential energy, potential energy of a spring, conservative forces: conservation of mechanical energy (kinetic and potential energies); non-conservative forces: motion in a vertical circle; elastic and inelastic collisions in one and two dimensions” (CBSE-Senior, 2011: 84).

It is evident that the basic concepts of work, energy and power from the secondary curriculum are built in to more complex scientific theory in the senior secondary curriculum. The concepts are extended and problems are described in two-dimensions instead of one dimension. The learners come to the senior secondary stage with prerequisite knowledge that is built upon. This provides some basic understanding for the learners to discover more progressive concepts during the active learning process. The curriculum allows “similar concepts to be taught at different ages but with increasing complexity” which is known as the spiral curriculum (Bentham,2003:44).

Progress in the Indian curriculum is not limited to the theoretical aspect of the course. Close analysis of the practical component of the curriculum shows a clear progression of the complexity of skills designed for scientific enquiry and analysis. For example, during the secondary stage the learners conduct practicals which include (CBSE-Secondary, 2011: 124, CBSE-Secondary, 2011: 129):

- To trace the path of the rays of light through a glass prism;
- To draw the images of an object formed by a convex lens when placed at various positions;
- To observe and compare the pressure exerted by a solid iron cuboid on fine sand/ wheat flour while resting on its three different faces and to calculate the pressure exerted in the three different cases;
- To determine the velocity of a pulse propagated through a stretched string/slinky.

The skills for the above practicals are built upon in the senior secondary phase of the curriculum. For example the senior secondary level practicals include (CBSE-Senior, 2011: 86):

- To find the weight of a given body using parallelogram law of vectors.
- Use a simple pendulum to plot l/t and l/t^2 graphs. Hence find the effective length of second's pendulum using appropriate graph.
- To study the relationship between force of limiting friction and normal reaction and to find the co-efficient of friction between a block and a horizontal surface.
- To find the downward force, along an inclined plane, acting on a roller due to gravitational pull of the earth and study its relationship with the angle of

inclination (O) by plotting graph between force and $\sin \theta$.

It is evident that these practicals involve more complex skills of analysing relationships, graphically representing data and verifying laws such as are required concepts whereas practicals in the secondary phase requires less complex skills to draw and trace ray diagrams and to find quantities such as velocity.

4.2.3. HORIZONTAL ARTICULATION

Horizontal articulation is the merging of all types of knowledge and experiences contained within the curriculum plan (Unger,2007:99). The Indian curriculum achieves horizontal articulation within and across subjects. Horizontal articulation within Physics is achieved by the close relationship between the learning outcomes, assessment standards and the content.

- Take the section of kinematics the elementary concepts of differentiation and integration for describing motion(CBSE-Senior, 2011: 83): The concepts of differentiation and integration are concepts studied in mathematics.
- Horizontal cross articulation assists in the active learning process in Physics by showing that Physics is not a stand-alone subject by requires knowledge of mathematics as well. The dependency of mathematics is very easy to realize when it comes to the teaching and learning process of Physics.
- If one examines the section on scalar and vector quantities, the equality of vectors, multiplication of vectors by a real number and the addition and subtraction of vectors are math and Physics related concepts(CBSE-Senior, 2011: 83).

Horizontal articulation of biology and chemistry is very apparent as well. Behaviour of perfect gas and kinetic theory and thermodynamics are chemistry concepts integrated into the Physics curriculum (CBSE-Senior, 2011: 84) whereas functioning of a lens in human eye, defects of vision and their corrections(CBSE-Secondary, 2011: 128) and the structure of the human ear (CBSE-Secondary, 2011: 123) are biology related concepts. This allows the learner to appreciate that the Physics course is not a standalone course but is connected to other subjects namely mathematics, chemistry and biology.

4.2.4. SEQUENCE

Sequence in a curriculum “refers to the order that topics are presented in a curriculum” and ensures continuous learning (Kerr,2009: 472). Moreover Ornstein and Sinatra (2004:153) state that sequence in a curriculum should be based on the logic of the subject matter or the way learners develop where the key components are:

- simple to complex learning: the content of the lesson or topic begins with a simple component and leads to complex components. The section on the Motion of system of particles and rigid body begins with concepts such as centre of mass and linear momentum and progresses into more abstract concepts such as angular momentum, rigid body momentum and moments of inertia(CBSE-Senior, 2011: 84).
- prerequisite learning to whole part learning: In the unit of work energy and power in the senior secondary curriculum (CBSE-Senior, 2011: 84) prerequisite concepts learnt in the secondary phase on the basic concepts(CBSE-Secondary, 2011: 123) must be understood to complete the whole part learning of this section.
- chronological learning: The content whose sequence reflects the time of real world occurrences. In the section of atoms and nuclei Alpha-particle scattering experiment; Rutherford’s model of atom; Bohr model, energy levels, hydrogen spectrum are taught in their chronological order to show the development of the atomic model(CBSE-Senior, 2011: 91) .

4.2.5. BALANCE

Balance is the weight age to each aspect of the curriculum in terms of “ a proper range of required knowledge, skills, concepts, and learning experiences” (Lunenburg & Ornstein, 2012:386). This is important for teachers and learners in order to see the level of importance and time allocation for each section. CBSE-Senior (2011:83-91) shows the time allocation for each topic.

The underlying principle of an inclusive curriculum is that all learners can succeed under the right conditions (Riseman et al, 2010: 217) . This is achieved when different groups of learners are all able to see how the curriculum relates to their own experiences and aspirations. As mentioned in 2.13. active learning suggests that the

learning experience is a personal affair. It is evident from the curriculum document analysis that the Indian curriculum provides plenty of opportunity for active learning and therefore by and large supports active learning. As mentioned previously during the analysis with regards to sequence of the curriculum the syllabus builds progressively from pre-requisite knowledge to more advanced concepts and provides opportunity to articulate vertically and horizontally through the curriculum.

4.2.6. CONTINUITY

Continuity means vertical relationship throughout the entire curriculum (Research and Training Centre, 1998:74). This refers to the vertical articulation of the curriculum design. Learners succeed best when higher order skills are reinforced throughout their educational life and when they are required to synthesise knowledge and skills learned in different places (AAHE, 1996:5-8). The Indian curriculum provides the learners with opportunities to revisit knowledge and skills in greater complexity as they progress from one grade to the next. For example, analysis of the Indian curriculum shows that learners study work done by a force, energy, power; kinetic and potential energy, law of conservation of energy in grades 9 and 10 (CBSE-Secondary, 2011: 123) These topics are continued in grades 11 and 12 but with a greater complexity (CBSE-Senior, 2011: 84). Learners build on previous learning but through active learning such as practicals, personal discoveries, discussions etc. This understanding and knowledge is reinforced, built upon and expanded. There is clear evidence that the Indian curriculum gives particular attention to Continuity.

4.2.7. RESULTS- 2011/2012 CLASS 12 PHYSICS EXAMINATION

The table below summarises the results obtained by the class 12 Physics learners for the National Examination of the 2011/2012 academic year.

School	No. of candidates that sat the Physics Exams	Percentage of candidates that passed the Physics exams	Percentage of candidates that obtained more than 60% in the exam
A	80	98	79
B	133	100	68
C	120	99	73
D	92	100	90
E	120	98	92
Average	105	99	80

An average of 99% passed the Physics exams in 2012 and 80% of the candidates averaged above 60%. The results were from the schools involved in the research study that implemented active learning in their large underfunded Physics classrooms. These examination results support various authors who share the idea that active learning encourages the learners to retain memory and achieve good examination results (Wilson & McLellan 1997:96; Malcom 2000:56-62; Bonwell & Eison, 1991:1). The results further support work done by Hake (1998:39), Giannola & Green(2011:5) and Settles (2008:52) in that active learning promotes good performances from the learners in large classroom environments. The researcher used the examination results to support his conclusion that the active learning approach in the large underfunded Physics classroom in the schools in Kerala is a success.

4.2.8. SUMMARY OF THE DOCUMENT ANALYSIS

The curriculum has scope, balance, sequence, continuity articulation and progression. The Indian curriculum is holistic in the sense that it allows learning to take place by allowing the child's education to be connected in order for learning to be meaningful (Taylor & MacKenny, 2008:144). The analysis of the curriculum document has provided the researcher with insight and understanding into the implementation of active learning in the Indian schools. Furthermore, the analysis of the class 12 Physics National Examination results of 2011/2012 academic year shows that there is a positive correlation between the active learning approach of large underfunded classrooms and the academic results.

4.3. SECTION B- DATA FROM OBSERVATIONS AND FINDINGS

Classroom observations were carried out during the visit to the five schools in the Kanur district. The notes taken during observations in the field provided running documentation of the teacher's and learners' behavior, attitude and interaction. The researcher recorded verbatim notes. The notes included descriptions of the content covered in the lesson and the materials used. The substance of the notes was similar for all classes observed.

The findings were organized into three broad categories:

- classroom context- the physical and psychological environment of the class;
- teaching and learning- instructional activities that are used to present the lesson;
- content of the lesson- the way the teacher presents the lesson and the nature of the learning task that the learners were asked to perform.

4.3.1. CLASSROOM CONTEXT

The learner-teacher ratio was an average of approximately fifty five learners which was indicative to a large class size (Murnane & Willet, 2010:168-169). The classes were cooperative however, the girls avoided sitting next to the boys. The girls sat in the front of the class whilst the boys sat at the back.

The classrooms were cramped and the learners sat in long rows. There was no electricity in any of the classrooms and the classes relied on natural light coming out of windowless openings in the wall. Some classes had worksheets and posters stuck on the wall however, there was no evidence of scientific equipment in the classrooms. The natural sounds of the outdoors was heard in the classrooms due to the ventilation openings in the walls.

Each school had a laboratory. The laboratories were poorly equipped. Some laboratories had a few sets of equipment that were needed for the compulsory practicals but not enough for the large class sizes. There were no extractor fans and the chemicals were stored in glass cabinets.

It was clear to the researcher that the conditions for active learning were difficult due to the lack of resources (Harrington & Terry, 2009:133). However, the teachers role as facilitator was to try to create a psychological climate where the learners felt free to learn without a fear of making mistake (Hale et al, 2008:75). It was observed that the teachers were always smiling and did not get upset when the learner gave an incorrect answer. They instilled positive reinforcement by using words of praise and encouraged the learners to take risks. Learners were allowed to answer in chorus. The learners always answered quickly and in unison. This was very effective in allowing the majority of the learners in the large class situation to participate in whole class discussions. The discussions were guided clues in obtaining the answers to the questions and the teacher never answered the questions for the learners without allowing them to figure out the answers first. The class was always asked whether they understood the concept before the lesson progressed to the next concept. The teachers used body action during explanation to describe concepts such as forces, magnetic fields, movement of charges etc. They were always moving focusing their attention to all in the class discussions.

The teachers were always actively involved with their classes throughout the observation period. They were not always engaged in teaching. They allowed the learners to take part in the process of self-discovery to investigate, explore and solve problems by working independently and only offered support as and when required. The teacher tended to guide certain groups and not interfere with others. It was

apparent that certain groups didn't need any assistance whilst some groups did. The teachers always remained standing during the lesson and were always engaged in managing learners or providing guidance between tasks. The teachers and learners were always on task and academically focused.

The researcher concluded that the lessons were learner-centred and activity based in relation to the theory discussed in section 2.1.2. The constructivist approach to active learning is praised and accepted by educationists in India (Ahmad,2009:79). The National Curriculum Framework of 2005 emphasises the active learning approach (Ahmad,2009:79). This active learning environment in the Indian classroom is supported by the Indian Ministry of Education through the National Curriculum Framework. This point is further discussed in section 4.4. This approach to learning is different from the teacher-led approach that dominates most developing countries as discussed in section 2.2.1.

4.3.2. TEACHING AND LEARNING

“Active learning is the act or process of acquiring knowledge or skills by engaged action or activity” (Harrington & Terry, 2009:133). The teachers provided plenty of opportunity for active learning, for example by creating activities for the learners to:

- Think aloud- During all activities the learners were encouraged to be verbal. The teachers promoted interest by asking questions that required elaborations and explanation. Some of the questions asked were: “Describe the practical application of Faraday’s Law of Electromagnetic Induction”, “How do you think we can increase the strength of induced emf during the induction process? Explain further.”, “Explain what is meant by centripetal acceleration”, “What is meant by forbidden energy gap?”

The questions rarely required one word answers. It was clear that many learners were not sure of the exact answer to the questions, however, they were given opportunities to think aloud or compare their answers with the learners sitting around them. This technique allowed the learners to argue abstract concepts such as semiconductor doping, Eddie Currents during induction, Centripetal acceleration. The learners did not have any pictorial aids apart from the drawing on the chalkboard and those represented in textbooks and worksheets when

available. The interpretation of the abstract concepts were visually interpreted through the teachers drawing and their picture the learners imagined by the learners.

This activity allowed learners to think through and process information. Learners were observed whispering to themselves. More confident learners spoke louder. The learners were not required to give their answers however, were encouraged to think. The brainstorming sessions were generally performed at the introduction of a new idea. It seemed as though the teachers did not expect a correct answer but simply tried to stimulate thinking at this stage in the lesson.

After a short time the learners' responses were listened to and this generally was guided by the teacher to reach the correct answer. This type of activity was learner-centred and required very little preparation by the teacher. The activity challenged the learner and accommodated the learners with low self-esteem.

- read aloud- The learners had no access to textbooks. The reading activities were done by hand written worksheets created by the teacher. These were conducted as short activities. The teachers selected random learners from the class to read the information. This activity was not very inclusive because only a few learners from a very large class had an opportunity to read.

A more effective read aloud activity was observed which certain teachers used to round up group activities.

A group activity on the analysis of a practical demonstration on the relationship between height of a liquid and pressure was demonstrated by one of the teachers observed whilst another teacher used the same idea to demonstrate the effect on the sound created by hack saw blades and its length. All teachers required their group leaders to read the group analysis of the practical demonstrations. This analysis allowed learners to share ideas and was more effective than just encouraging learners to read worksheets. However, this activity required a lot of preparation by the teachers. The teachers used materials brought by learners and constructed the practical with the assistance of some of the learners. This practical could be stored and used again for the next year. It could be an

investment for the teachers to build up these resources that can be constructed using material obtained at home.

Some other teachers formed starter activities through the use of groups in answering questions such as “ Differentiate between conductors and insulators”, “Classify semi-conductors as intrinsic and extrinsic doping”. Again key points were read aloud by group leaders. This activity was very simple to implement and was extremely effective in engaging learners and obtaining their ideas to the question.

- group orientated tasks- As explained above there was clear evidence of group orientated tasks by all teachers. These tasks did not dominate the lesson, however, it played a crucial role in varying the activity during the activity learning process. Group orientated tasks supported practical activities, brainstorming ideas for introducing new concepts as well as problem solving exercises.

These tasks allowed minimum teacher involvement, however, the teacher ensured guidance and discipline. The group orientated tasks collectively required question answer sessions, written activities, reading, solving problems and debating.

- group discussions- Group discussions involved small group to whole class discussions. Due to the large class size the teachers encouraged peer discussions. Starter activities were generally in the form of group discussion and was learner-centred. For example, a whole class discussion developed after the teacher presented a centripetal motion problem and asked the learners to discuss how the triangular law of vectors can be used to solve the problem. The discussion was in no particular order. The learners discussed the questions with other learners and the teacher entertained discussions with learners as well while the other groups continued to discuss the concepts. This allowed the teacher to interact with most of the learners and obtain a general view of their understanding of the scientific concept. The short activity concluded by the teacher writing the solution to the problem as guided by the learners. Feedback regarding common misconceptions was highlighted.

Whole class discussions were observed during the reflection phase of the lesson. At the end the lesson key points were summarised by the learners guiding the teacher on what they have learnt.

Observations of small group discussion followed when the learners were asked “How are P-type and N-type semiconductors are formed?”. The teacher instructed the learners to work in small groups. After a short time the learners responses were read. Certain teachers allowed the learners to share their ideas instead of reading it aloud.

Small group discussions were used as a tool to link theoretical concepts to real life application of key concepts. Teachers included discussions on practical application on Faraday’s law, transformers, use of semiconductors, the workings of a light emitting diode, the importance of semiconducting to electronics. This helped to show relevance to the theory being learnt showing its real life application.

From the responses during the small group to whole class discussions it was evident that the objectives had been met. The collaborative components in the large classes observed assisted in engaging the learners in the active learning process. The small group discussions made it possible for the teacher to interact and give attention to all the learners. The large classes were transformed into more manageable groups. It would have been impractical to provide this sort of support if the learners were not grouped. Furthermore, the collaborative activities allowed all the learners to have a chance to use the limited practical resources. Teachers that teach large underfunded classes would find this collaborative technique useful.

Whole class discussions were successful as well. In order to include all the learners the teachers used formative assessment tools such as raising of hands, showing of thumbs and chorus responses. These techniques seemed unique compared to other large, underfunded classes as discussed in section 2.2.1.

- problem solving- Most of the problem solving activities were merged with the group orientated tasks. All learners were required to have written proof of answers, however, they were allowed to share ideas with group members. Every lesson observed had problem solving activities. These included drawing of vector diagrams, analysis of practical demonstrations, applications of the laws of Physics, application of mathematical relationships etc.

The issues faced by the teachers when teaching problem solving to large classes is that they find it difficult to cater for the individual needs of the learners. The researcher observed the teacher encouraging the more able learners of the group to help the less able learners. The teachers also assisted the learners and guided them during the problem solving process. This is in keeping with Vygotsky's Zone of Proximal Development theory that was discussed in detail in section 2.1.4.

The responses of the learners to the questions posed by the teachers suggested that the learners understood most of the concepts. This approach adopted by the teachers is in keeping with the active learning principles and is aligned with accepted educational theory discussed in chapter 2.1. Large underfunded classes in developing countries, as discussed in 2.2.1, would find this teaching strategy useful and effective.

4.3.3. CONTENT OF LESSON

In the large majority of classes, the predominant activity of the class involved learning objectives at the lower and higher levels of Bloom's Taxonomy as discussed in chapter 2.1.6. Learners were more likely to be involved in mental activities such as remembering and applying as well as evaluating and creating. Teachers did more to model cognitive and metacognitive strategies by allowing the learners to think instead of just getting involved in the teacher-led discussions. Livingstone(1997) defines metacognition as "thinking about thinking." She further states that metacognition plays a critical role in successful learning and suggests that learners can be taught to better apply their cognitive resources through metacognitive control (Livingstone, 1997). In other words the learners can improve on their cognitive

development when they reflect on the strengths and weaknesses of their academic development.

During the plenary of the lesson the objectives were revisited and the learners required to self-assess whether the objectives were met. This involved whole class discussions. The teachers got feedback by using formative assessment tools such as raising of hands, showing of thumbs and chorus responses. This provided the learners and the teacher information regarding the aim of the lesson and how much of the lesson was understood by the learner. Moreover a learner centred approach to learning requires a learner-led assessment. The teachers encouraged learners to do self-assessment tasks and peer assessment tasks during intrapersonal and collaborative activities. This allowed the learners to reflect on their strengths and weaknesses. The teachers provided guidance and support by pointing out ways to improve understanding of the concepts. Model answers were written on the board during self-assessment tasks and rubrics were provided during peer assessment tasks.

Lower level activities of Blooms Taxonomy that requires recall of facts and basic application of theory were apparent in question and answer sessions, for example. “What is the use of a galvanometer?”, “Explain in your own words your understanding of centripetal acceleration”, “Draw a vector diagram of the acceleration and force components of circular motion”. This linked the activities to the lower thinking levels of the learning objectives. These activities catered for the lesser able learners.

Higher level of cognitive and metacognitive activities were aimed at higher levels of Blooms Taxonomy in relation to the learning objectives. This challenged the learners. Although this was aimed at the higher achievers all learners were given the opportunity to attempt the task. Examples of these observed tasks were as follows “Predict the hypothesis of practical”, “Explain the changes that need to be made in order to increase the induced emf of an A.C. generator”, “Relate the motor effect to the electrical braking system of the car”.

The application of the higher and lower level of Bloom's cognitive domain during the learner-centred activities provided the basis for differentiation in the lessons as discussed in chapter 2.1.8. The teachers accommodated for the different abilities of the learners. The lessons were observed to be multiple activity based. There was a minimum of two activities per lesson. Further opportunities were created for developing the different learning styles of learners as shown by Gardner with his Multiple Intelligences theory such as kinesthetic learning, visual learning, interpersonal etc (see 2.1.7.).

Logical and Mathematical reasoning were observed in activities such as application of Faraday's Law, calculation of centripetal acceleration, discussing the variables that effect induced emf, analysis of the conduction band energy level diagram. Kinesthetic learning was observed during practical activities. Linguistic intelligence and Interpersonal skills were exercised during small to whole group class activities as described in 4.3.2. Intrapersonal thinking skills were applied during individual problem solving tasks and think aloud activities were explained in greater detail in 4.3.2. Example of visual and spatial activities involved analysis on the conduction band energy diagrams, vector diagrams, pictorial explanation of the parts of the a.c. generator and the d.c. motor etc.

All active learning activities were linked to learning objectives of the curriculum. The activities were constructively aligned to the learning activities, discussed in more detail in chapter 2.1.5. For example the task on "Fleming's Right hand rule" were aligned to the "Force on a current-carrying conductor in a uniform magnetic field" (CBSE-Senior, 2011:89), the practical activity on the frequency of sound and the length of the vibrating objects were constructively aligned to the "range of hearing in humans" (CBSE-Secondary, 2011: 123).

During the active learning tasks the teacher was observed guiding the learners. There were times when the teacher rotated around the class observing and guiding groups if necessary whilst the learners continued with their activity. Certain members of the group helped the other members to complete the task. The learners were guided in their Zone of Proximal development (chapter 2.1.4). The teacher and more

able learners helped the less able learners during the task but did not provide them with the full solution.

From the observations of the activity based lessons the researcher concludes that the teachers implemented active learning processes in order to achieve the lesson goals. The sequential teaching and learning strategies conducted by the teachers suggested that most of the cognitive goals (understanding, applying, problem solving, analysing, describing etc.) had been met. These processes involved making the learners aware of the lesson objectives, planning and monitoring cognitive activities, checking whether the outcomes of those activities had been met and finally encouraging reflection of the lesson by using formative assessment tools.

4.4. INTERVIEWS

4.4.1 SETTINGS FOR THE INTERVIEWS

The interviews were conducted depending on the availability of the teachers. The interviews were not restricted to the Physics teachers because the researcher felt it was important to get the views of other staff members in order to get a broader understanding of the teaching and learning situation in the schooling environment. The interviews were conducted in English and responses were scribed. The interviews were conducted in the school's lab, staffroom and administration's offices. The aim of the interview was to find out what the teachers thought about active learning, the techniques that they use to implement active learning in their large underfunded classroom situations, the support that they got from the Ministry of Education and to find out some of the difficulties they have encountered in trying to implement the active learning approach

4.4.2. PATTERNS FROM THE INTERVIEW AND INTERPRETATION

Some of the responses of the interviews conducted are shown in Appendix 7. There seems to be a clear pattern in most of the questions answered. The researcher will provide analysis of the responses to each question in order to show the patterns and the interpretation of the responses.

Question: Could you describe to me a typical classroom in which you teach in respect to:

Venue;Class size;Seating arrangements;Electricity, lighting and ventilation;Resources;Distraction.

Interpretation of the response:

It was clear from the responses that that the classes were underfunded, under resourced and large. However, there was no mention of disruption by the learners during any of the interviews due to these teaching and learning conditions. The large classes had enough chairs and tables for all the learners.

All the teachers stated that there was no electricity. And some of them mentioned that there were no windows. One teacher even complained “ During the hot season the class gets very stuffy. During rainy days the class gets wet.”

According to the teachers their major tool for teaching was the “black board”. The black board is an essential tool for the “chalk and talk” method which is essentially a teacher-centred approach (Killen,2006:102). However, the teachers used the black board to summarise key points, write lesson objectives, show solutions to problems and aid their active learning approach.

The responses described the teaching and learning environment as similar to many developing countries as discussed in chapter 2.2.2. The resources were very limited yet active learning was still implemented despite the restrictions. Having no electricity meant that there was no Information Communication Technology to aid teaching and learning. To overcome these obstacles the teachers used creative methods discussed in 4.4.1. to bring the microscopic and macroscopic world of science alive in their learner-centred classroom. This was different from the teacher-centred practices implemented in many developing countries in similar situations as discussed in chapter 2.2.3.

Question : Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?

Interpretation of the response:

All the teachers that were interviewed were in support of the government's initiative to implement a learner-centred approach to teaching and learning. Some of the teachers' responses supported the policy by saying"

- "I think a more learner-centred approach is the best way forward for our children."
- "I support the governments initiative to have an education system that is inclusive, learner driven and encourages creativity."
- "I think it is important that the learners are involved in their lessons. If I just talk to the learners for the entire lesson they will become unfocussed and won't get all the information I need them to learn."

Although all the teachers that were interviewed supported the learner-centred approach, one teacher did say that "It takes a lot of hard work in order to implement this form of teaching because the class sizes are large and there are very little resources and the science curriculum is long and highly academic." Young & Paterson (2003: 283) suggest that in order to successfully implement active learning a lot of planning, preparing, development of active learning material and deciding how to implement them is required. Most teachers appreciated the benefits of the learner centred approach which is in keeping with the points discussed in chapter 2.1.2. This support for the learning approach motivates the teachers to implement active learning in their classroom. The success of the preparation was discussed in more detail in 4.4.1.

Question : What provisions are made to develop teachers towards this approach?

Interpretation of the response:

All the teachers stated that the Ministry of Education is supportive and provides professional development for the learner centred approach to learning. There are training programs once a year and there are district meetings once a month which is aimed at developing the teachers skills in supporting the government initiative of active learning.

There was positive feedback from the teachers that were interviewed. One comment shared by a teacher was “I enjoy attending the training courses because it allows us to share with teachers from other schools our best practices, especially at overcoming the limitations we have in our budget”. Another teacher stated that they do not only rely on the external staff development but also have professional development programs in school as quoted below.

“We receive regular training from the Ministry of Education but our Principal insists on weekly staff sharing events where we can share advice and good practices with our colleagues”.

As mentioned previously, active learning requires a lot of planning and preparation. In order to do this successfully the teachers require a certain level of skills. Scales et al (2011:9) state that in order to achieve success in education teachers must be trained with a framework of national standards and preferred teaching methods are encouraged. It is evident from the responses that the Indian educational authorities provide continuous support and development for the teachers and the preferred teaching method is the active learning approach. Furthermore, this continuous development is implemented within the schools and the local authority.

Question: Could you highlight the challenges faced by you in implementing active learning in your situation?

Interpretation of the response:

Teachers had varying views on the problems faced in implementing active learning. Budget problems, large class sizes as well as under-resourced classrooms were the obvious responses from the teachers. Two teachers made comments about the curriculum as stated below:

“The curriculum is very academic and sometimes it is difficult to cover so much content and support activity based learning. Certain abstract concepts have to be taught by the teacher before an activity can be done.”

“As mentioned we have very limited resources and the academic program is very long. ”

Sometimes budget and class sizes are beyond the control of the government; however,, the curriculum can be amended to suit the active learning approach for the teachers and learners.

Another teacher response was very surprising:

“For the senior classes school is open on Saturdays.”

“At workshops it was discussed as a strategy that schools be opened on Saturdays in order to complete the curriculum and prepare the pupils adequately for their examinations”

“ What office is there which involves more responsibility, which requires more qualifications, and which ought, therefore, to be more honorable than that of teaching” (Harriet Martineau as cited by Ryan and Cooper, 2008 :499). Many teachers in the district sacrificed their day off in order to complete the curriculum effectively. This is truly above and beyond the call of duty. Service to others lies at the very heart of what it means to be a professional (Ryan and Cooper, 2008 :499). The teachers in Kerala, India go beyond what is expected of them and serve their community selflessly. This commitment provides further evidence as to why their educational system is so effective despite the challenges.

A teacher also commented on the attention span of the learners in large class sizes :
“Attention span of the learners in such large classrooms are varied. It becomes difficult when they are side tracked.” This occurs when the learners lose focus of the lesson and become distracted, fidgety and are not involved in the discussions and activities. This behavior was not observed by the researcher, however, this tends to happen to all learners at some point.

The teachers that were interviewed did acknowledge that sometimes they will have to divert from what was planned in the activity based lesson. From the responses it is evident that teacher led discussion is required in order to implement active learning successfully. The teacher-centred approach being used in conjunction with the active learning approach was surprising and was not promoted in any literature read by the researcher. It does seem that the two approaches contradict each other. Despite the drawbacks of the teacher-centred approach as discussed in 2.1.2. teachers did feel that it is sometimes essential in teaching scientific concepts to provide key concepts

before the active lesson begins. Studies show that the attention span of learners starts waning after 20 minutes (Andrews,2009: 191). This time is much less than the average lesson in most countries, however, it does provide adequate time to have a teacher led discussion at the beginning of the lesson and follow through with the active lesson.

Question : Could you describe some of the techniques that you use in your classroom during the active learning approach?

Interpretation of the response:

Group activity seemed to dominate the active learning process. Responses suggest that the group activities varied during the following tasks:

- Practicals
- Discussions and debates
- Presentations
- Brainstorming ideas
- Demonstrations

A common response from the teachers suggested that these group activity techniques support the activity based lesson. Teachers also stated:

“We are required to conduct three activities in each lesson so that the children are practically engaged with the objectives.”

“ I try and do a few activities every lesson. I think the learners learn better when they are doing things rather than watching me every time”.

This implies that there is a drive to complete multiple activities in a single lesson instead of the conventional three part lesson plan that confines you to do a single activity in a lesson plan.

A teacher gave a very interesting suggestion to try and overcome the budget problem:

“The budget does not allow us to have a well-stocked laboratory so we need to use materials that I can get easily in the local community”

Question : How effective are these techniques?

Interpretation of the response:

According to the responses the techniques used were in support of the active learning learner-centred approach. The aim was to ensure that the learner was actively engaged with minimum teacher involvement unless required. The multiple activity lessons allowed the learners to be motivated throughout the lesson and engaged the learners whilst learning the scientific concepts.

The ideas of cooperative learning which involve practical work, discussions and debates, presentations, brainstorming ideas and demonstrations were common to all responses. The teachers did not depend on technology and made use of what was available. Some teachers mentioned that in conjunction to collaborative work they also implemented project work and case studies. These techniques were based on key concepts and encouraged independent learning.

There was a common feeling by the teachers that the active learning techniques allowed the learners to experience the content and allowed the learners to reflect on the lesson. The teachers gauged the success of the lesson by formative assessments in the form of question answer response, written activities and teacher student discussions.

Question : Do you have anything further to add about the teacher led approach?

Interpretation of the response:

Various responses from the teachers support the idea that the learner should be encouraged to take responsibility for their learning:

“... it is also important to take a step back and allow them to solve it for themselves”, “It will work better if the class sizes are small” and ‘It works very well even for large classes”.

Some responses cautioned not to totally eliminate the teacher-centred approach:
“The teacher does still need to explain and discuss objectives, explaining the theories etc.”

Whilst some responses cautioned not to forget the traditional technique of independent studying for the examination:

“The learners learn a lot from the activities but they still need to study very hard at home in order to do well in the examinations”

The researcher feels that the teachers are confident in the learner-centred approach to teaching and learning, however, teachers still recognised the importance of self-study and independent learning. It was interesting to note that teachers felt there is still a place for the teacher-led approach to a certain extent. It seems to make sense for the teachers to develop the teacher-led approach in the conducting of an extensive curriculum near the examination time.

Question : Practical work is essential to the active learning process. Could you describe how you implement the practical work during lessons?

Interpretation of the response:

Many teachers commented on the government requirements for many compulsory practicals:

“The education ministry prescribes a lot of practicals because they support the theory.”

There were further affirmations that the labs were under resourced:

“We have very limited equipment”

Group work seemed to be the solution to this problem:

“There are activity days when the classes are split into groups and the groups take turns to do the assessed practicals.”

“Group work and demonstrations are a way to overcome the lack of equipment.”

“During practical sessions the science classes are combined. A group will go to the lab and conduct the practical whilst the other learners complete supervised activities with another teacher.” This requires the science department to support each other. Another innovative technique in implementing practical work in under resourced situations is to use everyday items that are assessable to the teacher and learners to construct practical activities:

“We have been trained at workshops on using everyday items to construct practicals that support learning”

“Well, as I have already discussed we do activities in using everyday materials.” This enables and supports the learners in completing project work. Learners are motivated to perform to their abilities despite their financial situations

Question : How often is this done?

Interpretation of the response:

All the teachers stated that they do practical activities on a regular basis because this related the theory they learnt to the real life application of the scientific concepts. The researcher believes this showed learners the relevance of what they were learning.

Question : Do you have anything further to add about the implementation of practical work?

Interpretation of the response:

Further responses on practical work highlighted projects as well as science fairs. It was also suggested that long term projects encouraged parental involvement:

“Project work can also assist in practicals.”

“The science fair is a great way for the learners to work at home with their families using their learning from their practicals and activities we have done in class, to produce their own practical.”

The relevance of practical work linking the real life application of science to theory was also added:

“There is no point in teaching the theory without showing how it works in the real world.”

Despite the limitations, the common feeling by the teachers is that practical work is a central component of science education. The view of the teachers is that the educational benefit of practical work outweighs the financial and practical constraints. It was understood by all the teachers interviewed that practical work was part of the active learning process. The researcher felt that the collaborative techniques used by the teachers in Kerala, India will be very beneficial to schools that have large underfunded classrooms. Kerala proves that active learning can be done within school and as home projects despite limited resources. This is often the excuse that schools use to not do as many practicals (see 2.2.2).

Another reference to the demanding Physics curriculum was made:

“Sometimes it is not possible to complete practical work in such a demanding curriculum so we do practical demonstrations instead.” As already mentioned the teachers in Kerala accommodated for this rigorous curriculum by having lessons on Saturdays. The researcher feels that the teachers should not be in this situation. The document analysis conducted in 4.2. shows that the Physics curriculum is highly academic and rigorous. The researcher suggests that the curriculum should be adapted to fit into the school’s scheme of work and to ensure all objectives are met within the normal school week therefore no extra burden is placed on teachers. However, that dedication is part of Kerala’s success(see 2.2.5).

4.5. TRIANGULATION OF RESULTS

The differences between the three research instruments were that the document analysis focussed on the curriculum design, whether the curriculum supported active learning and the correlation between the active learning approach and the academic results. Whilst, the classroom observations focussed on the implementation of active learning within the teaching and learning process. Furthermore, the interviews

took into consideration the opinions of the teachers involved in the active learning process.

The information gathered during the interview gave the researcher certain expectations during the observations. The documentation analysis further informed the researcher of the curriculum requirements of the lesson. It seemed like a huge task for the teachers to practice the active learning strategies discussed during the interview and successfully achieve the aim and objectives in the curriculum document in a large and underfunded classroom situation. However, the reality was very impressive as to a large extent the teachers achieved it and to a high standard

The observations allowed the researcher to view the strategies discussed during the interview in action. The active learning techniques discussed during the interview were similar to what was observed. The collaborative work, presentations, small group to whole class discussion and the learner-centred problem solving techniques were all observed. The researcher observed the learners being actively engaged during tasks and were part of the learning experience.

The observations also allowed the researcher to witness the curriculum implementation as analysed in the documentation analysis. The evaluated data by the document analysis was aligned to what was observed during the lesson observations. The objectives of the curriculum document were clearly stated at the beginning of each lesson. Formative assessment techniques used at the end of the lesson gave the teacher an indication as to whether the curriculum objectives had been reached and to what level. The teacher used active learning techniques to ensure that the aim and objectives of the curriculum document were achieved.

The curriculum analysis, interviews and classroom observations all confirmed that the Kerala teaching and learning process supported the active learner-centred approach. The analysis of the class 12 National Examination Physics results synthesised the information analysis from the curriculum analysis, interviews and classroom observations and related it to the success of an externally assessed examination.

4.6. SUMMARY

This chapter focused on the presentation of data, data analysis and the interpretation of data. The collection of data was gathered by means of observations, document analysis and interviews. Data was presented, analyzed and interpreted in this chapter. The recommendations of this study will be considered within chapter five.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

“My role as a “progressive” teacher is not only that of teaching mathematics or biology but also of helping the learners to recognize themselves as the architects of their own cognition process.”

-Paulo Freire, *Pedagogy of Freedom*

5.1. INTRODUCTION

The scope of this study was to find strategies for active learning that work in large underfunded Physics classrooms. By conducting the literature study the researcher attempted to make readers aware of the key components of the pedagogy of active learning as well as the problems faced by nations that try to implement active learning but are hindered by large underfunded classrooms. Based on the literature review and on the research results, this chapter aims to highlight that active learning is still possible even if though these problems exist.

The data analysis in chapter 4 supported the answering of the three research questions in chapter 1.4. The document analysis provided the answer for research question one, “Does the Kerala Physics curriculum follow the constructivist approach to curriculum design that promotes successful implementation of active learning?”. From the analysis it was evident that the curriculum supported active learning (see 4.2). The curriculum design itself supports the constructivist approach to learning which is learner-centred by providing scope, depth, balance, continuity, inclusion in the curriculum, progression, opportunities to relate theory to real life application and articulation (see 4.2). Furthermore, the analysis of the class 12 National Examination Physics results further answered the research question 1 by showing a that there is a direct correlation between the classroom and the academic results of the learners.

From the information gathered during the classroom observations and the teacher interviews it was possible to answer the research question two, “What strategies do

the Keralan Physics teachers implement to achieve active learning in large underfunded classrooms?” The strategies used by the Physics teachers in Kerala were very similar from school to school.

- The teachers created a psychological climate where the learners felt free to learn without fear of making a mistake and facilitated the learners during the lesson on their path to self-discovery (see 4.3.1.).
- The teachers used active learning techniques such as think aloud activities, read aloud activities, group orientated tasks during problem solving tasks, brainstorming sessions, debates, presentations, discussions and practical work (see 4.3.2. and 4.4.2)
- The teachers overcame the problem of funding by using day to day items in order to construct practical demonstrations (see 4.4.2.). They also made do with what little equipment they had and by dividing their large classes into smaller groups to do practical work so that every learner had the opportunity to partake in the practical activities (4.4.2).
- The got continuous professional development provided by the Education Department in order for the teachers to refine their skills and learn better ways to implement active learning (see 4.4.2).

The classroom observations and the interviews also assisted in answering research question three, “How do the strategies used by the Physics teachers in Kerala model the theoretical framework?”

- The learning objectives of the lessons were linked to Bloom’s Taxonomy (see 4.3.3.). These objectives varied between the lower and higher cognitive domains in order to cater for the varied educational needs of the learners.
- The lessons were multiple activity based and was therefore informed by Gardner’s Multiple Intelligences (see 4.3.3.)
- The lessons were mainly learner-centred that followed the constructivist view of teaching and learning (see 4.2, 4.3 and 4.4).
- The observed activities were constructively aligned to the lesson’s objectives (see 4.3.3)

By answering the research questions, this research attempted to provide the education community of large underfunded classrooms with valuable tools to cope with their daily teaching and learning processes in a successful way. The research was aimed to help provide information to assist in the holistic development of teachers by providing them with coping strategies and knowledge in order to overcome problems faced with their everyday challenges in the large underfunded Physics classroom. Although the comments of the participants and the classroom observations strengthened the researcher's hypothesis that active learning is possible despite the challenges many schools throughout the world face, the researcher was fully aware of the limitations of the qualitative research. The limitations and credibility will also be discussed in this chapter in order to establish whether the strategies observed are transferable to schools with similar shortcomings.

Therefore, this chapter will also discuss the practical implications of the research, which will include its transferability dependability of results. The chapter will conclude by giving recommendations for future research to be conducted in this field of study.

5.2. SUMMARY OF FINDINGS

5.2.1. CONCLUSIONS FROM THE LITERATURE STUDY

In chapter 2.1 the concepts deemed significant to this study were discussed and their significance to the study was highlighted. These concepts include, among others, learner-centred education, Gardner's Multiple Intelligences, Bloom's Taxonomy, Constructive Alignment and Zone of Proximal Development.

It emerged from the discussion that these concepts were essential in promoting thinking and learning in an active learning environment. These concepts assisted the researcher in making valued judgements during the data gathering and the data analysis phase of the research.

The study investigated and found that many developing nations attempt to implement active learning, however, the teacher-centred approach dominated (see chapter 2.2.). The study has also shown that key issues due to the fundamental differences between the culture of Western science and developing countries indigenous knowledge of science, large class sizes, poorly trained teachers and limited financial resources still stand in the way of successful implementation of active learning (see chapter 2.2).

The research project also questioned whether there was a way to bridge the gap between holistic learner-centred and mainstream education in these countries (see chapter 2.2). It was evident from the literature review that although many attempts have been made by the governments of certain developing countries to implement active learning the teacher-led approach continues to dominate the teaching and learning process. However, chapter 2.2.5 shows that the Indian state of Kerala was successful in the implementation of mass education. It was clear from the literature review that strategies to implement active learning in large underfunded Physics classrooms were yet to be discovered. However, those being utilised in Kerala whilst not being perfect were extremely successful.

5.2.2 FINDINGS BASED ON EMPIRICAL RESEARCH

In chapter four the data gathered by means of interviews, observations and document analysis was presented and discussed. The observed findings made in this regard may be summarised as follows:

- The analysis of the National Examination results in Physics for the 2011/2012 academic year shows that there is a direct correlation between the learner-centred active learning approach in large underfunded Physics classrooms and the academic attainment of the learners (see 4.2.6).
- All the respondents demonstrated that they had a firm grasp of the learner-centred pedagogy (see 4.3.1, 4.3.2, 4.3.3 and 4.4.2. respectively). On the basis of the criteria used in the classroom observations and the interviews of educators in this study (see 4.3. and 4.4.2) all respondents may be said to

have demonstrated active learning in the large underfunded classroom situation.

- Most of the respondents supported the governments initiative to implement active learning and found it to be an effective way forward to implement a successful curriculum (see 4.4.2).
- Most respondents showed clear appreciation of the training courses offered by the Ministry of Education and commented that this helped them compare and use effective strategies to implement active learning in their classrooms (see 4.4.2).
- Many teachers viewed budget problems, large class sizes as well as under-resourced classrooms as major problems that challenged active learning, however, some teachers mentioned that they sometimes used the teacher-centred approach to deliver a course that covered many abstract concepts. However, responses from the teachers interviews showed a huge support for the active learning approach (see 4.4.2).
- Many teachers were observed implementing varying activities from the lower level activities of Bloom's cognitive domain that require recall of facts and basic application of theory to higher level of cognitive and metacognitive activities which challenged the more able learners (see 4.3.3). Furthermore, activities also supported the various learning styles according to Gardner's Multiple intelligences (see 4.3.3). All teachers constructively aligned their lesson to the lesson objectives, active learning tasks and formative assessments (see 4.3.3).
- The analysis of the curriculum suggested that the Indian Physics curriculum had scope, depth, progression, balance, articulation, sequence and supported the active leaning process (see 4.2.) However, some respondents interviewed stated that the rigorous and highly academic Indian Physics curriculum made the active learning process difficult to achieve all the time (4.4.2). They

suggested that a combination of both teacher-centred and active lessons were sometimes required.

- Most respondents found that the most effective way to implement practicals in large underfunded classrooms was to group learners in order to share the limited equipment while the rest of the class was involved in activities regarding the theoretical aspect of the practical (see 4.4.2).

The findings also suggest that there has been very limited research in respect of the successful implementation of active learning in large underfunded Physics classrooms. This is discernible from the fact that in the discussion of the findings, the researcher had to rely, almost exclusively on curriculum document analysis, interviews of teachers and observation of lessons conducted in Kerala, India (see chapter four).

The following conclusions may be drawn on the basis of the findings made in this study. It must be pointed out, however, that these conclusions are not in anyway generalisations, but are presented in order to acknowledge that the researcher has, indeed, achieved his research goals. The findings enable the researcher to conclude that:

- The Physics curriculum of India followed by the schools in Kerala shows indication of being holistic, challenging, aligning itself to global standards and supports active learning.
- Educators have successfully used active learning techniques in order to implement practicals, stimulate lower to higher cognitive and metacognitive development, develop problem solving skills, motivate learners and encourage learners to take risks in the large underfunded Physics classroom. Despite the limitations of having large underfunded classes the teachers in Kerala appreciated the educational value of practical work. The researcher observed group work and demonstrations used by the teachers. The teachers also implemented practical work in under resourced schools by

using everyday items that were accessible to the teacher and learners (see 4.4.2). From the curriculum document analysis in chapter 4.2. it was evident that the Indian Ministry of Education supported practical work. The large underfunded classes of the case study used techniques such as splitting the class into a simultaneous theory and practical session so that all the learners had the opportunity to use the limited practical resources.

- Contrary to the findings of the literature review this research suggests that active learner-centred teaching and learning can be successfully implemented despite having large underfunded classrooms. The analysis of the data collected during observations, document analysis and the interviews discussed in chapter 4 shows that an active learning approach is prevalent in the schools visited in the case study. The teachers implemented cooperative activities, practical work, discussions, debates, presentations, brainstorming ideas, demonstrations and problem solving during their activity based teaching. Furthermore, the success of the active learning process in Kerala was supported by the high class 12 National examination results in Physics.

- Despite the success of active learning in the large underfunded Physics classrooms in Kerala it was observed that all the classes displayed a limited variation of active learning techniques namely small group to whole class discussions, presentations and group problem solving tasks. These techniques could be supported by (SERC, 2008) :
 - Think Pair Share: learners ponder the answer to a question and then share their thoughts with a neighbour.
 - Role Playing: For example each student takes the role of a scientific concept (photon or an electron) or of a scientist being studied such as Sir Isaac Newton.
 - Jigsaw : this is a group discussion method employing many aspects of cooperative learning.
 - Peer Review: learners review and comment on materials written by their classmates.

- Problem solving using real data: learners use a variety of data to explore scientific questions.
 - Just in Time Teaching: learners read assigned material outside of class, respond to short questions, then participate in collaborative exercises during the following lesson.
 - Game Based Learning: uses competitive exercises, either pitting the learners against each other or creating a quiz game.
- The success of active learning in the schools was based on creativity, resourcefulness, hard work, patience of the highly skilled teacher as well as continuous help and support from the Ministry of Education of Kerala that strives to professionally develop the teachers on a regular basis;
 - A very in-depth curriculum of Physics within time constraints could hinder the active learning process and may limit teachers into implementing a teacher-centred approach to learning.

5.3. LIMITATIONS OF THE STUDY

“Science progresses through honesty and openness, and is retarded by ego defences and deception.”(Babbie & Maxfield, 2011:31)

Inherent in any study is a certain amount of error from different sources which result in a limitation to a study (Gassner,2006 :97). The researcher, in line with research norms, identified what may be considered as limitations to this study.

During the classroom observations the presence of the researcher unsettled the natural day to day environment of the classroom dynamic and during the interview nervousness and uneasiness of the respondents was observed. Chambers et al (2007, 75) affirms this by suggesting that while it is possible to limit observer bias, it is not possible to eliminate it.

During the classroom observations the researcher did his best to remain inconspicuous (see 3.7.2.), however, the presence of the researcher did make the classroom setting a bit foreign. The learners seemed very well behaved and polite at all times. At certain times the learners spoke very softly during group discussions. There were no signs of discipline or attention problems by the learners. This could be interpreted as too perfect. This questions whether the learners were behaving naturally or behaving well because of the researcher's presence. During activities the learners made an effort to observe the researcher through curiosity, however, they remained on task for the majority of the lesson. A further limitation of observing a classroom in its naturalistic environment is that the researcher does not have the opportunity to address how the behaviour of the participants may change under different circumstances (Green et. al, 2006 :211)

The researcher assured the respondents that the interviews were confidential (see 3.7.1.) However, in this study the researcher was also acutely aware that his presence in an interview situation could create a different result. Sometimes respondents answer questions according to what they think the researcher would like them to say or in fear of the principal or the educational authorities finding out what they said, instead of stating what they really felt. The limited number of participants could also question the accuracy of results (Green et. al, 2006 :211).

“Even cultural theory of education must somehow take into account of human limitations and individual differences in those limitations”.(Gearing & Sangree,1979 :145). Another limitation of this research is the transference of empirical ideas found in this research to other cultures. Some schools may find it difficult to implement ideas found in the research due to cultural differences of teaching and learning in their environment. However, the research may highlight the point that active learning in large underfunded classrooms is possible to achieve.

5.4 RECOMMENDATIONS

Both the aim of this study, which was to examine active learning strategies used by teachers in large unfunded Physics classrooms in Kerala, and the findings presented

in section 5.2, suggest the following recommendations which the researcher would like to make:

- The Physics curriculum that is used by large underfunded classrooms should be holistic, aligned to global standards and support active learning. The curriculum design should allocate sufficient time to complete all practical work and theory as well as repetition of lessons should it be required.
- Physics lessons should be based on multiple activities that support learner-centred teaching and learning. The lesson should be designed to develop the learners cognitively, creatively and encourage the learners to take risks in a supportive environment.
- The active learning techniques should not be restricted to small group to whole class discussions, presentations and group problem solving tasks. However, they should include a variety of activities such as role play, music, dance, building and constructing, puzzles, outdoor activities, excursions, case studies, peer teaching etc.
- Apart from the education authorities providing continuous professional development, schools should take the initiative to have regular meetings in order to discuss effective methods of implementing active learning in large underfunded classrooms.
- Teachers have to be highly trained, resourceful, creative and hardworking. Sometimes teachers may have to go above and beyond their required duties. Everyday materials should be used in order to implement the practical work and ensure every child gets an opportunity to complete practical work.

In addition to the above recommendations the researcher finds that the following concluding remarks are, in the light of the entire study, deemed to be appropriate.

5.5. RECOMMENDATIONS FOR FUTURE RESEACH

There is a need to replicate this study by using a bigger sample in several different cultural settings and locations and utilising verbatim accounts of teachers, lesson observations and document analysis.

Further research studies can be conducted to explore the following variables:

- To what extent do the professional development programs equip teachers with the tools to implement active learning in large underfunded classrooms?
- Does active learning provide a more effective approach to retain abstract concepts in Physics as compared to other approaches to learning?
- Does poverty have any influence over learners' participation and attainment in Science?

5.6. CONCLUDING REMARK

The aim of this research was to investigate strategies in implementing active learning in large underfunded classrooms. The analysis of the class 12 Physics results in the researched schools for 2012 show that the learners in the large underfunded Physics classes of Kerala are performing well and justifies the researchers conclusion that the active learning approach was instrumental for this success. The research findings of this study indicate that active learning can still be implemented in the large underfunded Physics classrooms despite the challenges the schools faced. It is further hoped that the findings and recommendations presented above will help educational authorities and educational authors in their plight to successfully achieve active learning in large underfunded classrooms.

APPENDIX

APPENDIX 1-INFORMED CONSENT FORMS TO THE PRINCIPALS OF THE SCHOOLS

Masters Study through the University of South Africa

Informed Consent form for teachers and administration team involved in the implementation of active learning in ██████████ Secondary School. The title of the research project is “ the effective strategies to implement active learning in large underfunded Physics classrooms”

Name of Principal Investigator- Mr Ronesh Rajcoomar

Name of Organization- University of South Africa

This Informed Consent Form has two parts:

- Information Sheet (to share information about the research with you)
- Certificate of Consent (for signatures if you agree to take part)

You will be given a copy of the full Informed Consent Form

PART I: Information Sheet

Introduction

My name is Ronesh Rajcoomar and I am a Masters student at the University of South Africa. I am inviting your school to participate in the research that I am conducting. You do not have to decide today whether or not you will participate in the research. Before you decide, you can talk to anyone you feel comfortable with about the research. There may be some words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask them of me.

Purpose of the research

Learner centred education is one of the most effective ways to teach. Its advantages outweighs its disadvantages and research has shown it is a more effective approach to teaching and learning than the outdated teacher led approach. The reason I am doing this research is because the active learning seems to be unsuccessfully implemented in developing nations where the classes are large and underfunded. My aim is to find strategies for teachers who teach large underfunded classes to successfully implement active learning.

Type of Research Intervention

This research will involve observations of Physics lessons and interviews with teachers

Participant selection

We are inviting Physics teachers and members of the administration to take part in this research.

Voluntary Participation

Indicate clearly that they can choose to participate or not. State, what the alternative - in terms of the treatment offered by the clinic - will be, if they decide not to participate. State, only if it is applicable, that they will still receive all the services they usually do whether they choose to participate or not. This can be repeated and expanded upon later in the form as well, but it is important to state clearly at the beginning of the form that participation is voluntary so that the other information can be heard in this context.

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you require more information please feel free to ask any time.

Procedures and Protocol

The researcher will arrive on the days and time arranged by you the principal of the school. The researcher will conduct interviews arranged by you the principal of the school. The researcher will also observed lessons of Physics classes that is arranged you.

B. Description of the Process

Duration

The research takes place over during the whole duration agreed by you the principal of the school. During that time, it will be necessary the staff and learners are made fully aware of the researchers intensions and not feel intimidated. There should be emphasis in explaining that the researcher in not there to judge the school.

Benefits

There may not be any direct benefit for you or your school during the research but your schools participation is likely to help us find the answer to the research question. There may not be any benefit to the society at this stage of the research, but in the future it may offer some solution to the success in implementing active learning to the developing world.

Reimbursements

Your will not be given any other money to take part in this research however, some stationary may be given to the classes observed as a token of the researchers appreciation.

Confidentiality

The researcher will not be sharing the identity of those participating in the research. The information that the researcher collects from this research project will be kept confidential. Information about you that will be collected during the research will be put away and no-one but the researcher and the university lecturers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is.

Sharing the Results

The knowledge that we get from doing this research will be shared with you through emails and telephonic conversations before it is made widely available to the public. Confidential information will not be shared. The researcher will inform you via email or telephonic conversation.

Right to Refuse or Withdraw

You do not have to take part in this research if you do not wish to do so. You may also stop participating in the research at any time you choose. It is your choice and all of your rights will still be respected.

Who to Contact

If you have any questions you may ask the researcher now or later, even after the study has started. If you wish to ask questions later, you may contact the researcher:

Mobile: 0096896283476

Email: ronesh.rajcoomar@gmail.com

PART II: Certificate of Consent

Please indicate your approval of this permission by signing the letter where indicated below and returning it to me as soon as possible. My email is ronesh.rajcoomar@gmail.com . By signing this letter, you are confirming that you own the copyright to the above described material.

Thank you for all your assistance

Yours sincerely,

Ronesh Rajcoomar



Name of school:

Signature of principal _____



Stamp if available:

APPENDIX 2 CLASSROOM OBSERVATION PROTOCOL

PRE OBSERVATION DATA

Teacher _____ Date _____

School _____ Grade/Level _____

Observer _____ Program _____

(This will be filled out prior to observing classes.)

Class period or time of class:

Topic or topics:

Placement of class or lesson within the unit of study:

Purpose (objectives):

Intended outcomes:

Materials Used (teacher-made, manufactured, district or department-developed; characterization of materials):

CLASSROOM ACTIVITIES

(this is to be filled out as classes are observed)

Introduction to Lesson: provides introduction/motivation/"invitation"; explains activity and how it relates to previous lessons; assesses learners' prior knowledge

Student Grouping _____ Duration

First Activity/Task: Content; nature of activity, what learners doing, what teacher doing; interactions.

Student Grouping _____ Duration _____

Second Activity/Task: Content; nature of activity, what learners doing, what teacher doing; interactions.

Student Grouping _____ Duration _____

Third Activity/Task: Content; nature of activity, what learners doing, what teacher doing; interactions.

Student Grouping _____ Duration _____

State whether activities are sequential or are different activities/tasks done at the same time:

OTHER OBSERVATIONAL DATA

Teacher: Date:

(This is done as the class is observed)

1 - Description of the classroom:

2 - Teaching aids/materials (per activity/task if appropriate):

3 - Assessment strategies used (per activity/task if appropriate):

4 - Time not devoted to teaching and nature of non-academic or procedural

activity (e.g., management, announcements, discipline); description of non-instructional event :

STUDENT DATA

(Filled during class observation)

1 - Number and gender of learners; number of minorities/majority:

Student Behaviors:

most learners	most learners
off task -----	on task

learners interact with	learners interact with
each other around	each other around
non-academic or	content
procedural issues -----	issues

learners are	learners actively and
hesitant to enter	enthusiastically
into the	participate in the
discussion/activity -----	discussion/activity

Teacher Role:

source of
knowledge ----- facilitator

questions/comments questions/comments
seek memory/ seek comprehension/
facts ----- opinion

Classroom Activities:

algorithms ----- heuristics

Emphasis:

connected to real
abstract----- world

Materials:

prescribed program ----- compiled by teacher

For Discussions

Amount of Time Observed:

Percent of learners contributing to the discussion:

closed questions ----- open-ended questions

teacher seeks facts ----- teacher seeks student understanding

learners do not use evidence to support claims ----- learners use evidence to support claims

teacher talks ----- learners talk

learners talk only to teacher ----- learners talk to one another

teacher helps learners reasoning ----- teacher provides reason through thinking process

REFLECTIONS AND INTERPRETATIONS

(Fill this out as soon as possible after the classroom visit.)

1 - Overall, what happened during the classroom observation?

2 - What didn't happen (e.g., learners didn't grasp the idea of the lesson)?

3 - Alternative ways instructor might have handled the lesson/question/ situation:

4 - Characterize learners and their attitudes toward the subject matter and the teacher:

5. Was effective active learning taking place throughout the lesson? Justify.

APPENDIX 3-INFORMED CONSENT FORM FOR TEACHER INTERVIEWS

Thank you for agreeing to participate in this study, which will take place between November 10 to November 25. This form details the purpose of this study, a description of the involvement required and your rights as a participant.

The purpose of this study is to find strategies for teachers who teach large underfunded classes to successfully implement active learning. Learner centred education is one of the most effective ways to teach. Its advantages outweighs its disadvantages and research has shown it is a more effective approach. The reason I am doing this research is because the active learning seems to be unsuccessfully implemented in developing nations where the classes are large and underfunded.

The benefits of the research will be:

- To better understand challenges faced by teachers implementing active learning in large underfunded classrooms;
- To identify significant strategies that could help in the implementation of active learning in large underfunded classrooms.

The methods that will be used to meet this purpose include:

- One-on-one interviews
- Mini discussion groups of two or three participants

You are encouraged to ask questions or raise concerns at any time about the nature of the study or the methods I am using. Please contact me at anytime at the:

- e-mail address – ronesh.rajcoomar@gmail.com
- mobile- 0096896283476

Our discussion will be transcribed to help me accurately capture your insights in your own words. The documentation will only be studied by me for the purpose of this study. If you feel uncomfortable with the proceedings you may stop at any time.

You also have the right to withdraw from the study at any time. In the event you choose to withdraw from the study all information you provide will be destroyed and omitted from the final paper.

Insights gathered by you and other participants will be used in writing a qualitative research report, which will be read by my supervisor. Though direct quotes from you may be used in the paper, your name and other identifying information will be kept anonymous.

By signing this consent form I certify that I _____ agree to

(Print full name here)

the terms of this agreement.

(Signature)

(Date)

APPENDIX 4- PROXY CONSENT (RESPOND IF NOT WILLING)

Hay Al-Sharooq Private School
PO Box 888
Sur
PC411
Oman

Email: ronesh.rajcoomar@gmail.com
Mobile: 0096883476

Re: Strategies to implement active learning in large underfunded classroom

Dear Parent/Guardian

My name is Ronesh Rajcoomar and I am a Masters student at the University of South Africa. My aim is to find strategies for teachers who teach large underfunded classes to successfully implement active learning. Learner-centred education is one of the most effective ways to teach. Its advantages outweighs its disadvantages and research has shown it is a more effective approach to teaching and learning than the out dated teacher led approach. The reason I am doing this research is because the active learning seems to be unsuccessfully implemented in developing nations where the classes are large and underfunded.

I have planned to observe to Physics lessons that your child is in. I will not intervene in the lesson and will just observe the day to day teaching and learning process. No-one will be named in the report.

The head-teacher of the school is interested in and willing to cooperate with my research and has identified classes that will be observed.

If you are **not** willing to agree to your son or daughter taking part, I would be very grateful if you could sign the attached form and return it to school. If you would like to know more about the project, I would be very happy to chat with you. If you wish to do this, please feel free to contact either the head teacher at the school or me at the above addresses.

Many thanks for taking the time to read this letter and for your help.

Yours sincerely

Ronesh Rajcoomar

Hay Al-Sharooq Private School
PO Box 888
Sur
PC411
Oman

Re: Re: Strategies to implement active learning in large underfunded classroom Project

I am aware that my childhas agreed to take part in your research

I **do not** wish my child to take part in the project.

Signed.....Parent/Guardian

Please print your name.....

Please return this form to school as soon as possible

APPENDIX 5- LETTER TO HIGHER AUTHORITY

Hay Al-Sharooq Private School
PO Box 888
Sur
PC411
Oman
Email: ronesh.rajcoomar@gmail.com
Mobile: 0096883476

10 October 2011

District Education Officer

AEO Office

Kannur South

Kannur

Re: Strategies to implement active learning in large underfunded classroom

Dear Sir/Madam

I am a Masters candidate in the Department of Educational Studies at the University of South Africa. As part of my research I am undertaking a qualitative study. Qualitative research, in general, seeks to understand certain phenomena of human behavior by examining the actions and words of the people in the situation under study, with particular emphasis on the context in which the situation occurs. In contrast to quantitative research, the results of qualitative research are intended to discover insights and to deepen our understanding of human experience, rather than to prove an hypothesis. Common methods for conducting qualitative inquiry are interviewing and/or observing the participants of the study, and/or asking them to do think-aloud protocols, and/or to keep journals or to undertake correspondence.

For my dissertation, I have chosen to study active learning in large underfunded classroom. My aim is to find strategies for teachers who teach large underfunded classes to successfully implement active learning. Learner-centred education is one of the most effective ways to teach. Its advantages outweighs its disadvantages and research has shown it is a more effective approach to teaching and learning than the out dated teacher led approach. The reason I am doing this research is because the active learning seems to be unsuccessfully implemented in developing nations where the classes are large and underfunded.

As part of this study, I plan to interview teachers and observe lessons in schools in the Kanur district from the Indian state of Kerala.

I am requesting permission from the education authorities from the Kanur district of Kerala to conduct this research in schools in the Kanur district that fits the large underfunded classroom profile.

If permission is granted, I would like you to know that:

- Participants may respond or not to any inquiry without prejudice.
- Participants may withdraw from the process at any time.
- Participants names will not be used in the study, but rather a pseudonym will designate remarks.
- Participants will have the opportunity to review the written transcript of interviews and to delete any portion they feel does not reflect the veracity of the interview process.
- The documentation regarding interviews and observations will be kept in a secure place by me until they are no longer needed and will be shared with no one other than my supervisor, Dr AT Motlhabane of the University of South Africa
- The material generated in the interviews will become part of a written project that satisfies the requirement of my masters dissertation and/or other publications deriving from this research. The nature of these publications would most likely be, but may not be limited to, scholarly research destined for an academic audience.
- I do not expect to benefit monetarily from this research in any direct way.
- Given the nature of my subject, I cannot foresee any unusual risks to the participants.

I would like to thank you for your consideration of my request. If you choose to grant permission in the above described research, please sign one copy of this form and return it to me.

Yours sincerely

Ronesh Rajcoomsr

I understand the conditions of this study and wish to grant permission as described above.

NAME: _____ SIGNATURE: _____ DATE: _____

APPENDIX 6 - INTERVIEW SCHEDULE

1. Opening

A. **(Establish Rapport)** [shake hands] My name is Ronesh Rajcoomar and I am doing my Master's degree through the University of South Africa.

B. **(Purpose)** I would like to ask you some questions about your teaching situation, understanding of active learning, techniques you use to implement active learning in your large classroom situation and some experiences you have had in trying to implement the strategies.

C. **(Motivation)** I hope to use this information to find effective strategies to implement active learning in large underfunded Physics classrooms.

D. **(Time Line)** The interview should take about 20-30minutes. Are you available to respond to some questions at this time?

(Transition: Let me begin by asking you some questions about your teaching situation)

II Body

A. Classroom situation

1. Could you describe to me a typical class you teach in respect to:

a. Venue;

b. Class size;

c. Seating arrangements;

- d. Electricity, lighting and ventilation;
 - e. Resources;
 - f. Distraction.
2. Do you have anything further to add about you teaching situation?

(Transition to the next topic: Can we now talk about your teaching approach?)

B. Active learning approach to learning

1. Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?
2. What provisions are made to develop teachers towards this approach?
3. Could you highlight the challenges faced by you in implementing active learning in your situation.
4. Could you describe some of the techniques that you use in your classroom during the active learning approach?
5. How effective are these techniques?
6. Do you have anything further to add about the teacher led approach?

(Transition to the next topic- Practical work is essential to the active learning process.)

C. Practical Work

1. Practical work is essential to the active learning process. Could you describe how you implement the practical work during lesson?
2. How often is this done?
3. Do you have anything further to add implementing practical work?

(Transition: Well, it has been a pleasure interviewing you. Let me briefly summarize the information that I have recorded during our interview.)

III Closing

A. (Summarize) Your views on active learning are.....

B (Maintain Rapport) I appreciate the time you took for this interview. Do you anything further to add regarding this research?

C. (Action to be taken) I should have all the information I need. Would it be alright to contact you if I have any more questions? Thanks again. You have added a lot of value to this research.

APPENDIX 7- EXAMPLES OF THE INTERVIEW RESPONSES

INTERVIEW OF THE PHYSICS TEACHER AT SCHOOL 1:

Researcher: Could you describe to me a typical classroom in which you teach in respect to:

Venue;Class size;Seating arrangements;Electricity, lighting and ventilation;Resources;Distraction.

Teacher: **Well we don't have any electricity or lighting, but the room is adequately furnished for the number of learners we have in our school.**

Researcher : Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?

Teacher: **I think a more learner centred approach is the best way forward for our children. The more traditional teaching methods of talking and the children listening and then copying everything down into their books do not produce the best results. The children should be able to ask, discuss and be able to take risks within their classrooms.**

Researcher : What provisions are made to develop teachers towards this approach?

Teacher: **The Ministry of Education is dedicated in keeping their teachers up to date to best support the Keralan education system. I enjoy attending the training courses because it allows us to share with teachers from other schools our best practices, especially at overcoming the limitations we have in our budget.**

Researcher : Could you highlight the challenges faced by you in implementing active learning in your situation.

Teacher: **Yes we do have challenges on a daily basis. As I just said we do not have a big budget here but we can do our best at providing practicals for the learners using the things we find in our local shops. We are lucky to have a laboratory here. It isn't big but it enables us to have science fairs and conduct the practicals as often as we can.**

Researcher : Could you describe some of the techniques that you use in your classroom during the active learning approach?

Teacher: **I try and do a few activities every lesson. I think the learners learn better when they are doing things rather than watching me every time. We**

usually work in groups to perform the activities, using the equipment and working out the theory or objective being taught in that lesson.

Researcher : How effective are these techniques?

Teacher: They seem to be very effective. Our learners do very well in the final exams and some are fortunate enough to go onto Tertiary education. It is the best we can do with our limitations in our budgets.

Researcher : Do you have anything further to add about the teacher led approach?

Teacher: It is important that the teacher guides and supports the learners in their learning, especially in the objectives. However, it is also important to take a step back and allow them to solve it for themselves. Even if that means it takes a little bit longer to conduct the practicals and activities. They will remember better if they worked it out amongst their group.

Researcher : Practical work is essential to the active learning process. Could you describe how you implement the practical work during lesson?

Teacher: We work in groups as I have already said. The lab is too small for us to use for our practicals so we have to use the classroom. It is big enough since we are working in groups. Physics requires practical involvement to discover how the theories work and to make the calculations for yourself.

Researcher : How often is this done?

Teacher: I try and do practicals as often as possible. Remember we only have a small lab and we only have the equipment that I can get easily but we try and do a practical every week.

Researcher : Do you have anything further to add implementing practical work?

Teacher: The science fair is a great way for the learners to work at home with their families using their learning from their practicals and activities we have done in class, to produce a their own practical.

Researcher : Your views on active learning are.....

Teacher: It is a balance between learners discussing and questioning, learners doing and teachers instructing. The theories need to be explained and noted before they can try and put them into practice. All are important for learners to complete the curriculum successfully.

Researcher : I appreciate the time you took for this interview. Do you anything further to add regarding this research?

Teacher: I think we covered everything. The learner centred approach is working in Kerala despite the obvious difficulties we experience. If it is implemented correctly and the teachers are supported I do feel it can work anywhere.

INTERVIEW OF THE PHYSICS TEACHER AT SCHOOL 2 :

Researcher: Could you describe to me a typical classroom in which you teach in respect to:

Venue;Class size;Seating arrangements;Electricity, lighting and ventilation;Resources;Distraction.

Teacher: Class size is about 55 pupils. There is sufficient furniture for everyone to sit and work and the class is equipped with a black board.

Researcher: What about resources?

Teacher: There are very limited science equipment. Not enough for the class sizes. We don't have modern teaching equipment and there is no electricity in the class.

Researcher : Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?

Teacher: I support the governments initiative to have an education system that is inclusive, learner driven and encourages creativity. This makes more sense than the lecture method of teaching.

Researcher : What provisions are made to develop teachers towards this approach?

Teacher: The State Council of Education Research Training Provides annual training.

Researcher: What sort of training do you undergo?

Teacher: We are work shopped on strategies to implement activity based learning. We also have regular district meeting with neighboring schools to discuss strategies

Researcher : Could you highlight the challenges faced by you in implementing active learning in your situation.

Teacher: The curriculum is very academic and sometimes it is difficult to cover so much content and support activity based learning. Certain abstract concepts have to be taught by the teacher before an activity can be done.

Researcher : Could you describe some of the techniques that you use in your classroom during the active learning approach?

Teacher: Group work activities is the key approach. Under supervision group activities are used to complete task.

Researcher : How effective are these techniques?

Teacher: Very effective, because the learner become responsible for their own learning.

Researcher : Do you have anything further to add about the teacher led approach?

Teacher: It will work better if the class sizes are small .

Researcher : Practical work is essential to the active learning process. Could you describe how you implement the practical work during lesson?

Teacher: We have very limited equipment. It is not possible for the whole class to do the practical at once. During practical session the science classes are combined. A group will go to the lab and conduct the practical whilst the other learners do supervised activity with another teacher.

Researcher : How often is this done?

Teacher: The government requires an average of 20 experiments to be done a year.

Researcher : Do you have anything further to add implementing practical work?

Teacher: Sometime it is not possible to complete practical work in such a demanding curriculum so we do practical demonstrations instead.

Researcher : I appreciate the time you took for this interview. Do you anything further to add regarding this research?

Teacher: What are you going to do with the research results?

Researcher : The results are going to be used to complete my Masters dissertation. I also hope to find practical strategies to support active learning in large underfunded classrooms that will help teachers that are having problems in this area.

INTERVIEW OF THE PHYSICS TEACHER AT SCHOOL 3:

Researcher: Could you describe to me a typical classroom in which you teach in respect to:

Venue;Class size;Seating arrangements;Electricity, lighting and ventilation;Resources;Distraction.

Teacher: Under resourced, no electricity and water, large class sizes. During the hot season the class gets very stuffy. During rainy days the class gets wet.

Researcher : Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?

Teacher: It takes a lot of hard work in order to implement this form of teaching because the class sizes are large and there is very little resources and the science curriculum is long and highly academic.

Researcher : What provisions are made to develop teachers towards this approach?

Teacher: We attend workshops on a regular basis.

Researcher: What sort of training do you undergo?

Teacher: The teacher undergo professional development on useful skills and techniques in teaching.

Researcher : Could you highlight the challenges faced by you in implementing active learning in your situation.

Teacher: As mentioned we have very limited resources and the academic program is very long. For the senior class school are open on Saturday's.

Researcher : That is very interesting. Does this only occur at your school ?

Teacher: At workshops it was discussed as a strategy that the majority of the in the district schools use in order to complete curriculum and effectively prepare the pupils for their examination

Researcher : Could you describe some of the techniques that you use in your classroom during the active learning approach?

Teacher: **I minimize talking about content. Poster work on flow diagrams, group activities and allowing the pupils to try and fail instead of not trying at all is what I feel works.**

Researcher : Do the teachers get extra pay for all their efforts.

Teacher: **No**

Researcher : How effective are these techniques?

Teacher: **The pupils respond very well to these techniques.**

Researcher : Do you have anything further to add about the teacher led approach?

Teacher: **It works very well even for large classes.**

Researcher : Practical work is essential to the active learning process. Could you describe how you implement the practical work during lesson?

Teacher: **The education ministry prescribes a lot of practicals because it supports the theory. We have been trained at workshops on using everyday items to construct practicals that supports learning. Group work and demonstrations are a way to overcome the lack of equipment.**

Researcher : How often is this done?

Teacher: **At least once every 2 weeks**

Researcher : Do you have anything further to add implementing practical work?

Teacher: **There is no point in teaching the theory without showing how it works in the real world.**

Researcher : I appreciate the time you took for this interview. Do you anything further to add regarding this research?

Teacher: **That's all, Thank You.**

INTERVIEW OF THE PHYSICS TEACHER AT SCHOOL 4 :

Researcher: Could you describe to me a typical classroom in which you teach in respect to:

Venue;Class size;Seating arrangements;Electricity, lighting and ventilation;Resources;Distraction.

Teacher: **Our classrooms do not have windows and electricity. We just have a basic chalkboard for teaching.**

Researcher: What about the lab?

Teacher: **Well, we do have a lab but it does not have enough equipment for the number of pupils we teach.**

Researcher : Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?

Teacher: **Oh, you mean the constructivist approach to learning started by Vygotsky. It eliminates the lecture method of teaching and protes activities. The education ministry recommends a minimum of three short activities for every lesson.**

Researcher : What provisions are made to develop teachers towards this approach?

Teacher: **We have district meetings once a month where we discuss teaching strategies.**

Researcher : Could you highlight the challenges faced by you in implementing active learning in your situation?

Teacher: **Attention span of the learners in such large classrooms. It becomes difficult when they are side tracked.**

Researcher : Could you describe some of the techniques that you use in your classroom during the active learning approach?

Teacher: **Brainstorming, Group activities, demonstrations, presentations.**

Researcher : How effective are these techniques?

Teacher: **The pupils prefer to be occupied on these tasks than listening to boring theory the whole lesson.**

Researcher : Do you have anything further to add about the teacher led approach?

Teacher: **The learners learn a lot from the activities but they still need to study very hard at home in order to do well in the examinations.**

Researcher : Practical work is essential to the active learning process. Could you describe how you implement the practical work during lesson?

Teacher: **There are activity days when the classes are split into groups and the groups take turns to do the assessed practicals. I also do a lot of practical demonstrations.**

Researcher : How often is this done?

Teacher: **Once after every few lessons.**

Researcher : Do you have anything further to add implementing practical work?

Teacher: **Project work can also assist in practicals.**

Researcher : I appreciate the time you took for this interview. Do you have anything further to add regarding this research?

Teacher: **I wish you all the best. Feel free to contact me should you need any more information**

INTERVIEW OF THE PHYSICS TEACHER AT SCHOOL 5:

Researcher: Could you describe to me a typical classroom in which you teach in respect to:

Venue;Class size;Seating arrangements;Electricity, lighting and ventilation;Resources;Distraction.

Teacher: **The learners sit on wooden benches with long wooden desks to work on and I have a chalk board to write notes on. There is no electricity or lighting, however, there is sufficient natural light for the children to work.**

Researcher : Indian Ministry of Education have a drive to implement the learner-centred approach to teaching and learning. What are your views on this approach?

Teacher: **I think it is important the learners are involved in their lessons. If I just talk to the learners for the entire lesson they will become unfocussed and won't get all the information I need them to learn. I encourage the learners to be involved, asking questions and discussing the objectives. I try and use**

Bloom's questioning techniques to ensure they get the best learning every day.

Researcher : What provisions are made to develop teachers towards this approach?

Teacher: **We receive regular training from the Ministry of Education but our Principal insists on weekly staff sharing events where we can share advice and good practices with our colleagues.**

Researcher : Could you highlight the challenges faced by you in implementing active learning in your situation.

Teacher: **We are recommended to conduct 3 activities in each lesson so that the children are practically engaged with the objectives. The budget does not allow us to have a well stocked laboratory so we need to use materials that I can get easily in the local community. Space is also an issue as there is not enough space for the children to work independently.**

Researcher : Could you describe some of the techniques that you use in your classroom during the active learning approach?

Teacher: **Despite the number of learners I think it is really important that everyone is involved and active. We work in groups, with me briefly discussing how to use the equipment and then the groups working together to conduct the experiment and practicals.**

Researcher : How effective are these techniques?

Teacher: **The learners learn far more when they are exploring and discovering for themselves instead of me telling them. They retain the information better and are able to make more connections to the other objectives we cover in the Physics curriculum.**

Researcher : Do you have anything further to add about the teacher led approach?

Teacher: **The teacher does still need to explain and discuss objectives, explaining the theories etc. However, that must go hand in hand with practicals for the learners to achieve the learning required to help them in their exams.**

Researcher : Practical work is essential to the active learning process. Could you describe how you implement the practical work during lessons?

Teacher: Well, as I have already discussed we do activities in every lesson using everyday materials. We work in groups as there is not enough equipment or space for learners to work individually.

Researcher : How often is this done?

Teacher: As much as possible, but at least 1 lesson every week involved practical work.

Researcher : Do you have anything further to add implementing practical work?

Teacher: I think we covered everything.

Researcher : Your views on active learning are.....

Teacher: It is an important part of the curriculum to ensure the best from all of our learners. The more actively engaged they are, the more likely they are to retain the objective of that lesson.

Researcher : I appreciate the time you took for this interview. Do you have anything further to add regarding this research?

Teacher: Thank you for coming to see how we do things in Kerala. It is not often the children are able to talk to people from outside the community.

BIBLIOGRAPHY

AAHE.1996. *AAHE Bulletin*. Washington, DC: American Association for Higher Education

Abell, S.K. Lederman, N.G. 2007. *Handbook of Research on Science Education*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.

Abimbola, I.O.1994. A critical appraisal of the role of laboratory practical work in science teaching in Nigeria. *Journal of Curriculum and Instruction*, Volume 4, No.1: 59-65. Available:
< <http://www.unilorin.edu.ng/publications/abimbola/A%20CRITICAL%20APPRAISAL%20OF%20THE%20ROLE%20OF%20LABORATORY%20PRACTICAL%20WORK%20IN%20SCIENCE%20TEACHING%20IN%20NIGER>>. [Accessed: 2 July 2012].

Absolum, M. 2010. *Clarity in the Classroom*. Auckland, New Zealand: Hachette New Zealand Ltd.

Adams, D.M. Hamm, M. 2008. *Bringing Science And Mathematics To Life For All Learners*. Massachusetts, USA: World Scientific Publishing.

Adedoyin, O.O. Shangodoyin, D.K. 2010. Concepts and Practices of Outcome Based Education for Effective Educational System in Botswana. *European Journal of Social Sciences*. Volume 13, Number 2: 161-170.

African Education Empowerment Network (AFREEN). 2011. *Project Proposal on Improvement of the Quality of Teaching and Learning of Science Subjects in Three Schools in Missenyi District-Tanzania*. Dar es Salaam, Tanzania: AFREENedu

Aggarwal,Y. 2000. *Public and Private Partnership in Primary Education in India: A study of unrecognised schools in Haryana*. New Delhi, India: National Institute of Educational Planning and Administration

Ahmad, J. 2009. *Teaching of Biological Sciences*. New Dehli, India:PHI, Learning Private Limited.

Aikenhead, G.S. Jegede, O.J. 1999. Phenomenon. *Journal of Research in Science Teaching*. Volume 36, No. 3:269-287.

Aikenhead, G.S.1997. *Towards a First Nations Cross-Cultural Science and Technology Curriculum*. Oxford, UK :John Wiley & Sons, Inc.

Altbach, P.G. Reisberg, L. Rumbley, L. 2009. *Trends in Global Higher Education: Tracking an Academic Revolution*. UNESCO 2009 World Conference on Higher Education: SIDA/SAREC

Amstrong, T. 2009. *Multiple Intelligences in the Classroom*. Third edition. Virginia, USA: Association for Supervision and Curriculum Development

Alvis, T. 1999. *The Best of Multiple Intelligences Activities*. California, USA : Teacher created Resources

Andrews, B. 2009. Human Resource Mgmt: Text For Hospitality. New Dehli, India: Tata McGraw-Hill

Attard, A. 2010. Student Centred Learning: An Insight Into Theory And Practice. Bucharest, Romania: Education International.

Atherton, J. S. 2011. *Learning and Teaching: Constructivism in learning*. Available: < <http://www.learningandteaching.info/learning/constructivism.htm>>. [Accessed: 25 Apr 2012].

Akatugba, A. H. Wallace, J. 2008. An integrative perspective on learners' proportional reasoning in high school Physics in a West African context. *International Journal of Science Education*. Volume 31, No. 11: 1473-1493

Akrust, V.G. 2011. *Learning and Cognition*. Oxford, UK: Academic Press

Babbie, E.R. 2010. *The Practice of Social Research*. Twelfth Edition. California, USA: Wadsworth CENAGE Learning.

Babbie, E.R. Maxfield, M.G. 2011. *Basics of Research Methods for Criminology Justice and Criminology*. California, U.S.A: Cenage Learning.

Baimba, A. 1993. Innovation in a science curriculum: A Sierra Leone case study. *International Journal of Science Education*. Volume 15, No. 2.

Baker, D.A. 1997. A Study of the Effect of Culture on the Learning of Science in non-Western Countries. Science and Mathematics Education Centre. Curtin University of Technology

Baker, D. Taylor, P.C.S. 2007. The effect of culture on the learning of science in non-western countries: the results of an integrated research review. *International Journal of Science Education*. Volume 17, No. 6: 695-704.

Barrett, A. Ali, S. Clegg, J. 2007. *Quality in Education, Teaching and Learning: Perceptions and Practice*. Namibia Pilot Study of Teacher Professional Development.

Barrow, K. Boyle, H. Ginsburg, M. Leu, E. Pier, D Price-Rom, A. 2007. *Professional Development and Implementing Active Learning, Student Centred Pedagogies*. Cross-National Synthesis on Education Quality Report No. 3. USA: United States Agency, International Development.

Beeby, C.E. 1966. *The quality of education in developing countries*. Cambridge, MA: Harvard University Press.

Berk, LE. 2006. *Child development*. Seventh edition. USA: Pearson.

Berry, M.W. Dayal, U. Kamath, C. Skillicorn, D. 2004. *Proceedings Of The Fourth Siam International Conference On Data Mining*. Lake Buena Vista, Florida: SIAM Pub

Berwick, G. 2004. *Voila: Teachers Book1*. Sydney, Australia: Nelson Thornes.

- Bentham, S. 2003. A Teaching Assistant's Guide to Child Development and Psychology in the Classroom. Abingdon, Oxon: Routledge Publications
- Bhate, B. 2009. India to be top economic superpower by 2030: Survey, Rediff Business. 2009. Available: <<http://business.rediff.com/slideshow/2009/dec/17/slideshow-1-india-to-be-top-economic-superpower-by-2030.htm>>.[Accessed: 15 Feb 2012].
- Biggs, J. 2003. Teaching for Quality Learning at University – What the Student Does? 2nd Edition. Buckingham, UK: Open University Press.
- Biggs, J. 2006. Enhancing learning through constructive alignment. Higher Education Journal, Vol. 32: 347-364.
- Biggs, J. Tang, C. 2011. Teaching for Quality Learning at University. Fourth Edition. Berkshire, England: Open University Press
- Black, P. William, D. 1998. Inside the Black Box: Raising Standards through classroom assessment. Phi Delta Kappan, Vol. 80 (2) :139-148.
- Blenkin, G.M. 1992. Change and the curriculum. London: Paul Chapman.
- Blake, B. Pope, T. 2008. Developmental Psychology: Incorporating Piaget's and Vygotsky's Theories in Classrooms. Journal of Cross-Disciplinary Perspectives in Education. Vol. 1, No. 2:59-67.
- Bloom, B.S. 1956. Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc.
- Blumberg, P. Weimer, M. 2009. Developing Learner-Centred Teaching: A Practical Guide for Faculty. San Francisco, California: Jossey-Bass Pub.
- Bonwell, C.C. Eison, J.A. 1991. Active learning: creating excitement in the classroom. Washington: George Washington University.
- Brink, H. van de Walt, C. 2006. Fundamentals of Research Methodology for Health-care Professionals. Second Edition. Lansdowne, Cape Town: Juta and Co. Ltd
- Biddle, B.J. Good, T.L. Goodson, I. 1997. International Handbook of Science Education. Part 2. Dordrecht, Netherlands: Kluwer Academic Publishers
- Brooks, M.G. Brooks, G.J. 1999. The Courage to be a Constructivist. The Constructivist Classroom. Volume 57, No. 3: 18-24.
- Brabrand, C. 2007. Constructive Alignment for Teaching Model-Based Design for Concurrency. Aarhus, Denmark: University of Aarhus.
- Bransford, J. 2000. How People Learn: Brain, Mind, Experience, and School Washington, USA: National Committee of Science.
- Brown-Acuaye, H. A. 2004. Science for Development: Failure in Ghana. African Journal of Educational Studies in Mathematics and Sciences, Vol. 2 No. 2: 11-20

Bryman, A. Buchanan, D. 2009. The SAGE Handbook of Organizational Research Methods. London, U.K: SAGE Publications Ltd.

Byram, M. 2000. Intercultural Communicative Competence: The challenge for language teacher training. Mountford:, A. and N Wadham-Smith.

Byrne, D.A. 2009. The Effects of Service Learning and Reflection on the Pre-service Teacher. Michigan, USA: Proquest LLC.

Caillods, F. Postlethwaite, T.N. 1989. Teaching and Learning Conditions in Developing Countries. Prospects Quarterly Review of Education. Volume 19, No. 2:169-190.

Cambaliza, O.L. 2001. Adapting Active Learning Approaches in Physics Education to Local Asian Enviroments: Quezon City, Phillipines.

Campbell, B. Campbell, L. 2009. Mindful Learning: 101 Proven Strategies for Student and Teacher Success. London, UK: Sage Ltd

Campbell, L. Campbell, B. Dickinson, D. 2004. Teaching and learning through multiple intelligences. Michigan, Detroit: Allyn and Bacon

Cantu, D.A. Warren, W.J. 2003. Teaching History in the Digital Classroom. Armonk, New York: M.E. Sharp, Inc.

Carlton, R. 2004. Play with learning. Constructivism and Games. Available: < <http://playwithlearning.com/2012/01/20/constructivism-and-games/>>. [Accessed: 25 Apr 2012].

CBSE-Secondary. 2011. Secondary School Curriculum: Main Subjects. Delhi, India: Secretary, C.B.S.E, 'Shiksha Kendra'.

CBSE-Senior. 2011. Senior Secondary School Curriculum: Main Subjects. Delhi, India: Secretary, C.B.S.E, 'Shiksha Kendra'.

Chambers, R. Boath, E. Rogers, D. Clinical Effectiveness and Clinical Governance Made Easy 4e. Fourth Edition. Oxon, UK: Radcliffe Publishing,

Chance, P. 2009. Learning and Behavior: Active Learning Edition. Sixth Edition. Belmont, California: Wadsworth, Cengage learning.

Chattergee, J. 2008. Primary and Secondary education reform should be India's top priority. Nature Network.

Available: < <http://network.nature.com/groups/natureindia/forum/topics/3340>>. [Accessed: 24 July 2012].

Chickering, AW. Gamson, ZF. 1987. Seven Principles for Good Practice. AAHE Bulletin 39: 3-7. Available: <<http://serc.carleton.edu/introgeo/gallerywalk/active.html>>. [Accessed: 17 Mar 2012].

Cobern, W.W. 2007. Constructivism and non-western science education research. International Journal of Science Education. Volume 18, No.3: 295-310

Cohen, L. Manion, L. Morrison, K. Morrison, K. R.B. 2007. *Research Methods in Education*. Sixth Edition. New York, New York: Routledge.

Colwell, R. Richardson, C. 2002. *The New Handbook of Research on Music Teaching and Learning*. Cape Town, South Africa: Oxford University Press.

Conklin, W. Sorell, C. 2010. *Applying Differentiation Strategies*. Hunting Beach California: Shell Educational Publishing, Inc.

Cyranoskil ,D., Gilbert ,N., Ledford,H., Nayar,A., Yahia ,M. 2011. Education. The Phd factory. Available:<<http://www.nature.com/news/2011/110420/full/472276a.html>> [Accessed 16 February 12].

Dahar, M.A. Faize, F.A. 2011. Mis-allocation of Student Teacher Ratio, Class size and Per Student Expenditure Leads to the Wastage of Resources and Lower Academic Achievement: An Issue of Resource Management. *International Research Journal of Finance and Economics* . Volume 62: 94-110.

Davidson, L. Rakfeldt, J. Strauss, J. 2010. *The Roots of Recovery Movement in Psychiatry: Lessons Learned*. Oxford, UK: John Wiley and Sons, Ltd.

Davis, W.E. Broadhead, G.D. 2007. *Ecological Task Analysis And Movement*
Champaign, Illinois: Human Kinetics

Daymon, C. Holloway, I. 2011. *Qualitative Research Methods in Public Relations and Marketing Communications*. New York, New York: Routledge Ltd

Donald, D. Bartel, NR. 2006. *Teaching learners with learning and behaviour problems*. Seventh edition. Texas: Pro- ed International Publisher.

Drori, G.S. (1998). A critical appraisal of science education for economic development. In W. Cobern (Ed.) *Socio-cultural perspectives on science education: An international dialogue*. Dordrecht, Netherlands: Kluwer Academic Publishers, pp. 49-74.

Du Plooy, G.M. 2002. *Communication Research: Techniques, Methods and Applications*.

Dunbar, R. 2006. Adapting distance education for Indonesians: Problems with learner heteronomy and a strong oral tradition. *Distance Education*. Volume12 no.2: 163-174

Dunne, T. Kurki, M. Smith, S. 2007. *International Realtions Theories: Dioscipline and Diversity*. Oxford, U.K: Oxford University Press.

Durairajan, S. Dayal, G. 2009. *Teaching Children Through Intrapersonal Intelligence*. Parentree.

Available: < <http://www.parentree.in/Parentree-editors/journal-860/Teaching-children-through-intrapersonal-intelligence--multiple-intelligence----Activities--Toys--Materials-Examples.html>> [Accessed 9 June 2012].

EBC (Education Broadcasting Corporation). 2004. Concept to Classroom: Workshop on constructivism as a paradigm for teaching and learning.

:<http://www.thirteen.org/edonline/concept2class/constructivism/index_sub.html>

[Accessed 10 May 2012].

Éireann, S.1990. Primary Education: Motion - Volume 125 Parliamentary Debates

Available:<<http://historical-debates.oireachtas.ie/S/0125/S.0125.199006060006.html>>

[Accessed 10 May 2012].

Farrell, M. 1999. Key Issues for Primary Schools. New York, New York: Routledge Publishing.

Felder, R.D. Rugarcia, A. Stice, J. Woods, D. 2000. Engineering Education: Teaching Methods that Work. Chemical Engineering Education Journal, Vol. 34, No. 1 : 26-39.

Forrester, M.A. 2010. Doing Qualitative Research in Psychology: A Practical Guide. London, UK. SAGE Publications Ltd.

Franke, R.W. Chasin, B. H. 1992. Kerala, development through radical reform. San Francisco: Promilla in collaboration with the Institute for Food and Development Policy.

Franke, R.W. Chasin, B.H. 2000. The Kerala Decentralisation Experiment

Achievements, Origins, and Implications. International conference on Democratic Decentralisation. Kerala, India: State Planning Board Kerala.

Fraser, B.J. Tobin, K.G. McRobbie, C.J. 2012. Second International Handbook of Science Education. Heidelberg: Springer-Verlag.

French,D.P. 2004. Tips for managing a large active learning class. Washington, USA: National Science teachers association.

Frost, J. 2010. Learning to teach Science in the Secondary School: A Companion to School Experience. Third Edition. New York, New York: Routledge Publishing.

Gabel, D. 1995. An Introduction to Action . National Association for Research in Science Teaching. San Francisco, USA: Available: <<http://Physicsed.buffalostate.edu/danowner/actionrsch.html>>. [Accessed: 26 August 2012].

Gardner, H.1991. The Unschooled Mind: How Children Think and How Schools Should Teach. New York: Basic Books.

Gardner, H. 2006. Multiple Intelligences: New Horizons. New York: Basic Books

Gassner, M.E. 2006. Investigating the Long- term Impact of adventure Education: Retrospective Study of Outward Bound Sigapore's Classic 21-day Challenge Course. Ann Arbor, Michigan: Proquest Information and Learning Company

Giannola, C.D. Green , L. S. 2011. 40 Active Learning Strategies for the Inclusive Classroom, Grades K–5. Thousand Oaks, California: Cowan Ltd.

- Gibbs, G.R. 2007. *Analysing Qualitative Data*. London, UK: SAGE Publications Ltd.
- Goldston, M.J. Downey, L. 2012. *Your Science Classroom: Becoming an Elementary/ Middle School Teacher*. London, UK: SAGE Publications Ltd.
- Giles, E. 2011. *The Teaching Continuum: The Wheel for Effective and Efficient Learning*. Indianapolis, USA: Author House.
- Gillham, B. 2000. *Research Interview*. New York, New York: Continuum Ltd.
- Gearing, F. Sangree, L. 1979. *Toward a Cultural Theory of Education and Schooling*. Hague, Netherlands: Mouton Publishes
- Grady, M.P. 1998. *Qualitative and Action Research: A Practitioner Handbook*. Indiana, USA: Phi Delta Kappa Educational Foundation.
- Gray, A. 1995. *"The road to knowledge is always under construction" : A life history journal to constructivist teaching*. Saskatoon, Canada: University of Saskatchewan Library Electronic Theses & Dissertations. Available: < <http://saskschoolboards.ca/research/instruction/97-07.htm>>. [Accessed: 24 Apr 2012].
- Green, S. 2000. *Research Methods in Health, Social and Early Years Care*. Cheltenham, UK: Nelson Thornes Ltd
- Green, L.J. Camilli, G. Elmore, P.B. 2006. *Handbook of Complementary Methods in Education Research*. Washington, U.S.A: American Educational Research Association.
- Hake, R. 1998. Interactive-Engagement vs. Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses. *American Journal of Physics*, Vol. 66, No. 1:64.
- Hale, C. Pekkain, J. Carlson, K. 2008. *Charting New Courses: Second Language Action Research in Japanese Junior and Senior School*. New York, New York: Accents Asia Press.
- Hamilton, K.E. 2000. *Presenting to Different types of learners*. Available: < <http://webhome.idirect.com/~kehamilt/spklearn.html>>. [Accessed: 28 June 2012].
- Hammond, L.D. Post, L. 2000. *Inequality In Teaching: Supporting High-Quality Teaching and leadership in Low income schools*. Twentieth Century Fund Inc.
- Hanushek, E.A. 1995. *Interpreting Recent Research on Schooling in Developing Countries*. World Bank Obs. Volume 10, No. 2: 227-246.
- Harmon, D.A. Stokes, T. 2005. *Elementary Education: A Reference Handbook*. Santa Barbara California: ABC Clio Inc.
- Harrington, N. Terry, C.L. 2009. (Harrington & Terry, 2008:133). *LPN to RN Transitions: Achieving Success in Your New Role*. Third Edition. Philadelphia, USA: Wolters Kluwer Health

- Hartas, D. 2010. Educational Research and Inquiry: Quantitative and Qualitative Research. New York, New York: Continuum International Publishing Group.
- Haṭ ivah , N. 2000. Teaching for Effective Learning in Higher Education. Dordrecht ,Netherlands: Kluwer Academic publishers.
- Heacox, D. 2002. Differentiating Instruction in the Regular Classroom. Minneapolis, USA: Free Spirit Publishing Inc.
- Heart, S. 1996. Differentiation and the Secondary Curriculum. New York, New York: Routledge Publishing.
- Holbrow, H.C. R. Loyd, J.N. Amato, J. Galvez, E.2010. Modern Introductory Physics. NY : Springer Science.
- Hoppers, C.A.O. 2002. Indigenous Knowledge and the Integration of Knowledge Systems: Towards a Philosophy of Articulation. Claremont, South Africa: New Africa Books Ltd.
- India Planning Commission. 2008. Kerala Development Report. New Delhi, India: Academic Foundation.
- Ivers,K.S. Pierson, M. 2003. A Teacher's Guide to Using Technology in the Classroom. Connecticut. USA: Greenword Publishing Group.
- Ingle, R., & Turner, A. (1981). Science curricula as cultural misfits. *European Journal of Science Education*, 3(4), 357-371.
- Jan, W.L. Wilson, J. 2009. Focus on inquiry: a practical approach to curriculum planning. South Victoria, Australia: Curriculum Corporation.
- Jegede, O.J. Aikenhead, G.S. 1999. Transcending Cultural Borders: Implications for Science Teaching Journal for Science & Technology Education. Volume 17, no. 1: 45-66.
- Jorgensen, C. 1998. Restructuring high schools for all learners: Taking inclusion to the next level. Baltimore: Paul H. Brookes Publishing Co.
- Gall, J.P. Gall, M.D. Borg, W.R. 1999. Applying educational research: a practical guide. Michigan, Detroit: Longman Publishers.
- Kail, V.R. Cavanaugh, J.C. 2010. Human Development: A life-span View. Belmont, California: Wadsworth, Cenage Learning.
- Kain, D.J.2002. Teacher-Centred versus Student-Centred: Balancing Constraint and Theory in the Composition Classroom. Durham, USA: Duke University Press
- Kaul, C. Moschovitis, V.T. 1999. Statistical Handbook on Poverty in the developing world. Phoenix, Arizona: Orynx Press

Keogh, B. Naylor, S. 1996. *Teaching and learning in science: a new perspective. Education-Line. Available: < <http://www.leeds.ac.uk/educol/documents/000000115.htm>>. [Accessed: 25 Apr 2012].*

Kerr, B. 2009. *Encyclopedia of Giftedness, Creativity, and Talent, Volume 1.* London, United Kingdom: SAGE Publications.

Killen, R. 2006. *Effective teaching strategies. Fourth Edition.* Sydney, Australia: CENGAGE Learning

Kingdon, G.G. 2007. *The progress of school education in India. Oxford Review of Economic Policy, Volume 23, Number 2: 168-195*

Klenke, K. 2008. *Qualitative Research In The Study Of Leadership.* Bingley, U.K: Emerald Group Publishing Limited.

Klentschy, M. Thompson, L. 2008. *Scaffolding Science Inquiry Through Lesson Design.* Portsmouth, NH: Heinemann

Knuth, R. A. Cunningham, D. J. 1993. *Tools for constructivism.* Heidelberg: Springer-Verlag.

Kridel, A.C.2010. *Encyclopedia of Curriculum Studies, Volume 1.* London, UK: Sage Pub.Ltd.

Kumar, R. 2008. *Research Methodology.* New Delhi, India: APH Publishing Corporation.

Kyriacou , C. 1997. *Effective Teaching in Schools: Theory and Practice.* Cheltenham-UK: Nelson Thornes Ltd.

Lantis, S.J. Kuzma, L.M. Boehrer, J. 2000. *The State of the Active Teaching and Learning Literature.* London: Lynne Rienner Publishes,Inc.

Lakshmi, G.V.S. 2004. *Methods Of Teaching Environmental Science.* New Delhi,India: Discovery Publishing House

Lall, M. 2005. *The Challenges for India's Education System.* Asia Programme, Chatham House.

Laudon, K. Laudon, J. (2010). *Management Information Systems: Managing the Digital Firm. Eleventh Edition (11 ed.).* New Jersey: Prentice Hall Pub.

Leonard, D.C. 2002. *Learning Theories, A-Z.* Connecticut, USA: Greenwood Publishing Group, Inc.

Lewin, K.M. 1992. *Science education in Developing Countries: Issues and Perspectives for Planners. The Development of Human Resources : UNESCO*

Leyendecker, R. Ottevanger, W. van den Akker, J.J.H..2008. *Curricula, Examinations, and Assessment in Secondary Education in Sub-Saharan Africa.*

World Bank Paper 128. Washington, USA: The International Bank for reconstruction and development.

Lichtman, M. 2009. Qualitative research in Education: A Users Guide. Second Edition. London, U.K: SAGE Publication Ltd.

Livingstone, J. 1997. *Metacognition: An Overview*. Available: <
<http://gse.buffalo.edu/fas/shuell/cep564/Metacog.htm>>. [Accessed: 7 May 2013].

Lockheed, M. Levin H. 1991. *Effective Schools in Developing Countries*. Washington DC, USA: The World Bank, Education and Employment Division, Population.

Lunenburg, F.C. Allan, A.C.Ornstein. 2012. *Educational Administration: Concepts and Practices*. Sixth Edition. California, USA: Wadsworth, Cengage Learning.

Lund, J. Tannehill, D. 2010. *Standards-Based Physical Education Curriculum Development*. Second Edition. London, United Kingdom: Jones and Bartlett Publishers

Malcom, C. 2000. Choosing the content of Science. In M. Schramm (Ed), *Proceedings of the Science and Technology Educators conference*. Hartfield: Science Education Project.

Mathews, M.R. 1998. *Constructivism in Science Education: A Philosophical Examination*. Dordrecht, Netherlands: Kluwer Academic Publishers

Matthews, M.R.2000. 'Constructivism in Science and Mathematics Education'. In D.C. Phillips (ed.), *National Society for the Study of Education, 99th Yearbook*. Chicago: University of Chicago Press.

Mathewson, J.H. 1999. Visual-spatial thinking: An aspect of science overlooked by educators. *Science Education*, vol. 83, Issue 1:33-54.

McDonald, E.S. Hershman, D.M. 2010. *Classrooms That Spark: Recharge and Revive Your Teaching*. San Francisco, California: John Wiley & Sons, Inc

McKenzie, W.2005. *Multiple Intelligences And Instructional Technology*. Second Edition. Washington, DC: International society for Technology in Education

McKinley, E. Stewart, G. *Falling into Place. Indigenous Science Education Research in the Pacific.Cultural and Historical Perspectives on Science Education: Handbooks. Volume 2, No.1:49-68*

Macmillan, J.H. and Schumacher, S. 2010. *Research in education: evidence based inquiry*. New Jersey: Pearson education Inc.

Miles, H.K. 2000. Excerpted from the audiotape in *A Better Return on Investment: Reallocating Resources to Improve Student Achievement*. Available: <
<http://www.ncrel.org/sdrs/areas/issues/envrnmnt/go/go600.htm>>. [Accessed: 10 April 2012]

Miller, H.G. Williams, R.G. Haladyna, T.M. 1978. *Beyond Facts: Objective Ways to Measure Thinking*. Englewood Cliffs, New Jersey: Educational Technology Publications.

Mills, J. Mills, W. R. 2002. *Primary School People*. New York, New York: Routledge Publishing.

Mitter, A. 2012. *The Fallacy of our Education Systems*. Udaipur Times. Available: < <http://www.udaipurtimes.com/the-fallacy-of-our-education-system/>>. [Accessed: 24 July 2012].

Mohidin, F. 2011. *Study Skills, Mind Maps and Bloom's Taxonomy*. Mind Map Tutor.

Available: < <http://www.mindmaptutor.com/2011/01/study-skills-mind-maps-and-blooms-taxonomy/>>. [Accessed: 3 June 2012]

Moll, L.C. 1990. *Vygotsky and Education: Instructional Implications and Applications of Sociohistorical Psychology*. London: Cambridge University Press.

Nagao, M. Rogan, J.M. Magno, M.C. 2007. *Mathematics and Science Education in Developing Countries: Issues*. Quezon city, Philippines: University of Philippines Press

Muchhala, B. 2012. *Info Service on Finance and Development*. Third World Network. Available: <<http://www.twinside.org.sg/title2/finance/2012/finance120303.htm>>>. [Accessed: 6 May 2012]

Murnane, R.J. Willet, J.B. 2010. *Methods Matter: Improving Causal Inference in Educational and Social Science Research*. New York, New York: Oxford University Press.

Mwamwenda, T.S. Mwamwenda, B.B. 1989. *Teacher characteristics and pupils' academic achievement in Botswana primary education*. *International Journal of Educational Development*. Volume 9, No. 1: 31-42.

Nakabugo, MG. Maani, JS. Opolot-Okuru, C. Ssebbunga, CM. 2008. *Large Class Teaching in Resource-Constrained Contexts: Lessons from Reflective Researching Ugandan Primary Schools*. Hiroshima University, *Journal of International Cooperation in Education*, Volume 11:85-102.

Newman, B.M. Newman, P.R. 2012. *Development Through Life.: Psychosocial Approach*. Belmont, USA: Wadsworth, Cengage Learning

Nicholas, J. 2004. *Curriculum and Teaching*. Volume 20, no. 6:60-75.

Northey, S. Vaterman, S.N. 2005. *Handbook on Differentiated instructions for Middle and High Schools*. Larchmont, New York: Eye on Education

Nunan, D. Lamb, C. 1996. *The Self-Directed Teacher: Managing the Learning Process*. Cambridge, UK: Cambridge University press

Ogunniyi, M.B. Jegede, O.J. Ogawa, M. Yandila, C.D. Oladele, F.K. 1995. Nature of Worldview Presuppositions among Science Teachers in Botswana, Indonesia, Japan, Nigeria, and the Philippines. *Journal of Research in Science Teaching*. Volume 32, No. 8: 817-831.

Onwu, G. Stoffels, N. 2005. Instructional functions in large, under resourced science classes: Perspectives of South African teachers. *Journal of Perspectives in Education*, Volume 23 : 632-642.

Oppenheim, A.N. 2000. *Questionnaire Design, Interviewing and Attitude Measurement*. New York, New York: Continuum.

Ornstein, A.C., Hunkins, F.P. 2009. *Curriculum foundations, principles and issues*. Fifth Edition. Boston, USA: Pearson Education Inc.

Ornstein, A.C. Sinatra, R.I. 2004. *K-8 Instructional Methods: A Literacy Perspective*, Mylabschool. University of Virginia, Virginia: Allyn & Bacon Incorporated.

O'Sullivan, M. 2004. The Reconceptualisation of Learner Centred Approaches: A Namibian Case Study. *International Journal of Educational Development*, Volume 24, 6:585-602.

Ottevanger, W. van den Akker, J.J.H. De Feiter, L. 2007. *Foreign Technology Imports and Economic Growth in Developing Countries*. Washington. USA: World Bank, Human Development Dept.

Owoeye, J.S. Yara, P.O. 2011. School Facilities and Academic Achievement of Secondary School Agricultural Science in Ekiti State, Nigeria. *Asian Social Science*, Volume 7, No. 7: 64-74

Pandey, S. 2006. Para-teacher scheme and quality education for all in India: policy perspectives and challenges for school effectiveness. *Journal of Education for Teaching*. Volume 32, Number 3: 319-334.

Patton, M.Q. 1990. *Qualitative evaluation and research method*. London, UK: Sage Publication, Inc

Patton, M.Q. 2002. *Qualitative research and Evaluation Methods*. Third Edition. London, UK: Sage Publications, Inc.

Pham-Minh, Hung. 1995. The educational system of Vietnam. In David Sloper & Le Thac Can (Eds.), *Higher Education in Vietnam* :41-61. Indochina Unit: Institute of Southeast Asian Studies.

Phillips, D.C. 2000. *Ninety-ninth yearbook of the National society for the Study of Education*: Chicaro, Illinois: Humana Press.

- Phol, M. 2000. Learning to Think, Thinking to Learn: Models and Strategies to Develop a Classroom Culture of Thinking. Cheltenham, Vic: Hawker Brownlow.
- Piggot, A. 2002. Putting Differentiation into Practice in a Secondary Science Classroom. *School Science Review*, Volume 83: 65-71.
- Price, K.M. Nelson, L.K. 2011. *Planning Effective Instruction: Diversity Responsive Methods and Management*. Belmont, USA: Wadsworth, CENAGE Learning
- Prichard, C. Trowler, P. 2003. *Realising Qualitative Research into Higher Education*. Hants, England: Ashgates Publishing Ltd.
- Polit, D.F. Beck, C.T. 2008. *Nursing Research: Generating and Assessing Evidence for Nursing Practice*. Eighth Edition. Philadelphia, Pennsylvania: Lippincott Williams & Wilkins
- Prophet, R.B. 1990. Rhetoric and reality in science curriculum development in Botswana. *International Journal of Science Education*. Volume 12, no.1: 13-23
- Quigley, C. 2009. Globalization and Science Education: The Implications for Indigenous Knowledge Systems. *International Educational Studies*. Volume 2, No. 1: 76-88.
- Rai, U. R. 2011. *Fundamental rights and their enforcement*. New Dehli, India: PHI Learning Pvt. Ltd.
- Raman, N. 2005. How almost everyone in Kerala learnt to read. *Christian Science Monitor*. Available: <<http://www.csmonitor.com/2005/0517/p12s01-legn.html>>.[Accessed: 15 Feb 2012]
- Ramanathan, C. 2006. *A call for change: Transforming Indian Education by Connecting Academic Disciplines to Student Realities*. Columbia University.
- Research and Training Centre. 1998. *Library Science with a Slant to Documentation*. University of Michigan, USA: Sarada Ranganathan Endowment for Library Science
- Richardson, V. 2003. Constructivist Pedagogy. *Teachers College Record*, Vol. 105, No. 9: 1623-140
- Rieber, R.W. Carton, A.S. 1998. *The collected Work of L.S Vygotsky, Volume 1*. New York, New York: Springer International Publishing.
- Riley II, J.P. 2001. International Development and Science Education: Issues and Considerations. CICE Hiroshima University, *Journal of International Cooperation in education*, Vol.4 No.1: 53-63
- Riseman, N. Rechter, Ellen, W.S. 2010. *Learning, Teaching And Social Justice In Higher Education*. Melbourne, Austrailia: UoM Custom Book Centre
- Roberts, C. 2007. *New Developments in Educational Research*. New York, New York : Nova Science Publishers.

- Rollnick, M. 2010. Identifying potential for equitable access to tertiary level science, digging for gold. New York: Springer Dordrecht Heidelberg.
- Ryan, K. Cooper, J.M. 2008. Those Who Can, Teach. Belmont, California: Cengage Learning.
- Sabathier, V.G. Faith, G.R. 2008. India's Space Program. Centre for strategic International studies. Available: <http://csis.org/files/media/isis/pubs/080125_sabathier.pdfhtml>. [Accessed: 15 Mar]
- Sana, E.S. 2010. Teaching and Learning in the Health Sciences. Quezon City, Philippines: the University of Philippines Press
- Scales, P. Pickering, J. Senior, L. 2011. Continuous Professional Development in the Lifelong Learning Sector. Berkshire, England: McGraw-Hill Education
- Seidman, I. 2006. Interviewing As Qualitative Research: A Guide for Researchers in Education and Social Science. Third Edition. New York, New York: Teachers College Press.
- SERC. 2008. Starting Point: Teaching Entry Level Geoscience. Available: <<http://serc.carleton.edu/introgeo/gallerywalk/active.html>>. [Accessed: 3 September 2013].
- Settles, B. 2008. Curious Machines: Active Learning with Structured Instances. Madison: The University of Wisconsin.
- Shepherd, J. 2010. World education rankings: which country does best at reading, maths and science? Guardian. Available: <<http://www.guardian.co.uk/news/datablog/2010/dec/07/world-education-rankings-maths-science-reading>> [Accessed: 6 May 2012]
- Sikoyo, L. 2010. Contextual challenges of implementing learner-centred pedagogy: the case of the problem-solving approach in Uganda. Kampala: Routledge.
- Shaffer, D.R. Kipp, K. 2007. Developmental psychology, child and adolescence. Eighth edition. USA Wadsworth Cengage learning.
- Smith, M.K. 2001. John Dewey. Infed. Available: <<http://www.infed.org/thinkers/et-dewey.htm>> [Accessed: 25 Apr 2012]
- Smith, D.J. 2007. High School Maths Reform and the Role of Policy, Practice and Instructional Activities. Mississippi, USA: Proquest Information and Learning Company
- South Africa. Department of Education. 2003. National curriculum statement grades 10- 12 (general): physical science. Pretoria: Seriti Printing (Pty Ltd).

- Stinger, J. 2003. Science Co-ordinators' Handbook. Oxford, England: Heinemann Educational Publishers.
- Stix,A. 2004. Social Studies Strategies for Active Learning. California,,USA: Shell Education.
- Sylvia, L.M. Barr, J.T. 2011. Pharmacy Education. London, UK: Jones & Bartlett Learning International.
- Tappen, R. 2011. Advanced Nursing Research. Ontario, Canada: Jones & Barlette Learning.
- Tashakkori, A. and Teddli C. 2003. Handbook on mixed methods in the behavioral and social sciences. Thousand Oaks, CA: Sage.
- Tashakkori, A. Teddlie, C. 2009:186. Foundations of Mixed Methods Research: Intergration Quantitive and Qualitative Reseach. London, UK: SAGE Publications Inc.
- Taylor, G.R. MacKenny,L. 2008.Improving Human Learning in the Classroom: Theories and Teaching Practices. Plymouth, U.K.: R&L Education.
- Thanh, P.T.H. 2010. Implementing a student centred approach at Vietnamese Higher Education Institutions: Barriers under Layers of Casual Layered Analysis. Journal of Futures Studies , Volume 15, No. 1: 21-38.
- The World Bank. 2008. Curricula, Examinations, and Assessment in Secondary Education in Sub-Saharan Africa. The World Bank Working Paper n. 128. Washington DC, USA: The International Bank for Reconstruction and Development
- Thomas, J.R. Nelson, J.K. Silverman, S. 2011. Research Methods in Physical Activity. Sixth Edition. Chicago, Illinois: Human Kinetics Ltd.
- Todd, W.R. Why Investigate Large Classes? KMUTT Journal of Language Education. Volume 9. Special Issue: 1-12.
- Tomei, L. A. 2005. Taxonomy For The Technology Domain. London, UK: Idea Group Inc.
- Tomlinson, C.A. 2000. Reconcilable Difference? Standards-Based Teaching and Differentiation. Educational Leadership, Volume 58, no. 1: 6-11
- Thomlinson, C.A. Allan, S.D. 2000. Leadership for Differentiating Schools and Classrooms. Virginia, USA: Association for Supervision and Curriculum Development.
- Tytler, R. 2010. The student as scientist. Deaken University, Australia: STEME Research Group.
- UNESCO. 2008.Status of Education in India National Report. New Delhi, India: Department of Higher Education, Ministry of Human Resource Development.

- Unger, H.G. 2007. Encyclopedia of American Education, Volume 1. Third Edition. New York, New York: Infobase Publishing
- Uwin, D. Tate, N. Foote, K.. 2012. Teaching Geographic Information Science and Technology in Higher Education. West Sussex, U.K:Wiley & Sons, Ltd.
- Valerian, J. 1991. Innovations for large classes: A guide for teachers and administrators. Paris: United Nations Educational, Scientific and Cultural Organisation.
- Van Graan, M. Leu, E. 2006. Professional Development and Implementing Active Learning, Student Centred Pedagogies. Cross-National Synthesis on Education Quality Report No. 3. USA: United States Agency, International Development.
- Vavrus, F. Thomas, M. Bartlett, L. 2011. Ensuring quality by attending to inquiry: Learner centred pedagogy in Sub-Saharan Africa. Fundamentals of teacher education development- 4: UNESCO
- Veric, S. Islam, I. 2010. The Great Recession of 2008-2009: Causes, Consequences and Policy Responses. IZA Discussion Paper No. 4934.
- Vivian, W. I, C. McGuire, K. 2009. Narrowing the Achievement Gap in a (Re) Segregated Urban School District. Virginia, USA: Information Age Publishing.
- Vosniadou, S. 2008. International Handbook of Research on Conceptual Change. Kampala: Routledge.
- Vygotsky, L.S. 1978. Mind and Society: The development of the higher mental process. Cambridge: MA: Harvard University Press.
- Ware, A.S. 1992. Secondary School Science in Developing Countries: Status and Issues. Education and Employment Division Population and Human Resources Department: The World Bank. Document No. Phree, 92:53.
- Wasowski, R.P. 2009. Cliffs Notes: The Notebook Teacher's Guide. Hoboken, New Jersey: Wiley Publishing, Inc.
- Watts, J. Cockcroft, K. Duncan, N. 2009. Developmental Psychology. Cape Town, South Africa: UCT Press.
- Weil, D.K. Kincheloe, J.L. 2004. Critical Thinking and Learning: An Encyclopedia for Parents and Teachers. Westport, Connecticut: Greenwood Publishing Group, Inc.
- Weimer, M. 2012. Active Learning for large classes: Simple to complex. Faculty Focus. Available: < <http://www.facultyfocus.com/articles/effective-teaching-strategies/active-learning-ideas-for-large-classes-simple-to-complex/> > [Accessed: 10 April 2012].
- Wellington, J. 2000. Science Learning and Science Teaching. New York, New York: Routledge Publishing.

Weyers, M. 2006. Teaching the FE Curriculum: Encouraging Active learning in the Classroom. New York, New York: Continuum International Publishing Group.

Whalberg, H.J. 1991. Improving School Science in Advanced and Developing Countries. Review of Educational Research. Volume 61. No.1: 25-69.

Wilkinson, B. 2002. Interpersonal Intelligence and the science classroom. How learners learn best. Available: < <http://www.howlearnerslearnbest.com/interpersonal-intelligence.html> > [Accessed: 9 June 2012].

Wilson, A.B. McLellan, D.L. 1997. Rehabilitation Studies Handbook. Cambridge, United Kingdom: Press Syndicate of the University of Cambridge.

Woodside, A.G. 2010. Case Study Research: Theory, Method, Practice. Bingley, U.K: Emerald Group Publishing Limited.

Wong, J.K. 2003. Are the Learning Styles of Asian International Learners Culturally or Contextually based. International Education Journal. Volume 4, No. 4: 154-166.

Yager, R.E. 1999. Science/Technology/Society as Reform in Science Education. Albany, New York: State University of New York Press.

Yager, R.E. 1981. The laboratory in science teaching: Main-course or desert? In L.W. Trowbridge, Becoming a Secondary school science teacher. Columbus, Ohio: Charles E. Merrill Publishing Company

Young, L.E. Paterson ,B.L. 2003. Teaching Nursing: Developing a Student-Centred Learning Environment. Philadelphia, USA: Lippincott Williams and Williams.

Yin, R. K. 2009. Case-study research: Design and Methods. Applied Social Research Series. 4th Edition. London, U.K: Sage Publications.

Zellner, R.M. 2011. The study of Relationship Between Instrumental Music Education and Critical Thinking. Florida, USA: Dissertation.com

Zhang, X. Zou, H. 1995. Public Economics Division. The world Bank, Policy Research Department. Policy Research Working Paper no.1412

Zeuli, J. 1986. The Use of the Zone of Proximal Development in Everyday and School Contexts: A Vygotskian Critique. San Francisco: American Educational Research Association.