GAMIFICATION IN EDUCATION: IMPROVING ELEMENTARY MATHEMATICS THROUGH ENGAGEMENT IN HYBRID LEARNING IN THE CLASSROOM

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DECLARATION

I hereby declare that this submission is my own work towards the MPhil Art Education degree and that to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

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ABSTRACT

The study of mathematics is essential in the education of an individual because it serves as the basis of science and engineering fields. Thus, knowledge in mathematics play effectual role in national development. In spite of this merit and numerous significances chalked by the study of mathematics, Ghana seems to suffer from student failure in mathematics both in the Basic Education Certificate Examination and the West African Senior Secondary Certificate Examination. According to research, general absenteeism on the part of teachers and students, lack of interest of students in the study of mathematics, lack of instructional materials, and lack of educational interventions that could help engage students in the study of mathematics are some of the causes of student failure in the study of mathematics. Based on these findings, the researcher adopted gamification framework as an intervention that can facilitate teaching and learning of at the basic level. The study employed the qualitative research design. Participant observation and interviews were used to collect and analyse data in the classroom environment of one primary school in Kumasi and also to evaluate the efficacy of the gamification framework as an intervention to improve interest and performance among lower primary pupils. Purposive and simple random sampling techniques were adopted to sample 125 lower primary pupils and three (3) lower primary teachers as respondents. The introduction of gamification and blended learning into the classroom encouraged active, participatory and collaborative learning by engaging pupils in the study of mathematics. This intervention changed the classroom dynamics and fostered new teaching and learning approaches. The introduction of this gamification model also boosted pupil-teacher interactivity, turned the pupils into motivated active learners, and increased the level of pupils' engagement in learning mathematics. The study

has reveal that there is a high potential of using gamification as an intervention to augment the traditional teaching methods used in the teaching of mathematics in primary schools with the end objective of increasing the level of pupil engagement, motivation and interaction in the classroom lessons and also making the teaching and learning of mathematics enjoyable in Ghanaian primary schools.

DEDICATION

I dedicate this project to the Almighty God for protecting and bringing me thus far. To my late most cherished father Mr. Forson Boateng and my lovely mother Mary Amankwah; and my siblings Bertha Boateng, Matilda Serwaa Boateng, and Kwasi Konadu Boateng for their support.

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ABBREVIATIONS

ICT – Information and Communications Technology

WASSCE – West African Senior Secondary Certificate Examinations

WAEC – West African Examinations Council

ISD - Instructional System Design

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter serves as the foundation of the study where the various elements needed for the study are discussed. It establishes the background to the study, the statement of the problem, the objectives, the research questions, justification, delimitation, limitation, definition of terms, significance of the study, abbreviations, facilities and sources of data.

1.2 Background to the study

Individuals do not feel that they are as good as they are in games in real life situations. When met with difficulties, people may feel depressed, devastated, discouraged or cynical; such feelings are not present in the gaming environment. They may also prefer instant pleasure to keep themselves engaged and motivated. This is where gamification steps in. Yu-kai Chou (2012) defined gamification as the craft of deriving all the fun and addicting elements found in games and applying them to real world or productive activities. Wang (2011) also refers to _gamification‘ as a series of design principles, processes and systems used to influence, engage and motivate individuals, groups and communities to drive behaviours and influence desired outcomes.

Deterding, Dixon, Khaled, & Nacke (2011) have it that _gamification‘ as a term was for the first time used in 2008 but was not widely adopted until late in 2010. Gamification is frequently confused with other terms such as _game layer‘, _applied gaming‘,

_productivity games‘, _funware‘ _playful design‘, or _behavioral games‘. The concept is that a designer ―takes the motivational properties of games and layers them on top of other learning activities, integrating the human desire to communicate and share accomplishment with goal-setting to direct the attention of learners and motivate‖ (Landers & Callan, 2011, p. 421).

Gamification has become a popular approach to encourage and influence specific behaviours in today‘s digital generation, to increase motivation and engagement. Though commonly found in marketing strategies, it is now being implemented in many educational programs as well, helping educators find the balance between achieving their objectives and catering to evolving student needs (Huang & Soman, 2013). Gamification helps to motivate students towards studying; because of the positive feedback, they are encouraged, show interest and are stimulated to learn. Muntean (2011) iterates that gamification constitutes a powerful boost to make students determined to study or read more. By using gamification in education, the study wishes to trigger a more efficient and engaging learning behaviour among pupils in elementary mathematics.

The use of information and communication technologies enhances students‘ attitudes towards learning (Alexander, 2010) and also encourage blended learning. Staker and Horn (2012) define blended or hybrid learning as a formal education programme in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path or pace while still attending a ―brick-and-mortar‖ school structure. In blended learning, face-to-face classroom methods are combined with computer-mediated activities (Strauss, 2012).

1.3 Statement of the Problem

Mathematics as a subject in general is essential for scientific and technological development of any nation. It is part of life without which man cannot function (Nabie, 2002). This means that no nation can improve upon her scientific and technological status to supersede her mathematics status; an indication that mathematics is indispensable for science. Mathematics is the means of sharpening the individual‘s mind, shaping his reasoning ability and developing his personality, hence its immense contribution to the general and basic education of the people of the world (Asiedu-Addo & Yidana, 2004).

The study of mathematics is of high significance in the education of an individual because it serves as the basis of modern science and engineering fields. Also, mathematics is an essential aspect of our daily life because we are confronted with mathrelated problems ubiquitously.

Seo and Ginsburg‘s study (2004) revealed that young children have the ability to develop strong interest in mathematically related activities and be eager to explore mathematical ideas with the appropriate encouragement. Duncan, Dowsett, Claessens, Magnuson, Huston, & Klebanov (2007) also have explained that early mathematics skill is more powerful than early reading and literacy and it is the strongest predictor of later academic triumph.

Many educators are starting to realize the current situation of early mathematics education and have begun to pay more attention to early mathematical research. In line with this, Starkey, Klein, and Wakeley (2004) have proved that mathematics intervention for young children significantly promotes young kids‘ mathematical knowledge.

In spite of the numerous merits in the study of mathematics, Fredua-Kwarteng and Ahia (2004) have cited on Ghanaweb that there is a national aversion to mathematics in Ghana and that math phobia has permeated all rungs of the education ladder. Mathematics learning was a problem even when Ghana had the best educational achievements in Africa. It is a problem that parents, teachers and education authorities are continually grappling with, because mathematics forms the basis of science and technology from which industrial development can take off (Ghanaweb, General News July, 22, 2003).

Results from the Trends in International Mathematics and Science Study (*TIMSS*), conducted by the International Association for the Evaluation of Educational Achievement (IEA) of the USA in 2003 and 2007 indicate that grade 8 children show poor mathematics achievement in Ghana. In the international study, Ghana_s eighth graders were ranked 43rd among 44 and 46th among 47 countries that participated in the study in the respective years (Agyei, 2010). The situation is similar to what goes on currently in Ghanaian primary schools. Mathematics is a core subject and if the basic concepts are not well understood, it may affect the pupil‘s performance as he or she progresses to the higher level of education. Poor performance in mathematics is especially serious at the senior high schools in that passing mathematics is a requirement for gaining admission into tertiary institutions. Failure to pass mathematics has resulted in many senior high school graduates being unable to continue their education at the

tertiary level.

This explains why in 2013, there was a sharp decline in student performance in the Senior High School core mathematics examinations as shown in Table 1.1. which shows that, of the 405,356 students who registered for the 2013 May/June West African Senior Secondary

Certificate Examination (WASSCE) core mathematics only 402,794 wrote the examination against 2,562 who did not write it. Table 1.1 has a summary of the performance of the students in mathematics.

NUMBER OF STUDENTS	GRADE	PERCENTAGE (%)
148,567	A1-C6	36.8%
141,057	D7-E8	34.9%
113,170	F9	28.0%

Table 1.1 WASSCE Performance of students in the 2013 core mathematics (Source: WAEC)

According to the chief examiners report on WAEC (2013), performance in Core Mathematics was very poor in 2012 and remained the same in 2013.

The main focus of this study was to introduce gamification as an educational tool and to find out how effectively it can enhance the teaching and learning of mathematics in the primary school curriculum and assess how beneficial this intervention can be.

1.4 Objectives of the Study

The study will enable the researcher:

1. To analyse the teaching and learning environment at the lower primary and introduce the gamification concept.

2. To adopt and modify the appropriate designed framework for gamification in the teaching and learning of elementary mathematics
3. To evaluate the effect of gamification after its introduction in the study of mathematics.

1.5 Research Questions

The introduction of gamification in education will help enhance the teaching and learning of elementary mathematics through engagement in hybrid learning in the classroom. Thus this research sought to answer the following questions:

1. How is the teaching of mathematics done at the lower primary school and how can gamification be introduced in the teaching and learning of mathematics?
2. How can a gamification module design be used and what gamification framework is suitable for the teaching and learning of elementary mathematics?
3. How efficient can gamification be in the teaching and learning of elementary mathematics?

1.6 Delimitation

This research was limited to the teaching and learning of lower primary mathematics by the teachers and pupils of Scales Adventist Preparatory School, Old Tafo Mile 3 in the Kumasi Metropolis.

1.7 Definition of Terms

Gamification: the use of game design elements in a non-gaming context.

Hybrid/Blended Learning: a formal education programme in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path or pace.

Points: Running numerical value given for any single action or combination of actions.

Badges: Physical emblem used to display the accomplishment of various achievements of a person or group.

Levels: A system or "ramp" by which players are rewarded an increasing value for accumulation of points.

Leaderboards: It is used to show players their ranking in the gamified system.

Alternate Reality Game: Augmented Reality Game (ARG): an interactive networked narrative that uses the real world as a platform and uses transmedia storytelling to deliver a story that may be altered by players' ideas or actions.

Regime competence: this means that the learner gets ample opportunity to operate within, but at the outer edge of his or her resources so that at those points things are felt as challenging but not ―undoable‖.

Self-knowledge: Activities that teach students how risks and responsibilities, penalties and rewards affect their behaviour.

Experience points: the part of character advancement that are generally gained by defeating an enemy or completing a task.

Immersion: The perception of being physically present in a non-physical world.

1.8 Abbreviations

ICT – Information and Communications Technology

WASSCE – West African Senior Secondary Certificate Examinations

WAEC – West African Examinations Council

ISD - Instructional System Design

1.9 Importance of the Study

The study will direct, maintain and energize workforce of pupils into constructive channels which will provide a sense of purpose and aspiration for the performance of tasks in mathematics in schools.

The study will provide opportunity for more research to be done in the area of gamification in education for improving teaching and learning environments in schools.

The findings will serve as a reference material for interested individuals who would want to acquire knowledge in using gamification in the classroom.

1.10 Arrangement of the rest of the Text

Chapter Two provides the theoretical and empirical review of literature relevant to the topic of gamification in mathematics education. Chapter Three deals with the methodology adopted for the research. The data analysis is presented in Chapter Four and Chapter Five entails the summary, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview

This chapter deals with pertinent literature on education, technology, gamification, learning theories, blended learning, classroom environment and teaching of mathematics.

The review deals with the following sub-topics:

- Education
- Teaching
- Learning
- Blended Learning
- Technology in Education
- Games in Education
- Gamification
- Mathematics Education in Ghana

2.2 Education

Education as a process consists of teaching and learning. Teachers do the teaching whiles students learn what is being taught. Generally it is the responsibility of schools to provide a conducive and enabling environment needed for effective teaching and learning to enable both teachers and students to be productive during school hours (Amissah, SamTagoe, Amoah & Mereku, 2002). Amissah, et al (2002) emphasize that the quality of education

depends on the quality of the teacher rather than the learner because the teacher does not depend on the learner any more than the learner depends on the teacher. This implies that effective curriculum and effective reform depends more on the teacher. Nevertheless, educational intervention is an important factor to consider for a teacher to accomplish the goal of achieving the curriculum or reform objectives.

2.3 Teaching

According to Tamakloe, Amedahe and Atta (2005), teaching is a means of directing knowledge towards the learner. To Kochhar (2004), teaching is not a mechanical process but a rather intricate, exacting and challenging job. To Farrant (1996:168), teaching is ―a process that facilitates learning‖. Teaching and learning are therefore described as the two sides of a coin because teaching does not happen without a learner (Amissah, SamTagoe, Amoah & Mereku, 2002).

While some authors depict teaching as an art because of its ability to allow the teacher an opportunity to do something creative like moulding personalities and the minds of the students, others describe teaching as a science because it hinges on a specified body of knowledge which is psychology. In line with this, Kochhar (2004: 22) asserts that ―teaching is a complex art of guiding pupils through a variety of selected experiences towards the attainment of a widening field of learning‖. Hence teaching directs growth and development. As the art involves the mind, the heart and the hand, so is teaching (Amissah et al, 2002).

2.3.1. Effective Teaching of Mathematics

Shulman (2000) has proposed three content knowledge domains for teaching to include: subject matter content knowledge (SMCK), pedagogical content knowledge (PCK), and curricular knowledge (CK). This means that for teachers to teach mathematics effectively, they need to have an in- depth understanding of the mathematical content of problem solving, the pedagogical principles of problem solving and curricular materials that inform the scope and direction of problem solving. More importantly, mathematics teachers need to have an integrated knowledge of these knowledge domains. Shulman (2000) describes that teaching is far more than mere transmitting of concepts and ideas to learners; it involves bringing out the accumulated ideas and experiences that students come to class with and working on those ideas and experiences together with the students by way of refining, reorganizing, co-constructing and repairing these ideas and experiences into meaningful and comprehensible form for students to assimilate. This forms the foundation on which teaching mathematics leans on. To Shulman (2000), the ideas, conceptions, preconceptions and experiences of students are made bare only when they are engaged in an interactive classroom environment.

2.4. Learning

Farrant (1996:107) defines learning as ―the process by which we acquire and retain attitudes, knowledge, understanding, skills and capabilities that cannot be attributed to inherited behaviour patterns or physical growth‖. To Farrant, capacity for learning is inherent and is based on psychological factors whiles rate of learning is based on both inherited and environmental factors. However, Skinner (as cited in Farrant, 1996) asserts

that learning is perceived as a series of experiences, each of which affects behaviour. Learning results should therefore be seen in terms of understanding the essential processes within the content standards.

The various types of learning identified by Farrant (1996) are discussed in this section are as follows:

a) Affective learning: deals with feelings and values and therefore has influence on our attitude and personality. An example is being disciplined and courteous.

b) Cognitive learning: is achieved through mental processes like recalling and reasoning or how one thinks.

c) Psychomotor learning: deals with the development of skills like efficient coordination between the brain and the muscles as in drawing or writing what we see.

2.4.1 Theories of Learning

Various psychologists have categorised learning according to how they see it to be. Some examples of the categories of learning are discussed as follows:

1. Learning as a product

In 1960s and 1970s, learning was usually referred to as a change in behaviour. Thus, it was assumed that learning is the end product of some process. However this approach to learning has been subjected to some debate and most interestingly by Merriam and Caffarella (1991) who raised the following critical questions:

i) Does a person need to perform in order for learning to have happened?

ii) Are there other factors that may cause behaviour to change?

iii) Can the change involved include the potential for change?

These questions have activated a number of reactions among theorists and some have identified learning as relatively permanent changes in behaviour, or rather the potential for change as a result of experiences. However, other theorists also see learning as changes in the ways in which people 'understand, or experience, or conceptualize the world around them' (Ramsden 1992: 4). They further argue that not all changes of behaviour that result from experience involve learning. The focus, to the authors however, is gaining knowledge or ability through the use of experience.

A research by Säljö (1979) on students‘ views on learning yielded the following responses (classified into five main categories) which throw more light from an empirical sense on the earlier assertions.

1. Learning is seen as a quantitative expansion in knowledge, thus, learning is acquiring information.
2. Learning is seen as memorising which implies that, learning is storing information that can be reproduced.
3. Learning is perceived as a means of acquiring facts, skills, and methods that can be stored and used when necessary.
4. Learning is seen as making sense of theoretical meaning in that the learner involves connecting parts of the subject matter to each other and to the real world.
5. Learning is interpreting and understanding reality in a different way. This means learning involves understanding the world by unravelling knowledge.

These views are clearly different with the argument that points 1 - 3 imply a less complex view of learning which makes learning seem somehow external to the learner whereby

people go out and buy knowledge. Conceptions 4 and 5 look to the 'internal' or personal aspect of learning which makes learning appear as something that one does in order to understand the real world.

2. Learning as a process

Merriam and Caffarella (1991: 124) opined that learning is 'a process by which behaviour changes as a result of experience'. Central to this notion has been the issue of the extent to which people are conscious of what is going on, that is if they are aware that they are engaged in learning. One significant contribution to learning as a process is that of Rogers (2003) who juxtaposed two learning approaches; namely ―the task-conscious or acquisition learning‖ and ―learning-conscious or formalized learning‖. Acquisition learning as described by Rogers goes on all the time. Roger further describes such learning as being concrete, immediate and confined to a specific activity and does not concerned itself with general principles. Formalized learning however, arises from the process of facilitating learning. It is 'educative learning' rather than the accumulation of experience. As Rogers (2003:27) puts it; 'Learning itself is the task. What formalized learning does is to make learning more conscious in order to enhance it'.

Many different theories of how people learn exist. Meyers and Freitas (2006) have categorized learning theories into different broad divisions but according to Tamez and Surles (2004), all learning theories are grounded in one or a combination of rationalism, empiricism or constructivism. _Rationalism‘ means that during decision making process, the individual is free from being influenced by third parties. The individual is independent

in his beliefs and thinking process. That individual would always have a set of principles based on his acquired knowledge from exposure to the world. _Empiricism‘ is a state of a higher level of experience, the more the individual becomes knowledgeable the better is his ability to make experienced decisions. Thus, decisions taken by the individual have a high level of soundness. With _constructivism‘, the individual is exposed both to the world and to his inner beliefs and uses both these knowledge to form his own principles. Therefore, the individual constructs meaning from the information of experience. Tamez and Surles (2004) argue that none of these theories in isolation dominates in real life; these are all extremes and in the real world, the individual uses a combination of these three theories. The end result is one of learning.

3. Reinforcement theory

Forming part of the behaviourist school of psychology (Laird, 1985; Burns, 1995), it is believed that behaviour is a function of its consequences. That is the learner will repeat the desired behaviour if he gets positive reinforcement. Also, it is also argued that negative reinforcement may also strengthen behaviour and refers to a situation when a negative condition is stopped or avoided as a consequence of the behaviour. Laird (1985) however, argues that punishment weakens behaviour because a negative condition is introduced or experienced as a result of the behaviour and teaches the individual to desist from the behaviour which was negatively reinforced. Although punishment as a fact is widely used in everyday life, Burns (1995) notes that it only works temporary and often only when the punishing agency is present. The criticism of this approach is that it is rigid and mechanical.

4. Cognitive-Gestalt approaches

This approach emphasises ―the importance of experience, meaning, problem-solving and the development of insights‖ (Burns, 1995, p 112). Burns iterates that the cognitivegestalt theory has created the concept that individuals have different needs and concerns at different times, and that they have subjective interpretations in different contexts.

5. Holistic learning theory

The basic principle of this theory is that effective learning requires activation of ‗individual personality which consists of many elements specifically the intellect, emotions, the body impulse (or desire), intuition and imagination' (Laird, 1985, p 121).

6. Facilitation theory (the humanist approach)

Laird (1985) discussed this theory and ascertained that learning will occur by the educator acting as a facilitator, that is by establishing an atmosphere in which learners feel comfortable to consider new ideas and are not threatened by external factors. Laird further characterised this theory by arguing that:

i) human beings have a natural eagerness to learn ii) there is some resistance to, and unpleasant consequences of, giving up what is currently held to be true and that the most significant learning involves changing one's concept of oneself.

7. Experiential learning

Kolb in (McGill and Beaty, 1995) proposed a four-stage experiential learning model. In fact, the process can begin at any of the stages and is continuous and cyclical in that there is no limit to the number of cycles one can make in a learning situation. This theory postulates that without reflection one would simply continue to repeat their own mistakes.

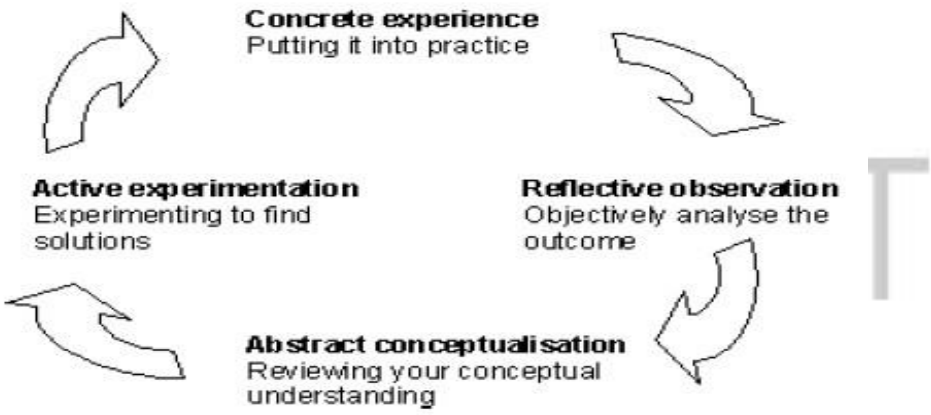


Figure 2.1 Kolb's experiential learning cycle.

Kolb's research found that people learn in four ways with the likelihood of developing one mode of learning more than another. As shown in the _experiential learning cycle' model (Fig. 2.1) learning occurs:

1. Through concrete experience
2. Through observation and reflection 3. Through abstract conceptualization
4. Through active experimentation.

As already discussed, the idea that people learn in diverse ways has been explored over the last few decades by educational researchers. Kolb, one of the most influential of these researchers, found that individuals begin with their preferred style in the experiential learning cycle. Honey and Mumford (1986 as cited in McGill & Beaty, 1995 p. 177), while building on Kolb's work, identified four learning styles:

i) Activist (enjoys the experience itself), ii) Reflector (spends a great deal of time and effort reflecting iii) Theorist (good at making connections and abstracting ideas from experience) iv) Pragmatist (enjoys the planning stage).

According to Kolb, each style has its own strengths and weaknesses. Honey and Mumford(1986) argue that learning is improved upon when one discovers his learning style, develops the strengths, and works towards minimizing the weaknesses to improve the quality of learning.

8. Action learning

McGill and Beaty (1995) describe action learning approach as one that connects the world of learning with the world of action through a reflective process within small cooperative learning groups known as _action learning sets'. Short, Stewin and McCann (1991) assert that group learning complicates teaching by adding to the teacher's preparation load, materials selection and attention for all that goes on in the classroom. This gives rise to further practical challenges because the teachers' attention can only be engaged on one group of students at a time, raising the question of what the other groups are doing. Despite the amount of activities on the part of the teacher, learning will be in vain unless students are actively involved in the learning experience (Singh & Rana, 2004).

9. Theory of Multiple Intelligences

To Gardner (1993), human intelligence should not only be equated to linguistic or logical-mathematical intelligence alone. Being the author of a new way of perceiving human intelligence, Gardner, a Harvard professor, identified seven different intelligences that humans may possess. The list comprises:

i) Linguistic intelligence ii) Logical-mathematical intelligence iii) Spatial intelligence iv) Musical intelligence

v) Bodily-kinesthetic vi) Interpersonal intelligence

vii) Intrapersonal intelligence

Gardner has worked on other intelligences that qualify as cognitive processes: "Multiple intelligences theory, on the other hand, pluralizes the traditional concept"(Gardner, 1993, p.15).

Gardner's interest with human intelligence and how the brain works started with an investigation of people who had experienced brain damage of some sort. He recognized that though some individual‘s may endure some form of brain damage yet not all their cognitive or motor-sensory abilities are eliminated. Gardner hypothesized that humans possess more than one form of intelligence.

The theory of multiple intelligences presents a more holistic view of the intelligence of humans. Gardner asserts that we may all endeavour to develop each of these intelligences to our optimum level. However, we may be more proficient in only certain of these intelligences. We may however, aspire through practice and development to improve in the remaining intelligences.

There have been important paradigm shifts throughout the ages on the concept of knowledge and learning. Evidence indicates that these shifts will continue as we understand more. The study of knowledge and learning took place in the realms of philosophy and religion until the mid 19th century when the first systematic move to study the human mind through scientific methods were made. Since then much has been learned. Recent brain-based research points out that:

- Learning engages the physiology completely and not only the cognitive processes; it derives essential information from experience
- Multisensory environments enhance learning
- The search for meaning is inherent
- Meaning enhances learning and memory
- Memory is actively organized through a process of pattern recognition and chunking
- Emotions have a positive or negative effect on learning
- Humans learn effectively through collaborating in social contexts
- New knowledge builds on existing knowledge, and
- The brain is formed by experience and can develop throughout our lifetime as found in the writings of CDSL (2000), Jensen (2010) as cited in Davis (2011); McCandliss (2012) and Sullo (n.d.).

10. Self-Determination Theory

As an approach to human motivation and personality, self-determination theory (SDT) is the phenomenon that uses traditional empirical methods while employing an organismic metatheory that highlights the importance of humans' evolved inner resources for personality development and behavioural self-regulation (Ryan, Kuhl, & Deci, 1997). Thus, SDT deals with making inquiries into people's innate growth tendencies and inherent psychological needs that are the basis for their self-motivation and personality integration, as well as for the conditions that foster those positive processes. Inductively, using the empirical process, identified three such needs--the need for competence (Harter,

1978; White, 1963), relatedness (Baumeister & Leary, 1995; Reis, 1994), and autonomy (deCharms, 1968; Deci, 1975) that appear to be essential for enhancing optimal functioning of the natural propensities for growth and integration, as well as for constructive social development and personal well-being.

2.4.2 Conditions of Learning

According to Kochhar (2004), these conditions include Psychological Security, Experimentation, Feedback, Practice, and Belonging and Configuration.

a. Psychological Security

Learner participation is essential in effective learning and this can be achieved only when the learner is secured. It is therefore required of the teacher to consider creating a stimulating learning environment under which the learner would be encouraged to try and possibly learn. The assumption is that warm, considerate teachers create great interest in school work whiles autocratic teachers who are strict, do not usually inspire confidence. Too much freedom also does not ensure psychological safety but leads to frustration. This implies that teachers who respect students' rights, wish and encourage their growth towards independent learning are rated high by students (Kochhar, 2004). The orderly and systematic teacher creates a classroom climate and atmosphere that is conducive to effective learning.

b. Experimentation

According to Piaget (as cited in Farrant, 1996), activity learning involves the learner making it the best. Effective learning comes by exposing the learner to the learning situation (Kochhar, 2004). Thus learning cannot be given to the learner but it is about

exploring, conceptualizing, experimenting and interacting. The idea is that experience with concrete situations is the basis for understanding therefore learning comes about when the learner is actively participating in the learning activity. Also, experience with the real things only helps a person get acquainted with its characteristics. The child should be helped to discover concepts and principles rather than emphasizing and memorizing principles, for this will lead to creative learning (Kochhar, 2004; Farrant,

1996).

c. Feedback

According to Kochhar (2004:28), feedback is _the evaluation information on the act of learning‘. Students learn rapidly when given regular feedback on their progress. Feedback is very essential to the learner because it is a form of motivational factor that influences effective learning. Therefore learners must be made aware of their results of achievements from time to time to let them gain interest in learning.

d. Practice

The influence of practice is very essential in skill learning especially in vocational education. It is therefore important for the teacher to plan the learning situation to consider incorporating practice to make learning more meaningful. To Kochhar (2004), practice makes man perfect and the more one does something, the more one knows**.**

e. Belonging and Configuration

Learning does not take place unless the experience is re-structured. It is after restructuring that the learner will be able to organise and integrate the experience in required relations before learning takes place. Nevertheless, the significance placed on what we learn affects how well we can recall (Kochhar, 2004; Farrant, 1996). Though the environment has an

influence on efficient learning, distraction and worries also affect concentration. Therefore circumstances which prevent practice and revision should be avoided for learning to be effective for the student.

2.4.3 Learning Environment

According to Wong and Wong (2005), an effective classroom management style consists of creating an environment and attitude towards the students that is task oriented, predictable, and consistent. Froyd and Simpson (2008) in referencing the National Research Council (2000) on synthesized research on learning, recommend that learning environment must be organized around four foci namely knowledge, learner, assessment, and community. Although the research and theory on student-centered learning is complex and diverse, McCombs and Miller (2006) provide a description that sufficiently summarizes how student-centered learning impacts the relevant components of a school system. The core of the Learner-Centered Model (LCM) is that all instructional decisions begin with knowing who the learners are individually and collectively. This is followed by thoroughly understanding learning and how best to support learning for all people in the system. Finally, decisions about what practices should be in place at the school and classroom levels depend upon what we want learners to know and be able to do. The Learner-Centered Model puts the learners at the heart of a system dedicated to learning and leading. It brings the educational system back into balance with what we know about learners, leading, and living systems (McCombs & Miller, 2006).

Guthrie, Wigfield and Perencevich (2004) also propose Concept Oriented Reading Instruction (CORI) as a framework for teachers, which situate a conceptual goal within a

unit and solicits questions from students. These questions indicate the background knowledge of the students relevant to the unit, and students are able to answer their questions through reading and hands-on activities (Guthrie, 2004).

According to Panitz (1999), effective learning learning demands a learning environment where collaborative learning is encouraged. Pantitz (1999) defines collaborative learning as a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning, and they respect the abilities and contributions of their peers. When teachers support students in collaborative activities such as checking each others use of a new comprehension strategy, students learn ―the importance of give-andtake, speaking and listening, and respect for others‖ (Guthrie, 2004, p.18). Students accrue benefits when the learning environment supports them working collaboratively, sharing insights and assisting each other in metacognitive processes (Vye, Schwartz, Bransford, Barron, Zech, & the Cognition and Technology Lab at Vanderbilt, 1998).

Gamified learning environment is a relatively new instructional approach that is inherently engaging and have the potential to motivate students to learn. The teacher is charged with the task of developing a gamified environment that not only compels and entertains the learner, but also teaches through role play and other techniques that tap into the intrinsic motivation of the learner.

2.4.4 How Children Learn

Learning by play is one effective way that children learn. Infants explore their world through their senses while adults in their world foster their development and learning

through playing games with them. Toddlers engage in pretend play when they imitate actions and events they have experienced in their family life. Play is a healthy and very significant part of childhood. As children grow into four and five year olds, they engage more and more in play activities that expand their knowledge of the world around them; they develop their motor skills and focus on their peers. Ginsberg (2007.p.183) asserts that _play is essential to the development of children because it allows them to use their creativity while developing their imagination, dexterity and physical, cognitive and emotional strength‘. Miller and Almon (2009.p.15) also describe play ―as activities that are freely chosen and directed by children and arise from intrinsic motivation‖. Kagan and Lowenstein (2004) also see play to be child-centred, engaging and a key to encourage children to learn.

However one chooses to define play, a true play-based programme is one where children participate in a balance of child-initiated and adult-guided activities in an environment where play is encouraged and nurtured. Much research about play and its positive effects on the development of children has been done. Marcon (2002), after following some children from different preschool programme through to grade four, reported that those who attended play-based programme improved academically than those who had attended academic-oriented programme. Children integrate all types of learning when they play. Almon (2007.p.3) asserts that ―research and experience show strong relationships between a child‘s capacity to play and his or her overall development, that is physical, social, emotional, and intellectual‖. Hewes (2006.p.1, 2010) also states that ―the developmental literature is clear that play stimulates physical, social, emotional and cognitive development in the early years‖. The following section discusses the effects play

has on children's social and emotional development, neurological development, physical development, oral language and early literacy development and early mathematical development.

1. Play and Social-Emotional Development

Studies have revealed that children who have good emotional health and good social skills are more likely to succeed academically (Berk, Mann, & Ogan, 2006; Fromberg, 2002; Shonkoff & Phillios, 2000). Children learn the give-and-take of appropriate social interactions through rough and tumble play; and learn to signal and detect signals, a social skill that is needed through school and life. Sociodramatic play that entails verbal communication and interaction in groups where children assume various characters in the society fosters empathy and consideration for the feelings of others. Role-playing within a group helps children to define social roles, practise turn taking, and be accepted by others all of which are important to successful group interaction needed later in life. Dramatic play encourages children to develop appropriate social behaviour (Burke, 2010).

2. Play and Neurological Development

Research in neurological development confirms that early relationships, attachment, movement, language, exploring the world through play, and hands-on activities are essential to a healthy childhood. According to Dr. Fraser Mustard of the Council for Early Childhood Development, ―problem based play programs optimize development of neural pathways during all periods of early childhood from infancy to grade one. A consistent play opportunity with other children provides rich sensory stimulation which the young child absorbs and integrates into core brain development‖ (McCain, Mustard &

Shanker, 2007.p. 139). Perry, Hogan and Marlin (2000.p.1) also assert that ―central to a child's healthy development is the opportunity to act on their natural curiosity to explore, to play and, thereby, to learn‖. Perry et al. (2000) point out that play and exploration enhance a child's brain to develop in an ideal way and accentuate that all child-centred learning programmes should focus on appropriate environment.

3. Play and Physical Development

Play provides activity through which a child's body gains strength and deftness. Active play helps to develop gross motor skills, fine motor skills, agility, coordination, and balance. Young children who are provided opportunities to develop their fine and gross motor skills and balance skills are more likely to reach a higher level of success when they meet new physical challenges when they are older (Stover, 2009; Rees, 2009). Play that develops large muscle skills usually requires little or no equipment. Thelin (2009) emphasizes that outdoor play for young children helps them with their sensory development because when they are playing outdoors they are using all of their physical senses. Outdoor environments that provide opportunities for children's physical development also allow them opportunities to engage in pretend play.

4. Play and Oral Language and Early Literacy Development

Play and literacy are inter-related. Play is enhanced when children draw from their knowledge and experience with stories and topics they have been exposed to through books and conversations. Engaging in pretend play allows children to develop oral language skills, storytelling, vocabulary, and explore the function of written language as a means to

early literacy development. As they pretend play, they are increasing their vocabulary, sentence length, and mastering the semantics of language (Perry et al., 2000). Burke (2010) asserts that during play, children often imitate literacy acts that they have seen adults model, such as ―writing‖ lists. Playing with language builds a base through which children later learn to decode words.

5. Play and Early Mathematical Development

Play contributes to the development of early logical or mathematical thinking. Play allows children opportunities to participate in problem solving activities, investigate and discover, explore cause and effect through hands-on experiences. All of these are a part of numerical thinking and mathematical development. Bergen (1998, p.56) says that

―play is vital to the development of children‘s mathematical thinking. Unlike some forms of knowledge, mathematical knowledge, which deals with relationships between and among things, cannot be learned by hearing adults talk about it‖. Playing with sand, blocks, water and clay helps children to develop their skill in logic. For example, playing with blocks encourages problem-solving, reasoning and divergent thinking and playing with water leads to knowledge of volume. Being familiar with shapes, directions, and positions as they use boxes to build a tower helps children in their understanding of mathematics. The ―informal‖ language they use as they talk about such concepts as

―over‖, ―on‖, ―higher‖, becomes the basis for ―formal‖ mathematical language later in their learning. Through play and problem solving children learn that there is more than one way to solve a problem, a skill that is increasingly important in today‘s world.

In summary, the literature on children‘s play indicates that:

- Play is a healthy, essential part of childhood
- Research shows strong links between play and language, physical, cognitive, and social development
- When children play they integrate all types of learning
- Play helps a child‘s brain develop
- Outdoor play helps with children‘s sensory and coordination development
- Play contributes to the development of early logical/mathematical development

2.5 Blended Learning

Blended or hybrid learning is a formal education programme in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path or pace (Staker & Horn, 2012) while still attending a ―brick-and-mortar‖ school structure where face-to-face classroom methods are combined with computer-mediated activities (Strauss & Valerie, 2012).

Staker and Horn (2012) continue that, one common feature of blended learning is that when a course takes place partly online and partly through other modalities, the various modalities are usually connected. In other words, what the students learn online informs what they learn face-to-face, and vice versa. Furthermore, if students have control over their pace, this control often extends to the entire subject that is blended, not only to the online-learning portion of the coursework. This type of learning implies the use of technology.

2.6 Technology in Education

The rapid spread of electronic communications has the capacity to affect the quality and efficiency of basic education throughout the world in dramatic ways – both positively and negatively (Chapman, Garrett, & Mählck, 2004). Chapman, et. al. (2004) continue to say that, the ease with which teachers and students can gather information over the Internet on virtually any topic has the potential to transform instructional content and pedagogical practice. Educators virtually everywhere have long looked to the emerging technologies of their time to improve the delivery of instruction in the classroom and to help them reach students (and teachers) in remote locations. In the early days of technology use, the focus was on the delivery of direct instruction via radio, interactive radio, and instructional television, for example.

Instructional technologies widely used for classroom purposes in low-income countries include the use of programmed instruction, the distribution of lessons on audiotape, the use of duplicating and photocopy machines to prepare learning aids, and television broadcasts of lessons at times that coincide with the school teaching schedule. Newer technology-based instructional strategies that incorporate the Internet and the World Wide Web (WWW) are used more to expand communication and increase access to resources. These newer technologies represent a significant change in the teacher‘s role in the instructional process. Whereas earlier technologies provided teachers primarily with a tool for continuing to teach in the manner they were already teaching (though presumably more efficiently), technologies such as e-mail and Internet tend to push teachers toward fundamentally different ways of teaching (Chapman, et al, 2004).

According to UNESCO (2004), online resources are used within education systems primarily in seven ways:

1. The most common use is in direct instruction. Lessons developed in one location can be broadcast via radio or television or made available through e-mail or the World Wide Web for use by students (individually or in groups) in other locations. Excellent teaching can be made widely available. This is especially important in countries in which large segments of the teaching force are underqualified for the grades they are expected to teach. Well-designed instruction in the form of lessons delivered by radio, television, or online may be able to offset weak teacher preparation.
2. Teachers can use online searches to find and access resource materials that are then used in the teachers‘ own lesson preparation. For example, teachers might locate maps and fact sheets about countries being studied in social studies class.
3. A variation of this approach is that teachers can use the web to access curriculum and instructional guides for their own use. For example, teachers may access instructions on how to lead a class in the dissection of a frog in biology.
4. Students can use the web to find and retrieve information they can use in their own class research projects. In some schools, allowing students to use school computers for independent study is used as a way to motivate and reward good students. However, this approach tends to be limited to classrooms that have sufficient technology to allow students to use the equipment for independent study.

5. Some teachers use web-based chat rooms and online communications technology to connect two or more classrooms in different parts of the world. Students at different locations can ask and answer questions from those at the other locations.
6. Technology-based instruction is used in many countries as a means of delivering in-service teacher education. Teachers need not leave their teaching posts to participate in professional development activities.
7. Teachers can have their lessons broadcast to multiple classrooms simultaneously. This is already widely used in higher education as a means of offering courses in low-enrolment subject areas. In secondary education this allows students in remote locations to have direct interaction with teachers at a central location.

A common element across all these innovations is that in order to effectively use such technologies, teachers sometimes have to learn new knowledge and skills, spend more time in lesson preparation, and engage in different types of conversation with students (Hernes, 2002; UNESCO, 2002). Research regarding the effects of age in technology adoption and use has indicated that younger technology users value usefulness of the technology more than older users when deciding on use intentions (Venkatesh, Morris, Davis, & Davis, 2003).

Furthermore, older users are considered to be more affected by social influence than young ones (Morris & Venkatesh, 2000; Venkatesh et al., 2003; Wang, Wu, & Wang, 2009) in their technology adoption processes, potentially due to higher affiliation needs (Morris & Venkatesh, 2000; Sun & Zhang, 2006; Venkatesh et al., 2003).

Gaming is already a widespread activity in most of the cultures around the world with more than 45 million homes having video-game consoles (Feller, 2006). In a given week, the average eighth-grade boy will play video games for about 23 hours, while the average girl will play about 12 hours that is even more than the time they spend watching TV (Dawley, 2006). Therefore, one of the most obvious benefits to using game technologies for learning is that students are often already familiar with these interfaces and the ―language‖ of interacting with and utilizing them.

2.7 Games in Education

From a game designer‘s perspective, a game is the ―system in which players engage in artificial conflict characterized by rules that result in a quantifiable outcome‖ (Salen & Zimmerman, 2003 p.153). Given this kind of definition, it is possible to assert that ―games exist all around us, whether or not we define them as such‖ (p.154).

2.7.1 Digital games

Digital games encompass much more than a computer‘s Solitaire or Nintendo‘s Super Mario Bros. Over the last decade, the genre of digital games has exploded to include numerous platforms and designs. Digital games, whether computer, game console, or handheld-based, are characterized by rules, goals/objectives, outcomes/feedback, conflict/competition/challenge/opposition, interaction, and representation of story (Prenksy, 2001) or more simply, ―Purposeful, goal-oriented, rule-based activity that the players perceive as fun‖ (Klopfer, 2008). They are distinguished by two key elements:

(1) An interactive virtual playing environment, and

(2) The struggle of the player against some kind of opposition.

2.7.2 Effects of Gaming

While additional high quality research on the effects of gaming is needed, there are important reasons for educators to engage with digital games. Initial reports show that gamers have well-developed skills including enhanced visual perception. Researchers such as Patricia Marks Greenfield argues that habitual playing of video games results in the development of new cognitive abilities that translate into the key skills for our transformed world (Facer, 2003). These skills are:

- The ability to process information very quickly
- The ability to determine what is and is not of relevance to them
- The ability to process information in parallel, at the same time and from a range of different sources
- Familiarity with exploring information in a non-linear fashion;
- A tendency to access information in the first instance through imagery and then use text to clarify, expand, and explore
- Familiarity with non-geographically bounded networks of communication; and
- A relaxed approach to _play,'—the capacity to experiment with one's surroundings as a form of problem solving (Jenkins, Purushotma, Clinton, Weigel & Robison, 2006).

2.7.3 Main Characteristics of Games

According to Johnson, Vilhjalmsson and Marsella (2005) there are certain educational artificial intelligence functions needed for serious games. These are:

1. Gameplay –computer games are so engaging because the primary objective of the game designer is to keep the user engaged (Prensky, 2002). Good gameplay does not come from the game graphics but from the continual decision making and action that engages the learner and keeps him or her motivated to continue (Johnson et al., 2005).
2. Feedback - Sending information back to the user about what action has actually been done, what result has been accomplished – is a well-known concept in the science of control and information theory (Norman, 1998). Good games provide users with feedback on their actions, so that they know how well they are doing and can seek to improve their performance (Johnson et al., 2005).
3. Simple interface – Well defined simple interface helps to guide the player during the game (Johnson et al., 2005) and provide information about the player‘s location (Whitton, 2010).
4. Challenge - An important aspect of game design is ensuring that users experience a proper level of challenge. The role of challenge in promoting intrinsic motivation is not limited to games but has been noted by motivation researchers as relevant to all learning activity (Johnson et al., 2005).
5. Fish tanks and sandboxes – Some games provide smaller versions of the real game where gameplay complexity is limited or versions of the game that have similar

gameplay to the real game, but where there is less likelihood for things to go wrong these help users to practice for the challenges of the full game (Johnson et al., 2005).

6. Story and character identification – For keeping user interest it is important that the player identifies with the story and the main character (Johnson et al., 2005).
7. Fun and learning orientation - Fun in the learning process creates relaxation and motivation. Relaxation enables learners to take things in more easily; motivation enables them to put forth effort without resentment. Given this, it certainly makes sense that fun and learning should go hand in hand (Prensky, 2002).

Another essential characteristic of a serious game is interaction. The game environment should allow flexible interaction and different methods of interaction for the users. Interaction enhances learning and for the game designer, it helps to get feedback from the players (Whitton, 2010).

Children aged 3–10 represent the largest demographic of the virtual world and online games (Kzero, 2011). They themselves choose to engage with and identify as significant to them (deCastell & Jenson, 2004). The recognition that digital games are a critically important dimension of younger children‘s lives at home and in early years‘ locations presents challenges as well as opportunities for early childhood education. Though there is a growing body of work on the use of technology in the early years, much of the research has focused on multimedia tools and popular culture as pathways to multimodal literacies with relatively little focus on digital games (Marsh, 2010; Marsh, Brooks,

Hughes, Ritchie, & Roberts, 2005; Plowman, McPake & Stephen, 2008; Plowman, Stephen, & McPake, 2010; Wolfe & Flewitt, 2010; Yelland, 2010). Therefore, with this open perspective of what a game is, it is important to identify useful models of player

motivations to understand the link between player behaviours and game design in order to link gamification and education.

2.8 Gamification

Yu-kai Chou (2012) has defined gamification as the craft of deriving all the fun and addicting elements found in games and applying them to real world or productive activities Wang (2011) also describes gamification as a series of design principles, processes and systems used to influence, engage and motivate individuals, groups and communities to drive behaviours and effect desired outcomes. Kapp (2012) further defines gamification as using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning and solve problems.

The term _gamification‘ was first used in 2008 but was not widely adopted until late in 2010 and is frequently confused with other terms such as _game layer‘, _applied gaming‘, _productivity games‘, _funware‘ _playful design‘, or _behavioural games‘ (Deterding, Dixon, Khaled, & Nacke, 2011). The concept is that a designer ―takes the motivational properties of games and layers them on top of other learning activities, integrating the human desire to communicate and share accomplishment with goal-setting to direct the attention of learners and motivate‖ (Landers & Callan, 2011, p. 421).

2.8.1 The What, Why and How of Gamification

Serious games and gamification terms can be overlapping, but at the same time they are not synonyms. Similar to serious games, gamification uses elements of games for purposes

other than their normal expected use as part of an entertainment game but serious game describes the design of full-fledged games, gamified applications merely incorporate elements of games (Deterding et. al. 2011).

According to Kapp (2012, 13), ―gamified learning can and is, difficult, challenging, and stressful. Well-designed games help learners acquire skills, knowledge and abilities in short, concentrated periods of time with high retention rates and effective recall. Games for learning should not be thought of in the same way as games for children. Gamification is a serious approach to accelerating the experience curve of learning, teaching complex subjects, and system thinking‖. The foundation upon which gamification should be built consists of elements of games such as engagement, interactivity, storytelling, visualization of characters and problem solving (Kapp, 2012).

Kruse (2012) says that when it comes to learning events, we need to understand that, while we can benefit from the thoughtful application of gamification techniques, not every learning activity has to be a fully-fledged game. However, Kapp (2012 pp.12-15) brings out the misconceptions of the term and describes what gamification is not as follows:

- Gamification is not badges, points and rewards. This is what is often understood by gamification, but these are just some components of games. It is often forgotten that interactivity, storytelling and problem solving are just as important as badges, points and rewards.
- Gamification does not trivialize learning. Elements of serious games are rather used in military training, sales training and medical training to accelerate learning.

- Gamification is not new to learning. There is a lot of evidence that games have been used in education for centuries and many teachers and trainers use game-like techniques for a long time. What is new is the growing acceptance of game thinking applied to learning and instruction.
- Gamification is not foreign to learning professionals. It is the goal of the learning professionals to create compelling materials that will help to achieve learning goals.
- Gamification is not a panacea to learning situations. It is not suitable for every situation and if overused loses its impact.
- Gamification is not easy to create. It takes a lot of work to create a game that is both fun to play and instructional.

Sonts (2013) also points out what gamification is not by these examples:

- Gamification is not only game mechanics. Often, the whole experience is neglected in favour of design separate game elements.
- Badges, points and rewards: these are certainly parts of gamification, but they should not be the only game characteristic used. Gamified activity should involve more game elements to take the engagement and learning to the next level.
- Trivialization of learning: gamification should not cheapen the real learning. Gamified learning can also be and often is difficult and challenging.
- New: the elements of gamification have been used long before in military, education etcetera, than the term gamification was first used.
- Perfect for every learning situation: gamification is not a solution for every learning process. It is important to approach the gamification of content and learning carefully and methodically.

- Easy to create: it takes time and a lot of effort to develop the right methods, theme and goal setting.

Nicholson (2012) introduces the term meaningful gamification. Meaningful gamification focuses on introducing elements of play instead of elements of scoring. What these means is that rather than using merely the point system of games, meaningful gamification encourages a deeper interaction of game mechanisms into non-game contexts.

2.8.2 Frameworks of Gamification

A number of authors from varying disciplinary backgrounds have offered principles of how best to apply gamification. Most of the principles can be grouped under three key concepts: Meaning, Mastery, and Autonomy (Deterding, 2011). These three principles were adopted from the self-determination theory (Deci & Ryan as cited in Groh, 2012) which describes three innate needs for intrinsic motivation. According to this theory, Meaning comes from Relatedness, the universal need to interact, to be connected, and to tap into personal and shared goals, interests, and a meaningful story. Mastery comes from Competence, the need to be effective and master a problem in a given environment. The third principle Autonomy, it is defined as the universal need to control one‘s own life.

Intelligent gamification for any situation should be built on these principles (Deterding, 2011; Groh, 2012). Meaning, Mastery and Autonomy have been explained in the following sections:

1. Meaning

Meaning as a principle in designing framework for gamification should be based on the following:

i. Connect to personal goals and interests

Strong engagement can be accomplished if there are attainable, personal, motivating short-term goals such as developing a particular skill, a personal quality, social recognition, or academic excellence (Kapp, 2012).

ii. Connect to shared goals

The goal of _preparing for the future‘ can be abstract and distant for students. Establishing (exciting and aspirational) long-term goals while relating to short-term tasks creates growth with a purpose (McGonigal, 2011).

2. Mastery

Mastery as the second principle in designing a framework for gamification is categorized into:

i. Provide interesting challenges

Present compelling and meaningful challenges in order to trigger intrinsic motivation (Groh, 2012) and the mind‘s natural curiosity (Malone, 1981). To keep the pleasure of intrinsic satisfaction going, the brain needs an increasing level of challenge and complexity (Willis, 2011). Students are motivated by challenges that are just out of reach but attainable (Gee, 2005). Creating an experience of Flow requires remaining in a narrow zone between things being too hard and things being too easy (Prensky, 2005).

ii. Scaffold challenges

Make the onboarding process easy by scaffolding the challenges and reducing scaffolding as students‘ progress through the game (Kim, 2011), making it _Easy to learn, difficult to master‘.

iii. Make challenges incrementally attainable through leveling

Break longer mastery arcs into smaller nested skill-chains (van Diggelen, 2012). Mission based levels help structure the progression of learning and motivates learners by developing mastery as the levels become more difficult and learners must recall, use, and improve their skills and knowledge to advance (Kapp, 2012). Replay ability will allow for failure as a strategy for a fruitful learning process (Kapp, 2012).

iv. Provide clear, visual, varying, well-structured goals

Goals create purpose, focus, and measurable outcome. In order for an environment to be challenging, it needs adaptive goals perceived as worthwhile for the learner and, goals whose attainment is uncertain.

v. Provide juicy feedback

Juicy feedback means feedback that is effective, exciting, and engaging because it is balanced, coherent, continuous, emergent and fresh (Hunicke as cited by Kapp, 2012). Intrinsic motivation is activated by offering clear goals combined with an intense and varied performance feedback system (McGonigal, 2011; Prensky 2005). Feedback can give information or guide the gameplay.

vi. Create a reward system for intrinsic and extrinsic motivation

The designing of a successful reward system is complex. One of the most important issues is to understand the different roles played by intrinsic and extrinsic motivation. There are

measurement achievements that have an evaluative function to create a perception of competency which in turn feeds intrinsic motivation. Completion achievements for performance or non-performance creates extrinsic motivation and should be used sparingly as their overuse can reduce intrinsic motivation. The idea is to make achievements challenging for the greatest returns in player performance and enjoyment. Phrase achievements and design interactions increase player self-efficacy (Blair as cited in Kapp, 2012).

vii. Design for fun

Fun must be created. Collecting, sharing, customizing, exploring, collaborating, competing, role-playing and problem solving, are all activities learners can perceive as being fun (Werbach, 2012).

3. Autonomy

Empower the player and create a feeling of agency by allowing for decisions and choices that influence the outcome (Kapp, 2012). The different designers of gamification have both different and similar ideas as shown in Table 2.1. Based on these elements, Kapp and Werbach seem to have all the significant factors but Werbach's model was found most appropriate and was therefore adopted for this study.

	Chou	Deterding	Van Diggelen	Groh	Hammer and Lee	Hannify/MIT	Kapp	Kim	Mievre	Sheldon	Simeos et al	Werbach
MEANING												
Personal goals	*	*	*	*			*	*		*		*
Meaningful community		*	*	*			*	*	*	*		*
Meaningful story		*	*	*			*			*		*
Emotional Experience	*	*	*		*	*	*	*		*	*	*
MASTERY												
Challenges		*	*	*		*	*	*		*	*	*
Goals		*	*	*			*	*		*		*
Rules		*					*	*		*	*	*
Incremental progress	*	*			*		*	*		*	*	*
Skills, levels		*			*	*	*	*		*	*	*
Scaffolding		*					*			*	*	*
Juicy feedback	*	*	*	*			*	*		*	*	*
Flow			*				*	*		*		*
AUTONOMY												
Agency, value activity	*	*		*	*		*					
OTHER												
Social styles			*				*	*	*			
Player types	*		*				*	*		*		
Player styles							*			*		*

Table 2.1 Frameworks of gamification from different designers.
Source: (van Diggelen, 2012; Deterding, 2011; Chou, 2012; Kapp,2012; Kim, 2011b; Hammer & Lee,2011; Mieure, 2012; Werbach, 2012; Hannify/MIT, 2012; Sheldon, 2012; Simeos et al., 2012)

2.8.2.1 Kevin Werbach's framework for gamification

According to Werbach's framework, before any gamified application is created, the development must be approached with a game design-like thinking (Werbach, 2012). Only then is it possible to see which of these elements contribute and add extra value to the user experience and which of them do not.

Werbach (2014) has categorized these elements under the following subheadings:

- Define objectives
- Delineate target behaviours
- Describe your players
- Devise activity loops
- Don't forget the fun!
- Deploy the appropriate tools

These are explained as follows:

1. Define objectives

Why are you gamifying? How do you hope to benefit your business, or achieve some other goal such as motivating people to change their behaviour? As you state your objectives, emphasize the end goal or goals of your gamified design rather than detailing the means through which you'll achieve this goal. Basically, if your gamified system does what you intend, what specific positive results will it generate for your organization?

2 Delineate target behaviours

What do you want your players to do? And what are the metrics that will allow you to measure them? These behaviours should promote your business objectives, although the relationship may be indirect. For example, your business goal might be to increase sales, but your target behaviour could be for visitors to spend more time on your website. As you describe the behaviours, be sure to explain how they will help your system achieve its objectives. The metrics should in some fashion provide feedback to the players, letting them know when they are successfully engaging in the intended behaviours.

3. Describe your players

Who are the people who will be participating in your gamified activity? What is their relationship to you? For example, are they prospective customers, employees at your organization, or some other community? And what are they like? You can describe your players using demographics (such as age and gender), psychographics (such as their values and personalities), Bartle‘s player types, or some other framework. You should show that you understand what sorts of game elements and other structures are likely to be effective for this population. For example, you might discuss whether a more competitive or cooperative system would be better for this player community.

4. Devise your activity loops

Explore in greater detail how you will motivate your players using engagement and progression loops. First, describe the kinds of feedback your system will offer the players to encourage further action, and explain how this feedback will work to motivate the players. (Remember: rewards are only one kind of feedback.) Second, how if at all will

players progress in your system? This includes how the system will get new players engaged, and how it will remain interesting for more experienced players.

5. Don't forget the fun

Although more abstract than some of the other elements, ensuring that your gamified system is fun remains as important as the other aspects. In order to fully explore this aspect of the design process, consider how your game would function without any extrinsic rewards. Would you say it was fun? Identify which aspects of the game could continue to motivate players to participate even without rewards.

6. Deploy the appropriate tools.

By this point, you've probably identified several of the game elements and other specifics of your gamified system. If you have not already, you should explain in detail what your system would look like. What are some of the game elements involved and what will the experience be like for the players? What specific choices would you make in deploying your system? For example, you might discuss whether the gamified system is to be experienced primarily on personal computers, mobile devices, or some other platform. You might also describe what feedback, rewards, and other reinforcements the players could receive. Finally, think about whether you have tied your decisions back to the other five steps in the process, especially the business objectives.

2.8.3 Limitations of gamification

Gamification has its own limitations. A number of potential pitfalls for gamification are discussed in this section. Some of the key points of the not inconsiderable criticism from game researchers, game designers and educators refer specifically to the issue of

pointsification. It has been said that the proponents of gamification do not actually understand the substance of games and in their enthusiastic fervour have mistaken some of the least essential elements of games – things like leaderboards, points, and badges – as the essence of games (Pihil, 2012). Or that gamification would better be called pointsification for this reason. Points, badges, and leaderboards (PBLs), it is argued, have no closer a relationship to games than they do to websites and fitness apps and loyalty cards (Robertson, 2010).

Author and games designer Ian Bogost calls pointsification _exploitation ware' whereby people are led to believe that in order to meet commercial objectives, points, badges, levels, leader boards, and rewards are ―key game mechanics‖ (Bogost, 2011, page p.). Key game mechanics are, in his opinion, the operational parts of games that produce an experience of interest, enlightenment, terror, fascination, hope, or any number of other sensations. Points and levels and the like are mere gestures that provide structure and measure progress within such a system. Jon Radhof (2011, para.2) ―game designer and blogger, speaks up against reducing what is so important to creating successful game experiences, the problems of immersion, cooperation, and competition to Skinner boxes
(―push-button, get cookie‖), a part of behaviourist psychology‖.
Applying gamification strategies and/or technology to curriculums may often do a better job of teaching. However, it does not mean it should be a replacement for a comprehensive curriculum or face-to-face instruction. Instructors must be careful not to depend on extrinsic motivators in the game to modify student behaviour, as the habit created during the gamified process may not sustain once the extrinsic reward is gone.

And finally, instructors must not disregard the importance of human teaching, because as Ben Leong states, ―teaching is fundamentally a human activity‖ (Wendy & Soman, 2013).

2.8.4 Gamification in Education

Given these features, it would seem that school should already be the ultimate gamified experience. However, something about this environment fails to engage students. In contrast, video games and virtual worlds excel at engagement (McGonigal, 2011). As evidence of this, 28 million people harvest their crops in ―Farmville‖ on a daily basis (Mashable, 2010), and over five million people play ―World of Warcraft‖ for more than 40 hours per week (Blizzard, 2010). On the other hand, the default environment of school often results in undesirable outcomes such as disengagement, cheating, learned helplessness, and dropping out. Most students would not describe classroom-based activities in school as playful experiences. Clearly, the existence of game-like elements does not translate directly to engagement.

Gamified learning environment is a relatively new instructional approach that is inherently engaging and has the potential to motivate students to learn. The teacher is charged with the task of developing gamified environment that not only compels and entertains the learner but also teaches through role play and other techniques that tap into the intrinsic motivation of the learner.

Richtel (2010) asserts that in education, the reasons for drop-outs or low performance include boredom or lack of engagement, a pattern of escalating absenteeism where each

absence makes the person less willing to return to school, and most importantly, being distracted by technology such as smartphones and the Internet.

Today's schools therefore face major problems around student motivation and engagement. Gamification or the incorporation of game elements into non-game settings, provides an opportunity to help schools solve the difficulty of motivating and engaging students because gamification encourages students to perform an action; for example, motivating students to practice computer programming will increase their skill and motivating students to memorize consistently can increase their knowledge. Another example is if the instructor hopes for the student to hand in assignments faster, a point‘s ladder according to when the students hand in their work could be added as a game mechanic. This in turn can incentivize them to develop behaviour of doing their assignments ahead of time and thus, lead to achieving the original objective (Huang & Soman, 2013).

2.8.5 Significance of Gamification in Education

A number of potential benefits of gamification that have been outlined are:

1. Student Motivation and Engagement

The expectations to deliver in the area of increased engagement, motivation and learning outcomes are high. If using only external rewards with a lack of insight can be a pitfall, harnessing all the motivational - intrinsic and extrinsic - qualities in a knowledgeable way games can be of great benefit to students. Games are designed for success, and according to Zichermann (as cited by Deterding, Dixon, Khaled, & Nacke, 2011), they can demonstrably motivate users (learners) with unparalleled intensity and duration. When games are well-designed they tap into our deeply rooted, intrinsically motivated,

biologically programmed love of learning (Gee, 2009). Gamification can motivate students to engage in the classroom and to bring their full selves to the pursuit of learning. It can create effective, interactive experiences that motivate students and engage them in the learning process, practising behaviours and thought processes that can easily transfer from the classroom environment to real life (Trybus, 2012) and eventually translate to a career of lifelong learning (Hammer & Lee, 2011).

The large majority of traditionally designed instructions contain course objectives - not challenges, bulleted lists - not interactivity and end-of-lesson quizzes - not continual corrective feedback. Interactivity challenges and continual feedback are what makes gamification so effective as a perspective for designing and delivering instruction (Kapp, 2012).

Despite the ability to perform demonstrations and the use of experiments to reinforce science concepts, students lack interest in pursuing science courses in school and science careers. Traditional instructional methods have made it difficult for students to concentrate and develop a desire to learn about science. Being engaged in the content is the first step towards learning that content, and that begins with motivating students to crave knowledge. Motivation is a key aspect of effective learning but it needs to be sustained through feedback, reflection and active participation in order for the intended learning to take place (Garris, Ahlers, & Driskell, 2002).

Muntean (2011) also has it that gamification helps students gain motivation towards studying, and because of the positive feedback, they get pushed forwards and become more

interested and stimulated to learn. Gamification can constitute a powerful boost to determine them to study or read more. The use of gamification can bring about significant increase in motivation and engagement. It exploits our basic psychological urges such as goal-setting, competition, and the need for status and recognition (Antin & Churchill, 2011). Therefore the key challenge for effective learning with gamification is for the learner to be motivated, supported, and interested with not only the activity but with the content that he or she is trying to learn.

2. Connects better to student expectations

Gamification will engage and motivate students more powerfully as it connects better to the expectations of digital native students of the 21st century (Keramidas, 2010). Applying the learning principles in games to designing learning environments (Gee, 2005) not only makes the learning experience more beneficial to students, and more fun, it meets more closely the expectations of these at this point in time.

3. Connects to 21st century skills

Systems thinking, collaboration, and disciplinary knowledge, media literacy, solid epistemic frameworks, higher order thinking skills have all been mentioned as important skills that can give students the capabilities needed to negotiate the demands of the 21st century (Binkley, Erstad, Herman, Raizen, Ripley, & Rumble, 2010). Using games and game elements connects firmly to these skills and can play an important role in producing an educational system that supports 21st century outcomes for today‘s students (Binkley et al., 2010).

4. Uses existing skills of learning professionals

An advantage for educators is that it offers the opportunity to append existing skill sets rather than retrain as a game designer, to re-imagine preexisting materials (courses, programs) rather than begin entirely anew, with a shallower learning curve than needed in designing fully developed games for the classroom (Keramidas, 2010). Gamification can be used to promote learning because many of the elements of gamification are based on educational psychology and are techniques that designers of instruction, teachers, and professors have been using for years. Items such as assigning points to activities, presenting corrective feedback, and encouraging collaboration on projects have long been the staples of many educational practitioners. The difference is that gamification provides another layer of interest and a new way of weaving together those elements into an engaging game space that both motivates and educates learners (Kapp, 2012). It can also give teachers better tools - more engaging and goal oriented- to guide and reward students (Hammer & Lee, 2011). Learning professionals have many of the skills, knowledge and abilities to take a leadership position in the gamification of learning and instruction (Kapp, 2012).

5. Incremental application

Designing a full-fledged game is a long and complicated, often expensive process. Gamification has the advantage of being applied in incremental steps, making it less complicated, more manageable, and less expensive. There are smaller adaptions to be made to parts of courses that can be improved and added to over time. Gamifying a whole course can also be done in various steps allowing for improvements and additions. In education there are, in any case, two possible approaches to gamification. One is gamefully designing the learning process whilst leaving the course content unchanged (Kapp, 2013). The second

option alters the course content, making it feel more game-like as in an Alternate Reality Game (ARG) described by Guilmour (2011) in the following section.

2.8.6 Educational Works on Gamification

As Guilmour (2011) describes, freshmen at the University of Southern California School (USC) of Cinematic Arts were offered a unique way of getting to know each other. They could play *Reality Ends Here*, a trans-medial ARG card and web-based game that enabled them to create collaborative media projects such as films, games, events, or other artwork. Once students were lured into the game via a series of mysterious communications they received a pack of 10 cards with challenges and prompts. By connecting to other players' cards they could form multifaceted deals. Active participation and high scores offered interesting rewards such as mentorship opportunities, meet ups and encounters with alumni, artists, and other industry professionals that were not connected to gathering study points.

The overwhelming majority of students participated in the voluntary game, giving the faculty reason to play it again in 2012. This game is a useful example of how a simple core mechanic- exchanging cards - can create a complex game with multiple possibilities for creating projects and interacting with fellow students (Guilmour, 2011).

Jackson (2009) also created a game-like structure for an educational technology course that she called ―game-based learning‖ in 2009, before gamification became a household name. Her approach of gamifying course structure was inspired by James Paul Gee's principles of learning such as leveling, well-ordered problems, immediate feedback, resubmission, and discovery learning. Adapting these principles, Jackson restructured her class as a game

around a series of design assignments (Jackson, 2009). In this environment, students could submit their assignments multiple times which was a hit among Jackson‘s students because it changed mistakes to learning opportunities, gave students more opportunities to practise based on feedback, and allowed students to take more risks. The students also had to _level up‘ by earning a certain number of points before moving on to the next assignment which enabled them to build skills for the next assignment thus providing _well-ordered problems‘. Offering three levels of expertise: Proficient, Expert, or Guru, added the element of _adaptivity‘, allowing students to learn at the edge of their _regime competence‘ and use their _self-knowledge‘ (Jackson, 2009). Qualitative data from course evaluations, focus groups, and unsolicited student comments supported the conclusion that game-based teaching outscored direct instruction in cognitive motivational and emotional processes. Some points for improvement were: creating a storyline to make it more compelling and adding elements of immersion, agency and rethinking the points system as the students said although they liked the use of Experience Points, this added little to their motivation (Jackson, 2009).

2.9 Mathematics Education in Ghana

Mathematics in general is an essential subject for scientific and technological development of any nation. It is part of life without which man cannot function (Nabie, 2002). This suggests that no nation can grow scientifically and technologically above her mathematics status; an indication that mathematics is indispensable for science.

Mathematics is the means of sharpening the individual's mind, shaping his reasoning ability and developing his personality, hence its immense contribution to the general and basic education of the people of the world (Asiedu-Addo & Yidana, 2004).

Seo and Ginsburg's study (2004) show that young children could develop strong interest in mathematically related activities and become eager to explore mathematical ideas with appropriate encouragement. An increasing number of educators are starting to realize the current situation of early mathematics education and have begun to pay more attention to early mathematical research. Starkey, Klein, and Wakeley (2004) have proved that mathematics intervention for young children significantly promotes young kids' mathematical knowledge. This implies that gamification can help children develop quality mathematical skills; thus, gamification as an intervention will help improve the teacher-learner gap that exists in the teaching and learning of lower primary mathematics in Ghanaian schools.

CHAPTER 3

METHODOLOGY

3.0 Overview

This chapter describes the research process that informed the study. It comprises of the research design used, the population sampling procedure and sampling technique. It also discusses the instruments and how they were developed, the pre-intervention, intervention and post-intervention data collection procedure and analysis and finally data analysis plan. The design involved using gamification in education to improve the teaching and learning of elementary mathematics through engagement in hybrid learning in the classroom.

3.1 Research Design

Burns and Grove (2003: p.195) have defined research design as ―a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings‖. Parahoo (1997: p.142) also describes research design as ―a plan that describes how, when and where data are to be collected and analysed‖.

The design adopted for the research was educational design research which is also known as design-based research or design research. According to Plomp (2009), educational design research is the systematic study of designing, developing and evaluating educational interventions (such as programmes, teaching-learning strategies and materials, products and systems) as solutions for complex problems in educational practice, which also aims at advancing our knowledge about the characteristics of these interventions and the processes of designing and developing them. Plomp (2009) further adds that, the research process in design research encompasses educational design processes. It is like all

systematic educational and instructional design processes and therefore cyclical in character: analysis, design, evaluation and revision activities are iterated until a satisfying balance between ideals (_the intended‘) and realization has been achieved.

Educational design research (EDR) addresses educational problems in the real-world and not in laboratory settings. In contrast to many kinds of educational research, EDR has two primary goals: to develop knowledge, and to develop solutions. Like other research types, EDR extends theoretical knowledge through data collection and analysis. Barab and Squire (2004) also opine that educational design research is a series of approaches, with the intent of producing new theories, artefacts, and practices that account for and potentially impact learning and teaching in naturalistic settings (Educause Learning Initiative, 2012).

But unlike many other kinds of research, the EDR process is embedded in the (often cyclic) development of a solution to the problem being tackled. This process can be illustrated in various ways. Figures 3.1 and 3.2 illustrate a few examples show how different authors have visualized the research process.

Reeves (2006) depicts the design research approach as shown in Fig. 3.1.

Educational Design Research Approach

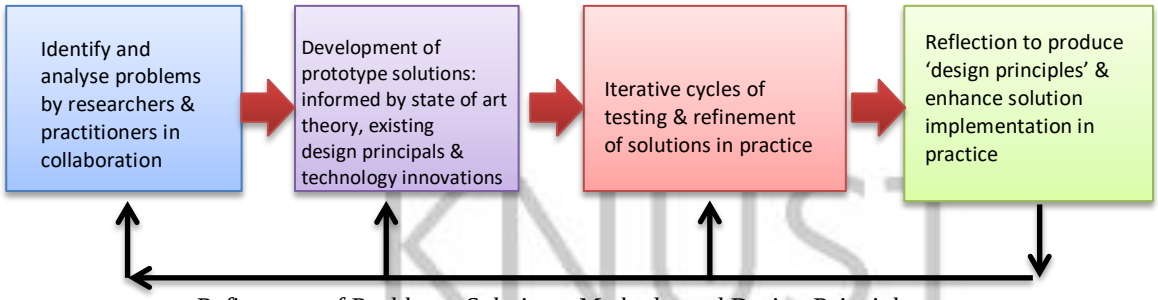


Figure 3.1 Educational Design Research Process

Source: Reeves (2006)

Building on Plomp's (1982) educational design model, Verhagen (2000) also sees EDR as represented in Figure 3.2.

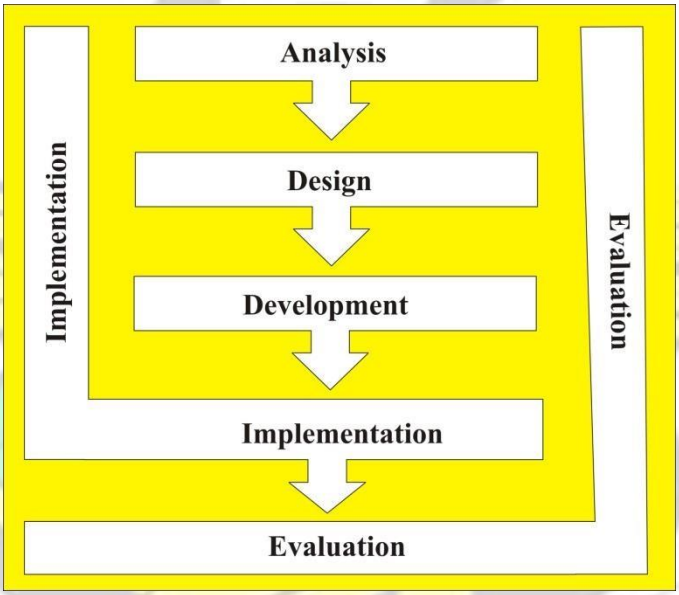


Figure 3.2 Verhagen's model on EDR, built on the EDR model of Plomp.

Source: Verhagen (2000)

The researcher adopted the Reeves (2006) model or EDR approach since this current research is addressing a practical educational setting problem where teaching and learning takes place. In line with this, three main attributes of EDR were considered by first

identifying and analysing how the teaching and learning of mathematics are done at the lower primary school level in a selecting research setting, designing the appropriate gamification module using the most suitable gamification framework for the teaching and learning of elementary mathematics; and evaluating the effectiveness of using gamification in the teaching and learning of mathematics.

3.2 Reasons for adopting Educational Design Research

This research focused on determining how the use of gamification and hybrid learning can improve the teaching and learning of mathematics among young children at the lower primary school level. There was the need to look at how gamification and hybrid learning as an intervention can be used to improve the teaching and learning of mathematics by creating engagement to improve pupils‘ participation in the learning of mathematics. Educational design research seemed the most appropriate design to address problems in educational practice (Reeves, 2006).

3.3 Framework for Gamifying the Mathematics Lessons

Werbach‘s (2014) gamification design framework discussed in Chapter Two of this thesis was adopted with a modified curriculum context to suit the Ghanaian classroom setting. This framework was chosen because it had all the significant factors that will encourage gamifying learning environment.

3.4 Gamifying the mathematics lessons

The classroom environment, teaching methods adopted by the teachers, the sample pupils‘ responses to the teacher‘s questions and lessons in the classroom, feedback given to pupils

in the class, the reward system applied in the classroom and the use of ICT in the teaching of mathematics were observed and analysed. Werbach's gamification framework was adopted and modified to suit the Ghanaian classroom setting since the gamification model develops a set of criteria for the judgement of gamification in business organisations. This model presents six (6) stages namely: definition of objectives, delineation of target behaviours, description of players, devising of activity loops, with fun in mind and deployment of the appropriate tools. The framework was afterwards evaluated through observation and responses that emerged from interviewing both the teachers and pupils in the sampled school to find out its efficacy for teaching and learning of mathematics. The items on the interview guide and the observation checklist (See Appendix E) were constructed taking into consideration the criteria for game enjoyment and game flow (Sweetser & Wyath, 2005).

3.5 Population

The population chosen for the research consisted of the pupils in lower primary schools (Primary 1-3) in Kumasi and the accessible population, as shown in Table 3.1, was the lower primary teachers (2 females; 4 males) and pupils (134 females; 116 males) in Scales Adventist Preparatory School at Old Tafo, a suburb of Kumasi in the Ashanti Region of Ghana. The ages of the pupils ranged from 6-9 years and there was a higher dominance of females in the lower primary classes.

The school was chosen because the researcher has a good relationship with the school management and the teachers in the school. The school also has in place an ultra-modern information and communications technology laboratory to facilitate the research.

Permission was sought from the school management with a letter from the department of General Art Studies in the Kwame Nkrumah University of Science and Technology which was granted to enable the researcher conduct this study.

Table 3.1 Accessible Population

CLASS	NUMBER OF PUPILS	M	F	NUMBER OF TEACHERS	M	F
CLASS 1	80	36	44	2	-	2
CLASS 2	82	36	46	2	2	-
CLASS 3	88	42	46	2	2	-
TOTAL	**250**			**6**		

3.6 Sampling

Sampling is the process of selecting a portion of the population to represent the entire population (Alhassan, 2006). The purposive sampling technique, which is a nonprobability sampling technique, was used to ensure that only mathematics teachers and pupils at the lower primary classes were selected. The purposive sampling technique was also used to select 125 pupils from the accessible population of 250 pupils in Class 1, Class 2 and Class 3 of the selected school for the study. The class distribution of the pupils who participated in the study was 40 in Class One, 41 in Class Two and 44 in

Class Three respectively. This purposive sampling technique was adopted because the pupils at the three lower primary class levels exhibit almost similar characteristics of interest to the study.

3.7 Data Collection Instruments

Considering the nature of research questions that were being examined, the instruments used for the collection of data were observation and a semi-structured interview. These instruments were used to offset the weaknesses of each other.

3.7.1 Observation

Observation, according to Awanta and Asiedu-Addo (2008), is the process of studying the outward and non-verbal behaviours of the person and recording what is observed as it happens. Observation helps researchers to identify problems associated with pupils' behaviours or other people. Data obtained from observations are said to be imperative as observation affords the researcher the opportunity to gather _live data' from _live situations' rather than at second hand (Padgett, 2004). Since this study sought to explore mathematics education in the classroom and interpret among others, the introduction of gamification in the teaching and learning of it, observation was used as one of the data gathering instruments. This was because observation provides the opportunity for the researcher to come to terms with what occurs in the mathematics classroom.

In this study, an observation checklist (See Appendix E) was used to collect the data. The observation checklist had items which were adopted from the criteria for game enjoyment and game flow suggested by Sweetser and Wyath (2005) for evaluating activities and elements of the subject as this model met the requirements of the game enjoyment criteria. The items were modified to meet the classroom context. This was done by selecting only the items which in the researcher's view best suit the Ghanaian classroom situation. The checklist included items concerning teachers' use of game elements in classroom

instructional practices (see Appendix E). The checklist items sought data on how teachers' used game elements in their teaching of mathematics in the classroom. The observations were conducted on the selected lower primary teachers and pupils in classroom settings.

3.7.2 The Observation processes

Observation was used by the researcher to identify and analyse how teaching and learning of mathematics was being done; whether there were game elements present in the classroom before the introduction of gamification; and how game elements were used in the classroom after the introduction of gamification.

The researcher personally observed how the mathematics teachers taught their lessons in the three lower primary classes, how the pupils responded to their teaching; and how the already existing reward systems in the classes were being used. Each class was observed three times in an 80 minutes (2 periods) lesson within the academic term. One class was observed per day. Observation notes were taken to gather data which for the study. The observation lasted from September 29th to November 28th, 2014.

Observing the participants during the introduction of gamification provided the researcher the opportunity to come to terms with the realities of teachers' use of game elements in the teaching of mathematics to create engagement through blended learning in the classroom. The researcher therefore observed these in the three lower primary classes in the selected school.

The observation sought for data concerning teachers' classroom practices with the introduction of game elements in the teaching of mathematics lessons. While observing

teachers during lesson delivery, the checklist (See Appendix E) were ticked for any gamified approach the teacher adopted in the delivery of the lessons. Each class was observed three times in an 80 minute lesson within the academic term. One class was observed per day. Observation notes were also taken to gather data which was not on the observation checklist yet relevant to the study. The observation lasted from January 15th to April 1st, 2015.

3.7.3 Validation of interview guide

The interview was conducted in two phases: pre-interview and actual interview. Preinterview was conducted to enable the researcher rehearse, and to ascertain the suitability of the instrument; whereas the actual interview was conducted after the pitfalls of the preinterview was corrected by the researcher. Thus the pre-interview offered an opportunity for the researcher to rehearse and gain fore knowledge of the right techniques that would be adopted for the main interview. For this reason, one lower primary mathematics teacher and a pupil were initially interviewed, audio-recorded and the interactions examined. The responses were scrutinized and peer-debriefed after listening to the recorded version (Merriam, 1998). It was realized from the recording that the researcher was too conscious about the time allotted for the interview which did not allow the interviewees to explain their actions further. Consequently, another lower primary mathematics teacher and a pupil were also interviewed and their responses examined.

Obviously, improvements were seen and all was set for the actual interview.

The researcher interviewed 15 pupils, five (5) from each of the three lower primary classes, and three (3) teachers who taught mathematics at the lower primary level in the sampled school. This number was deemed appropriate after considering the depth of the interview required (Kumekpor, 2002).

The choice of interviewing only five pupils from each of the selected classes was necessary because of the challenges associated with organizing and managing large qualitative data from interviews. Besides, the quality of the data was considered much more important for the purpose of this study than the issue of representativeness of the target to population as in quantitative studies (Creswell, 1999).

3.7.4 Organization of the Interview

The interview was conducted in two folds. The first main interview was conducted to assess how the teaching of mathematics is done and the effect the teaching has on the learners. The second one however was done at the evaluation period to assess the effect the gamification and blended learning strategy had had on the teaching and learning of mathematics in the lower primary classes. The interview time frame for the teachers was between 20-30 minutes and that of the pupils was between 20-25 minutes. All questions and their corresponding responses of each of the interviewees were recorded by the researcher.

The first set of the main interview was conducted from December 10 to December 14, 2014 to enable the researcher to analyze the teaching and learning environment of mathematics; and to find out how game elements could be introduced to the mathematics lessons. The second set of interviews took place between 5th and 10th April, 2015. This was

conducted to evaluate the introduction of gamification and blended learning in the teaching and learning of mathematics lessons in the sampled classrooms. Items for the final interview after the introduction of gamification and blended learning strategy were constructed taking into account, the game flow evaluation method suggested by Sweetser and Wyath (2005). The questions were however, modified by the researcher to meet the needs of evaluating computer and non-computer based gamified subjects. The questions were categorized to evaluate all the elements that are needed to create enjoyment and free flow in games.

3.8 The design process of the modified instructional material

The researcher considered, adopted and followed the ADDIE model (Sommerville, 1989) for creating instructional materials required to overcome the difficulties that were identified from the teaching of mathematics lessons observed in the case study school. It was envisaged that the sample instructional materials would enhance the teaching and learning of maths.

3.8.1 The ADDIE Model

The most commonly used model for creating instructional materials is the ADDIE. ADDIE stands for analyse, design, develop, implement and evaluate. These five steps represent a dynamic and flexible guideline for building effective training and performance support tools.

During the analysis stage, the classroom environment, learner characteristics, and activities to be learned were observed and analysed in order to produce suitable instructional

materials that would fit well in the math classroom. Various topics of the maths lessons to be treated in the project were sought from the Ghana Schools Syllabus for Teaching Mathematics in Primary 1-6 and learning objectives were developed to fit the instructional approach. The mathematics instructional materials were personally developed from odds and ends as shown in Figure 3.3 and 3.4. The materials used were mostly found as _waste' in the environment with the intention to promote the recycling of waste materials that are regarded as sources of pollution in the local environment. These _waste' materials included pieces of plywood boards, tarpaulin, tissue paper moulds, bottles and empty cans. Assessment and evaluation of the instructional materials were done to ascertain their efficacy as resources for teaching and learning of mathematics. The first sets of the instructional materials were considered as prototypes or models.

During the test of validity of the constructed instructional models, formative evaluations were embedded in each of the five steps for judging the value of that process while the activities were happening. As a result, revisions were made to the final sets of constructed instructional materials to improve their efficiency as tools for the teaching and learning of mathematics to young children in the lower primary school.

Figures 3.3a and Figure 3.3b: Some of the found materials used in constructing the sample instructional materials.
Source: Field work (2014)

Figure 3.4a and Figure 3.4b: Working on construction of the sample instructional materials
Source: Field work (2014)

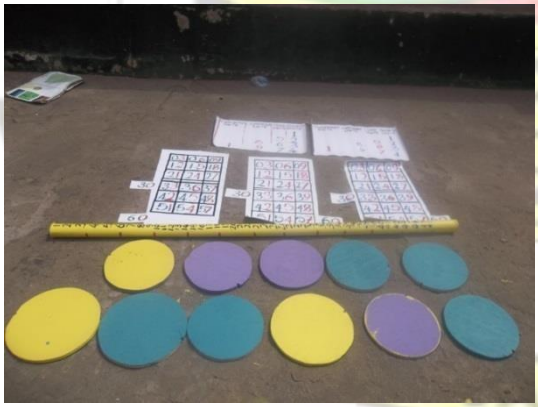


Figure 3.5a and Figure 3.5 b: Display of some of the constructed mathematics instructional materials.
Source: Field work (2014)

3.8.2 Validity of the prototype instructional materials

The prototypes of the instructional materials constructed for the various mathematics topics were tested on four pupils each from Primary 4, Primary 3 and primary 2 as control group (see Figure 3.6) to test the prototype of the instructional materials made specifically for the teaching and learning of mathematics. The selected pupils from Primary 4 tested the instructional material meant for Primary 3, the selected pupils from Primary 3 tested the instructional material meant for Primary 2 and the selected pupils from Primary 2 tested for Primary 1. These pupils were selected to test the validity of the constructed instructional materials because they had been in those classes the previous academic year and had been taught the relevant topic before. Formative and continual feedbacks as expected from the instructional materials were evaluated whiles they were being used by the selected pupils. Pitfalls of the constructed instructional materials pointed out by both teachers and pupils were taken note of and improvements were made to these instructional materials during the final production stage.

Figure 3.6: Pupils testing the validity of one of the instructional materials. Source: Fieldwork (2015)

3.9 Ethical Considerations

Permission was obtained from the authorities of Scales Adventist Preparatory school to use the lower primary mathematics teachers and pupils as subjects for the study. Participants' consent was sought before the researcher conducted the observations and interviews. The purpose of the study was clearly stated to the participants and they were assured that the data collected would be treated with confidentiality. Participants were also assured that their participation in the study was voluntary and that they could withdraw from the study without any consequence.

3.10 The Intervention Strategy

Five days after consent was obtained from the school, a workshop was organized for the teachers on how to use the adopted and modified gamification framework of Kevin Werbach (2014) and also, how to use the Edmodo learning management platform as interventional tools for teaching maths at the lower primary class (as shown in Figures 3.3a,b &c). This was done to equip the sampled teachers with the knowledge on how to effectively modify their teaching strategies with gamification and how to integrate the Edmodo learning platform with their normal classroom teaching of mathematics.

Figure 3.3a

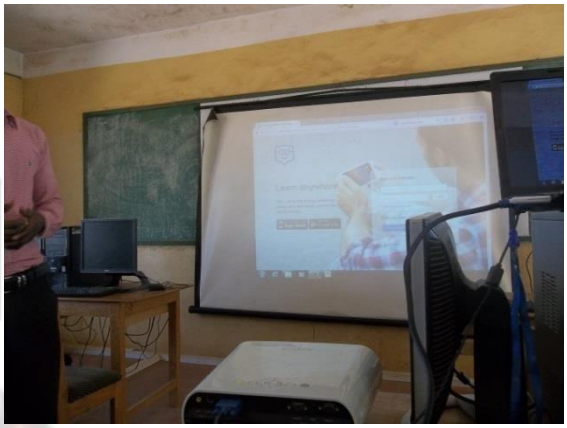


Figure 3.3b

Figure 3.3c

Figure 3 .3a, Figure 3.3b & Figure 3.3c: Some of the teachers watching demonstration on the use of gamification and Edmodo learning platform during the training workshop. Source: Field Study (2014)

The various maths topics which were selected for the study and were taught by the teachers for the second academic term at the lower primary is summarised in Table 3.2.

Table 3.2 Teaching activities considered for intervention lessons.

CLASS	TOPIC(S)	UNIT(S)
One	Addition: sum up to 5	1.5
	Solid shapes	1.6
	Numbers and numerals	1.7
	Addition sums up to 9.	1.8
	Subtraction 0 - 9	1.9
Two	Measurement of length, capacity and weight	2.5
	Addition (sums 0 - 99)	2.6
	Subtraction (numbers less than 100)	2.7
	Fraction	2.8
	Measurement of Time and money	2.9
Three	Collecting and Handling data	3.5
	Estimating and Measuring Capacity and Weight	3.6
	Multiplication of Numbers	3.7
	Division	3.8
	Plane Shapes	3.9

3.11 Data analysis plan

The data were assembled, analysed, the facts interpreted, conclusions drawn and recommendations made. The details of the discussion are provided as Chapter Four.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Overview

This section of the thesis presents the analysis of data collected through the field work where major findings from the study are presented and discussed relative to other research findings. The study explored gamification in education: improving elementary mathematics through engagement in hybrid learning in the classroom. Data were collected using two instruments, interview and observation. Results of the data analysis presented in this chapter shows how the classroom environment was analysed; appropriate gamification framework was modified and used in the teaching of mathematics; and the evaluation of the game elements used in the gamified mathematical lessons by observations made by the researcher, interview responses of the pupils and at some point, the teachers.

4.2 Objective One: To analyse the teaching and learning activities in the sampled school

The school observation and interviews revealed the following as practices that are associated with the teaching and learning of mathematics in the lower primary school.

1. **Instructional Period**

Upon interviewing the teachers on whether the instructional period allocated on the school timetable was adequate for the many topics that they have to tackle in mathematics, all of them were of the opinion that the instructional periods were inadequate. This is because six

periods of mathematics a week was found on the timetable instead of the eight periods a week that the syllabus specifies. Each period lasted 30 minutes so six periods meant the teachers had 180minutes or 3 hours for maths education instead of 4 hours per week. This implies some topics could be skipped or not taught in-depth for the pupils to understand the content.

2. Objectives of Lessons

The observation revealed that the sampled teachers were teaching maths without clearly explaining to the pupils the objectives of learning the particular topics. Although some of the teachers at times mentioned the objectives at the beginning of the lessons, they did not clearly define them to the pupils. Most of the teachers were also teaching without prepared lesson plans, thus they taught their lessons extemporaneously. Upon questioning, it was realised that the teachers failed to explain the objectives of their lessons to the pupils simply because they thought the pupils would understand the purpose of the lessons as the lessons progressed and at the conclusion of the lessons. Interview response gathered from the pupils revealed that most of them were of the view that the teachers always state the objectives of the lesson before teaching.

3. Teaching Approaches

The classroom observation made it evident that collaborative learning was absent in the sampled lower primary mathematics class. There was no kind of group discussion or group demonstrations by the pupils. Mathematics teaching at the lower primary school actively involved the teachers and few pupils in the class which made the majority of pupils less active and therefore, passive learners. The only time the pupils became active was when

the teacher called one of the pupils to respond to a question or when the pupils were doing class assignments during the lessons. Correct answering of a question by a pupil was considered to be an indication that all the pupils in the class had understood what they were being taught and could as well answer questions successfully when given the opportunity. It was also observed that most of the pupils spent more time than was required of them in doing class assignments during lessons. It was also observed that there was no form of small groupings for group work in the sampled lower primary class. Thus, the pupils performed mathematics activities individually.

When the teachers' views on collaborative learning were sought, all the three sampled teachers responded that collaborative learning was a new concept to them. However, they were aware of the common terms _group learning' and _group work'. They added that group activities were sometimes given to the pupils in the other reading subjects but not in the study of mathematics. The pupils who were interviewed also confirmed that no form of group work is done during mathematics classes. A follow up question on whether the pupils liked solving mathematics questions on their own received a 60% _Yes' and 40% _No' answer from the 25 pupils interviewed.

4. Resources for Mathematics

It was also identified that instructional materials were not used by the teachers who teach mathematics during their delivery of lessons to the lower primary pupils. Mathematics lessons were taught theoretically with few demonstrations by the teacher on the blackboard. This, in effect, made the pupils passive learners rather than active recipients of information provided by their teachers. It was observed that the pupils being passive learners were also not engaged to ask questions in class. When interviewed, the teachers reported that they do

not use instructional materials during mathematics lessons because the school does not provide any for teaching activities. One of the teachers pointed to a few multiplication table charts that had been designed on cardboard and mounted on the wall behind the class as what the pupils use to learn the concept of multiplication. Thus, the teachers were aware of the significance of using instructional materials in teaching yet they were not using any because of their unavailability in the school.

5. Motivational Elements

Motivation enables pupils to put forth effort without resentment (Prensky, 2002). Another observation the researcher made in relation to the teaching of mathematics at the lower primary level in the sampled school was that the reward system in the class was not motivating the pupils enough to perform mathematics activities. The only form of reward system that was motivating in the classroom during the teaching and learning of mathematics was applauds the pupils may receive from their colleagues after giving the right answers to questions asked by the teacher. Poor reward system in effect demotivated the pupils and feelings of reluctance to perform activities in mathematics were aroused.

―Feedback is very essential to the learner because it is a form of motivational factor that influences effective learning‖ (Kochhar 2004:28). Interview responses of the pupils revealed that they do not have access to their summative scores although they were aware of their formative score by way of the marked exercises shown in their exercise books and their marked examination answer sheets. The summative score of the pupils were translated on report cards and sent to the guardians or parents of the pupils at the end of the term.

Some pupils may not know their overall score and how they performed in class if their guardians refuse to show them their report cards.

In interviewing the sampled teachers who teach mathematics at the lower primary on the reward and scoring system, all of them reported that they give back marked exercise books to the pupils for them to know their scores and also do corrections on the questions they answer wrongly. Thus, they see marks given for the pupils‘ marked exercises as recorded in their exercise books as part of the reward system which allows the pupils to know their scores. The responses of the pupils interviewed revealed that most often, they only become aware of their respective academic performance positions at the end of the term when their teachers mention it in class before the school goes on vacation for that academic term.

6. Teacher Centred Teaching

From the classroom observations, it was gathered that mathematics lessons in the school were more _teacher centred‘ than _learner centred‘. The teachers were not using structured teaching materials and therefore relied solely on textbook routine tasks. This resulted in the teachers teaching for the pupils to grasp the import of lessons conceptually for reception.

7. Response System

The observation revealed that there were elements of feedback such as teachers reacting verbally to a question or an answer given by a pupil during the progress of the lesson. The teachers also allowed pupils to applaud their peers who do well during lessons in the classroom. Homework and class assignments that were given to the pupils were marked by the teachers and the exercise books were given back to the pupils for them to make

corrections to the questions they got wrong. This is done after the teachers have solved those problems with the pupils' input on the board. Although there was feedback on mathematics activities during lessons, it was observed that most of the pupils felt reluctant asking or answering questions asked during lessons.

In responding to whether they give feedback to pupils after they perform an activity in mathematics, the teacher interviewees revealed that they have a feedback system which they use and this feedback system was they marking class assignments and home works. The teachers further added that they respond verbally to the pupils' answers or most often solve problems or work sums the pupils ask for during lessons on the blackboard. The responses of the pupil interviewed however, suggested that majority of the pupils were not even conscious about the feedback system the teachers talked about. This suggests how poorly feedback is given by the teachers.

8. Use of Technological Resources

The researcher observed that all the mathematics lessons were taught in the classroom only and without the use of any ICT resources. The teachers interviewed made it known that they thought the ICT lab in their school was meant for the study of ICT as a subject and not for the study of mathematics. The pupil interviews also confirmed that they are only allowed access to the ICT lab when they had ICT classes.

Based on evidence derived through interviews and analysis of the teaching and learning activities observed in mathematics at the lower primary level of the study school, it was found necessary to modify Kevin Werbach's (2014) gamification framework to enhance the teaching and learning of maths in the Ghanaian lower primary classroom. Sample

instructional materials that would be needed to enhance the teaching and learning of selected mathematics topics for the second term were therefore designed and deployed as an intervention to address the challenges identified in the observed lessons.

4.3 Modifying Werbach's Framework for Gamification for the teaching of the Mathematics Lessons

The lessons that were gamified took into consideration the six stages of Kevin Werbach's gamification framework (2014) which consists six of the features described in the following sections.

1. Define Objectives

The objectives for the various topics were based on what the Ghana Education Service Mathematics Syllabus for Primary Schools (2007) has specified for each lesson. These objectives were turned into goals (See Appendix H), explained to the pupils and were clearly written on the blackboard in the classroom during the delivery of each lesson by the teacher. The pupils were further made to understand that each goal was to be achieved before they could move a level up for each assigned task.

2. Delineate Target Behaviours

The gamified mathematics lessons aimed at allowing the pupils to interact socially with their peers and to establish trusted relationships. In the three lower primary classes, feedback was to be given by instant responses from the teachers, from the instructional materials the pupils may use, or from the Edmodo online learning platform. Trust points

were awarded to pupils who by themselves performed any mathematics activity successfully. For example, when a pupil solved sample questions on mathematics lessons in the textbook without the pupil being told to do so by the teacher, the pupil earned a trust point. These points were recorded by the teacher on a score sheet and later transferred on the leaderboard which was hung at the back of the classroom for the pupils to see. Instant feedbacks were given by the teacher or the instructional material being used and the appropriate points were earned by the pupils.

In order to encourage peer tutoring and collaborative learning, the pupils (named players) were organised in groups with each group having four (4) members. The pupils were asked to cooperate with their colleagues (players) to perform mathematics activities assigned to their cohorts. This created a social platform where the pupils shared ideas to perform mathematics activities in order to earn points for their group.

3. Describe your players

According to Werbach (2014), one can describe players using demographics (such as age and gender) and psychographics (such as their values and personalities). The designer should show that he understands what sort of game elements and other structures are likely to be effective for this population. For example, the teacher might discuss whether a more competitive or cooperative system would be better for this player community. In line with this, the age (Figure 4.1) and gender of the pupils were used to describe the players.

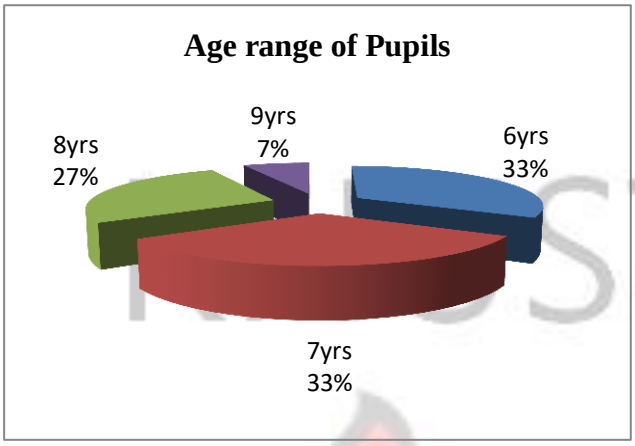


Figure 4.1: Age of pupils at the lower primary. Source: Field Study, (2014)

Based on the Self-Determination Theory (Ryan et al., 1997), the gamified mathematical lessons at this stage incorporated and triggered the following motivation elements:

1. **Competence**

As players (pupils) engaged in more mathematics activities they become more confident in their mathematical skills. The instructional materials and the Edmodo Learning Platform provided opportunity for the pupils to redo finished tasks. By repeating and correcting wrong answers they gave in earlier practice, Pupils became more confident in solving questions on such topics.

2. **Autonomy**

Players (Pupils) were able to choose which mathematical activities they wanted to engage in. The 10monkeys App in the Edmodo learning platform provided opportunity for the pupils to select which mathematical topic they would want to perform an activity on. Also, the pupil as an individual and as the various groups were able to choose which mathematical activity they wanted to engage in by requesting from the teacher the mathematical instructional material they wanted to use to learn during their free periods.

The teachers were able to keep track of the various activities the pupils engaged themselves in.

3. Relatedness

The gamified environment provided the opportunity for the players (pupils) to develop relationships with other players by performing tasks assigned to their respective groups. This was possible because the pupils were grouped into 10 cohorts (4 pupils in a group) in each of the lower primary classes. This was done to encourage collaborative learning and also, to encourage them to relate well with each other. A consistent positive result in relatedness was designed to help the player develop a good reputation and trust and be recognised by the cohorts.

4. Category Achievers

Achievers are pupils who become intrinsically motivated by the points they earn through the lesson and the progress they make upon completion of a challenge (Werbach, 2012). In order to get achievers engaged in the lessons, points were spread throughout the lessons. The pupils however, were awarded points for successful completion of any mathematical activity they were assigned by the teacher. This included experience points for the successful completion and submission of home assignments (known as missions). Points were awarded for asking and answering questions in class and also for regular attendance to school. Points for being a member and participating in a group were awarded to the pupils.

5. Category Socializers

Socializers are pupils who get extrinsically motivated. For extrinsically motivated players, non-reward aspects in a game keep them engaged because to them they are fun (Werbach,

2014). For this reason, pupils in the various cohorts engaged themselves with their group members to perform tasks assigned to their cohorts. The pupils helped each other in group presentations and also other group works in order to earn marks for the group. Thus, it created a platform for the extrinsically motivated players to cooperate, compete, and to help achieve rewards for their cohorts.

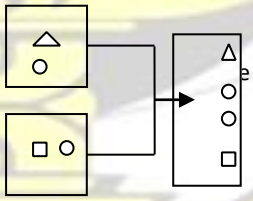
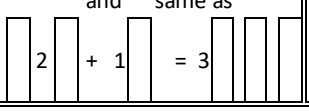
Ten cohorts were created in each class with four members in each cohort. The scoring system was clearly explained to the pupils for them to know the points they may get after they complete a particular task, whether as individuals or groups. This was also to enable them to control the points they earned by choosing and continuing from the levels they reached previously in a task. Points control was also to motivate the pupils in performing other tasks that did not directly relate to the teaching and learning of mathematics in the classroom such as turning in home assignments on time. This enabled the pupils to continue working on assigned mathematics tasks even when they were within or without the school boundary.

4. Devise activity loops

Engagement loop ensures that learning becomes a process that gives the user the motivation to do something. If the motivation is strong enough, the user will react and create the desirable action. When the action is taken, an immediate feedback is given to the user, which should be an indicator of how well the user has performed, which then by itself should become a motivator for the user, thus closing the engagement loop (Werbach, 2012). In consideration of this motivational attribute of engagement loop, teachers gave verbal or written feedback to tasks performed by the pupils; the Edmodo learning platform gave

instant feedback to tasks performed by the pupils; the instructional materials were constructed to be able to give instant feedback to pupils about tasks performed; and the pupils gave feedback to their colleagues who got answers wrong in the performance of group activities. Furthermore, peer review was introduced in the class to give feedback on activities performed by the pupils. These were done to motivate pupils to continue performing activities. The lessons' progression loop started with smaller challenges that were part of a larger challenge as indicated in Table 4.1.

Table 4.1: Lesson plan for primary 1 showing lesson categorized into smaller challenges. Source: Field work (2015)

UNIT	SPECIFIC OBJECTIVES/GOALS	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1.5 **ADDITION:** **SUM UP TO 5**	The pupil will be able to: **Goal 1:** Count and tell how many objects are in two groups of objects put together. **Goal 2:** Write addition sentences for two groups of objects and put together using the 'plus' and 'equal to' symbols.	**Level 1** Putting two groups of objects together **Level 2** Addition sentences	**TLMs**: Bottle tops, seeds, r sticks, shells, stones. Guide pupils to form grou for two given numbers (0 – 5), put the groups togethe and find how many they make altogether. E.g.  Guide pupils to identify th plus sign (+) as adding numbers and equal to (=) sign as the symbol for same as. 	**Challenge 1.** Let pupils: Find how many objects are there in two groups of objects put together. **Challenge 2** Use the plus and equal to sign to perform operations.

Not to overwhelm the pupils, the gamified lessons presented to the pupils the final objective of the lesson to be achieved; however, in order to achieve the objective, the pupils needed to finish all the smaller and larger challenges packed in the lesson. Parts of the lessons were done in the ICT lab with the use of the Edmodo learning platform. Some of the features of Edmodo included creating and management of classes, creating small cohorts within the classes, deployment of quizzes, and deployment of virtual awards. The pupils were however, tutored on how to use this platform to perform tasks assigned by the teacher. It must however, be noted that, since the pupils involved were within the ages of 6-9 years and their level of ICT competence was low, most of the features of the learning platform like commenting on posts of friends were considered advance knowledge for them and therefore, they were taught the basic features of Edmodo like how to launch 10 monkeys (a mathematics game app) which is a feature of Edmodo which the teachers deployed to the various classes on the platform. This App contained exercises on the mathematics lessons that were to be treated by the teacher in that academic term. The ICT lab was opened always to the pupils to voluntarily visit it with the purpose of performing a task with the Edmodo learning platform on their own without necessary being given that task by the teacher.

5. Don't forget the fun!

The teachers together with the pupils drew a storyline for the gamified mathematical lessons. The storyline was that, the entire mathematics lesson was a quest which contained challenges known as _levels' to complete to finally make it to the end of second term

examination which was termed ―big boss fight‖. Each level had a goal to be completed before one moved up that level; and the higher the level, the more challenging the task became. Fun was created by sprinkling challenges and puzzles between levels. All actions were designed to be fun and interesting and were beautifully designed. The feedback system for completion of task was designed to be rewarding, motivating and pleasant. Therefore the completion of task was linked to a positive feeling and since it was fun, the player tends to perform more tasks. In order to do away with negative attitude towards mathematics, attitudes like laziness, isolation and procrastination, were labelled as _villains' that needed to be conquered by the player (pupil). With this, the teacher was to identify such pupils, find out their reason(s) behind such negative attitude(s), and apply possible remedy (ies) to such demotivating attitudes.

6. Deploy the appropriate tools

The game elements that were adopted to gamify the mathematical lessons were points, levels, leaderboards, badges, feedback, activity loop, avatar, rewards, and boss fights. These are explained as follows:

1. Levels

Each lesson was broken into levels and had three components:

a) Step-by-step instructions, required information, and a few compulsory exercises.

b) A practice problem section. This is completed by students on a needs basis. If a pupil feels he is competent on a given topic, he can skip this section and go straight to the mastery test.

c) A mastery test is the final component of any level. They were to be completed without help in a quiet part of the classroom or the computer laboratory. Pupils (Players) were allowed to use their notes and calculators. However, they were not allowed to talk to other pupils (Players) or ask the teacher for help. Pupils could tell the instructor (teacher) when they felt they were ready to take the test. If they did not pass, they were welcome to redo the test until they do succeed, or go back and try some practice problems.

The lessons and practice were for learning and the mastery test was for showing the pupils that they had learned something.

2. Points

Points were awarded only for successful completion of tasks. The points allotted for the successful performance of a task was deliberated and agreed upon by the pupils and the teachers in the various lower primary classes; thus the pupils also cooperated in the designing stage of the gamified mathematics lessons. This enabled them to understand the scoring system designed for the gamified lessons.

3. Real time Feedback

Feedback in gamification can come in many forms – points, badges, and progression bars and is even a key element in the engagement loops. However, it does a lot more than just showing how well you have done. Feedback provides knowledge of practice results, it does not only tell the user if they answered the question correctly or incorrectly, but it also provides the opportunity to explain why the answers are correct or incorrect (Clark & Mayer, 2011). Instant feedback was given by the teacher, the Edmodo learning platform,

the instructional material and fellow cohort members of the pupils, to engage and motivate the pupil performing that task.

4. Badges

Just like all game mechanics and elements, points, badges and leaderboards are seen as extrinsic motivators that can provide feedback on the players' performance that is intrinsic, giving the player a sense of autonomy and competence (Kapp, 2012). For this reason, badges were used as reward system after the pupils successfully achieved the goal of that level, in this case badges were awarded after the pupils accumulate a certain number of points. Categories of badges (See Appendix F) used for the gamified lesson are outlined in Table 4.2.

Table 4.2 list and meaning of badges used in the gamified mathematics lessons. Source: (Field work, 2014)

BADGE	MEANING
Good Heart Badge	For voluntarily collaborating to help a colleague.
Thumbs Up Badge	Awarded to pupils who have been consistent with their progression in the mathematics lessons.
Good Job Badge	For excellent task performance.
Trophy Badge	for successfully making it to the terminal exams (Big Boss Fight)
Star Badge	For outstanding performance in a task.
Team Badge	For being a team player.
Speed Badge	For finishing a task at a faster rate.
Gold Award	For getting the highest score in the gamified course.
Silver Award	For getting the second highest score in the gamified course.

Bronze Award	For getting the third highest score in the gamified course.

5. Avatar

Avatar was used as the characters the pupils played (See Appendix G). At certain thresholds of accomplishment, the pupils were allowed to replace their basic avatars with ones that are fancier. The initials of the names of the pupils were used as the basic avatars before the fancy avatars were chosen by the pupils.

6. Leaderboards

According to Werbach (2012), a leaderboard is a ranked list of participants in a game, with the highest score on top. This helps to determine, which of the pupils of the gamified lessons were doing best. In these gamified lessons, two leaderboards were used with one displaying individual progress and the other displaying group or cohort progress. They were displayed at the back of the class for the perusal of the pupils.

7. Rewards

Rewards come in the form of badges, points, fancy avatar, etc. and they were used in the gamified lessons to motivate pupils to engage in the mathematics activities or tasks assigned to them.

8. Boss fights

Boss fights is the final challenge that the pupil has to complete to finish a particular level. They were considered as the final stage of each level. The end of term exam was considered as big boss fight which each pupil worked hard to beat.

9. Blended learning

After applying the game elements on the mathematical lessons, the pupils were taught to use 10monkeys app in the Edmodo learning platform to practise mathematical problems on the topics which were taught or being taught by the teacher. Thus, part of the lessons was done at the ICT lab using the web based learning platform Edmodo.

Objective 2: To adopt and modify the appropriate designed framework for gamification in the teaching and learning of elementary mathematics.

4.4 Interventional Teaching Strategies and Anecdotal Records of Activities

The following sections focus on anecdotal records of the intervention (gamified) lessons which also highlight the teaching strategies, the activities and attitudes that were imparted to the pupils by the class teachers after they had been taken through the actual process of using game elements in a real environment and Edmodo as an online learning management platform by the researcher. As the usual practice is in real games, the player is expected to know the rules that governed the game before he starts playing. For this reason, the teachers explained the rules that govern the gamified lessons to the pupils.

The teachers together with the pupils also designed the storyline for the gamified lessons. The storyline was that the entire mathematics lessons was a quest which contained challenges labelled as _levels‘ to complete to finally make it to the end of second term examinations which was termed the —big boss fight‖.

The gamified math activities were based on Unit One, Unit Two and Unit Three of the Primary One, Primary Two and Primary Three Mathematics syllabus respectively. This

was done to show the extent of lessons that can be taught in one academic term. The teaching strategies of two topics each of the lower primary classes and their anecdotal reports as discussed are provided in the following sections. Only two teaching strategies were selected and discussed because the teaching and learning experience that happened during lessons on other topics were the same or very similar in the different lower primary classes during the gamification intervention in the classroom.

1. Unit One

The entire Unit One of the Primary School Mathematics syllabus deals with Numbers and Investigation with numbers. The activities described here involves addition sums up to 5, solid shapes, numbers and numerals, addition sums up to 9 and subtraction of 0 to 9. The teaching strategy of addition sums up to 5 and solid shapes are the ones discussed in this section.

Gamified Teaching Strategy 1: Addition Sum up to 5

1. Teacher started teaching by reviewing relevant previous knowledge of the pupils.
2. Teacher clearly wrote the topic of the lesson and its objectives on the blackboard and explained them to the pupils.
3. Teacher explained the levels to be completed in order to achieve the various objectives.
4. Teacher explained what is meant by _sum‘ of two numbers.
5. Teacher demonstrated to the class using bottles, bottle tops and stones to demonstrate sum of two numbers up to 5.

6. Teacher groups pupils and provide them with bottle tops, bottles and stones.
7. Teacher directs pupils to cooperate to solve some questions written on the blackboard with the provided instructional materials. The questions were given in four categories with each category representing a level. Pupils were however cautioned to finish answering questions for level 1 before they move to level 2, 3 and 4.
8. Under the supervision of the Teacher, the various groups were allowed to continue working to solve questions written on the blackboard. Teacher awarded points to the group in her point's record book and later translated the marks on the group leaderboard which was hanged behind the classroom wall.
9. Teacher asked question verbally to test individual understanding of the pupils.
10. Teacher wrote home assignment on the blackboard and asked pupils to submit the next day.
11. After the period was over, Teacher asked the pupils to put away the instructional materials and prepare for the next subject.

Blended Lesson Strategy

The subsequent lesson on _addition sum up to 5' took place at the ICT lab. The detail of the teaching strategy is described as follows:

1. Teacher takes the pupils to the ICT lab and introduced them to the Edmodo Learning management platform and assisted the pupils to create their usernames and passwords.

2. Teacher taught the pupils how to launch 10monkeys app and showed them how to choose the topic on addition of numbers as shown in Figure 4.1a.
3. Teacher demonstrated the whole process of signing in the Edmodo platform and launching 10monkey app to play addition of basic numbers as shown in Figure 4.2a.
4. Teacher assigned the pupils to work in groups and repeat the whole process again.
5. Teacher supervised the various groups as they work on their assigned activity.
6. Teacher awarded points to the pupils for showing up and participating in class. These points were later transferred on the leaderboard which was hanged at the back of the class.

Anecdotal Record

It was observed that the teacher clearly explained the objectives (goals) of the lesson to the pupils. Thus the pupils became aware of the goals they had to achieve at each level of the lesson. The teacher explained what was meant by the term _sum' and demonstrated the concept using bottles and bottle tops, by placing the bottles together and shouting the phrase —I am summing up the bottles‖. Afterwards, the teacher allowed the pupils to count with her the total number of the bottles, from 1-5 after she finished summing up.

The pupils' attention was sustained as the teacher kept saying —I am summing up the bottles‖ during the demonstration. The pupils were engaged to the assigned activity in their various groups and each individual group member contributed to the assigned mathematics activity. Points were awarded for successful completion of levels and badges were issued to the various groups who successfully completed the levels. These badges were pasted on

the group leaderboard. Group Avatars were selected by the various groups from the teacher and were pasted on the Avatar column of the group leaderboard.

At the ICT lab, the pupils were very happy to have had access to the computers; this attitude was observed by the smiles on their faces because they usually have access to the place only when they had ICT as a subject. Using the Edmodo platform was challenging to the pupils but they became conversant with its use after several practises. The 10monkeys app gave feedback response (Figure 4.1) on the performance of the players and also enabled the players to do finished activities again. This enabled the pupils to make corrections to wrong answers and also imbued in them the competence and confidence to approach mathematics activities.

During the lesson the teacher cautioned the pupils who were found moving from one group to the other and also encouraged the various groups in their assigned activities.

Skills that were developed in this lesson were:

- summing up 0-5
- Logging in to Edmodo and
- Launching and performing mathematical activities with the 10monkeys app.

Values the pupils gained included patience, tolerance, competence, relating well and sharing.

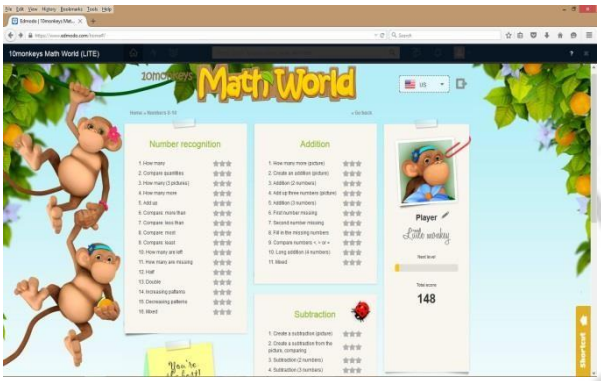


Figure 4.2a

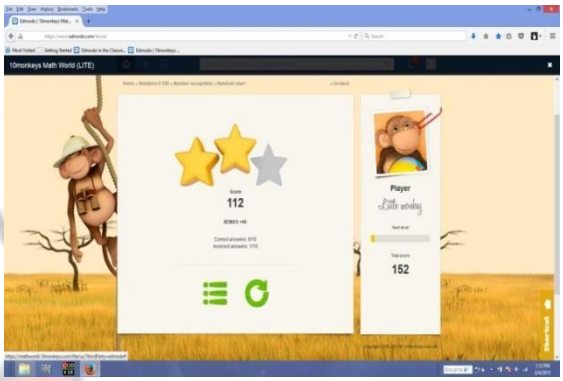


Figure 4.2b

Figure 4.2a &4.2b: A screen capture of the interface of 10monkeys showing instant sub topics on addition and subtraction of numbers; and feedback of a pupil's performance in a task. Source: Fieldwork (2015)

Gamified Teaching Strategy 2: Solid Shapes

1. Teacher started teaching by reviewing relevant previous knowledge of the pupils on shapes.
2. Teacher clearly wrote the topic of the lesson and its objectives on the black board and explained them to the pupils.
3. Teacher explained the levels to be completed in order to achieve the various objectives.
4. Teacher showed milo tin and matchstick box to the pupils and asked them to identify the shape of the edges of both the milo tin and the matchstick box.
5. The pupils responded by mentioning the names of the basic shapes as they saw on the shown objects such as circle, square and rectangle.

6. Teacher demonstrated to the class by grouping different objects according to specific criteria like shapes and edges.
7. Teacher gave instructional materials of varied shapes and asked pupils to cooperate to solve some questions written on the blackboard with the provided instructional materials. Teacher reiterated the assurance of winning points after successful completion of the activities to the pupils.
8. Under the supervision of the Teacher, the various groups were allowed to continue working to solve questions written on the blackboard. Teacher associated points to the group in her point‘s record book and later transferred the points on the group leaderboard for the perusal of the pupils.
9. Teacher wrote three categories of questions on the blackboard and this time instructed that it should be done individually. Each category represented a level the pupil had to complete.
10. Teacher assigned home work to the pupils‘ to do on the taught topic and they were asked to submit in the next day.
11. After the period was over, Teacher asked the pupils to put away the instructional materials and prepare for the next subject.

Blended Lesson Strategy

The subsequent lesson on _Solid Shapes‘ took place at the ICT lab. The details of the teaching strategy is described in this section.

1. Teacher took the pupils to the ICT lab and asked them to log on the Edmodo leaning platform.

2. Pupils launched 10monkeys app and selected geometry patterns which enabled them to learn more about basic and solid shapes.
3. Teacher assigned and assisted the pupils individually as they play and learn basic and solid shapes with 10monkeys app.
4. Teacher supervised the pupils as they work on their assigned activities and also assisted those who were having difficulties with using the Edmodo platform.

Anecdotal Report

The researcher observed that the pupils in the Primary One class turned in their homework and were excited to see the teacher awarding them with points for submission on the score sheet. During the instructional period the pupils were attentive to the activity of shape identification assigned to them by the teacher. In the classroom, groups of pupils were busily giving answers to the activities assigned to their group through collaboration. The teacher associated points to the various groups and individuals on the leaderboards. Team badges (see Appendix F) were issued to the various groups for successfully completing levels in the lessons and these were later pasted at the badges column on the group leaderboard back in the classroom. This was done to reward the various groups on collaborating well with their fellow team members in performing the mathematics activities.

It was observed that the pupils were much elated upon seeing their first badge issued to them in the gamified lesson. Back at the ICT lab, it was observed that some of the pupils were struggling with the use of the Edmodo platform but the teacher did well to assist such pupils. The teacher also allowed the strong pupils in the various cohorts to help the weaker

pupils in learning how to use the 10monkey App. This encouraged peer tutoring as the pupils taught their peers to get the understanding in the performance of the activity assigned by the teacher. The pupils demonstrated positive attitudes such as selfconfidence, concentration and patience and they also improved upon their skills in using the Edmodo learning management platform.

2. Unit Two

The entire Unit Two of the Primary School Mathematics syllabus deals with Numbers and Investigation with numbers. The activities described here involve measurement of length, capacity and weight, addition (sums 0 - 99), subtraction (numbers less than 100), multiplication. The teaching strategy of multiplication and addition (sums 0 - 99), are the discussed by the researcher in this section.

Gamified Teaching Strategy 3: Multiplication

1. Teacher started teaching by reviewing relevant previous knowledge of the pupils.
2. Teacher clearly wrote the topic of the lesson and its objectives on the black board and explained them to the pupils.
3. Teacher reiterated and further explains the levels to be completed in order to achieve the various objectives of the lesson.
4. Teacher explained what is meant by multiplication.
5. Teacher demonstrates by arranging bottles in a rectangular array and together with the pupils counted the number of objects in each case.
6. Teacher writes a multiplication sentence to describe the array of objects.

7. Teacher further use different instructional material (Figure 4.3) to explain the multiplication concept.
8. Teacher allows pupils to sit according to their respective cohorts and guides them to write a multiplication sentence to describe an array of bottles he has arranged in front of the classroom.
9. Teacher allows pupils to demonstrate to the class their understanding of multiplication with the use of an instructional material as shown in Figure 4.4a & 4.4b.
10. Teacher distributes instructional materials to the various cohorts and assigned them multiplication activities to perform as shown in Figure 4.5a & 4.5b.
11. Teacher supervised the activities of the cohorts and assisted the pupils who needed further clarification on the assigned activity.
12. Teacher wrote three categories of question on the blackboard and the pupils were instructed to perform the next activity only when he/she successfully complete answering questions from the previous level(s).
13. Teacher gave marks to the activities of pupils who finished and asked those who completed the levels successfully to progress to the next level.
14. Teacher awarded points on his score sheet and transferred them later on the group leaderboard.
15. Teacher assigned home assignment to the pupils and asked them to submit it next day.
16. After the period was over, Teacher asked the pupils to put away the instructional materials and prepare for the next subject.

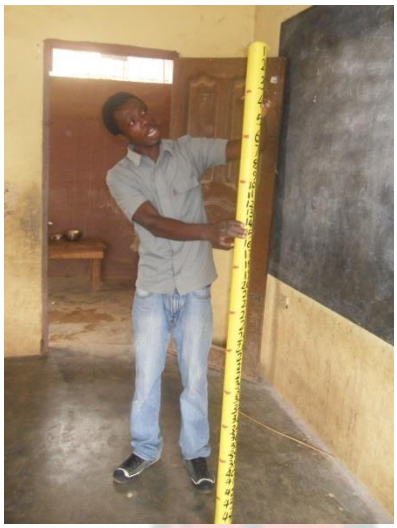


Figure 4.3: Teacher demonstrating to the class using an instructional material. Source: (Fieldwork, 2015)

Figure 4.4a & 4.4b: Pupils demonstrating to the class using an instructional material. Source: (Fieldwork, 2015)

Figure 4.5a & 4.5b: Pupils performing mathematics activity with instructional Materials. Source: (Fieldwork, 2015)

Blended Lesson Strategy

The subsequent lesson on multiplication took place at the ICT lab. The detail of the teaching strategy is described in this section.

1. Teacher takes the pupils to the ICT lab and asked them to log on to the Edmodo platform.
2. Teacher assigned the pupils to work individually in performing multiplication activities with 10monkeys app.
3. Teacher supervised and assisted the pupils as they work on their assigned activity.
4. Teacher awarded points to the pupils for showing up and participating in class. These points were later transferred on the leaderboard which was hanged at the back of the class.

Anecdotal Report

The researcher observed that the pupils in the Primary Two turned in their homework and like the pupils in Primary One, were excited to see the teacher awarding them points for submission on the score sheet. The teacher after marking the homework gave the pupils opportunity to rework on the questions they got wrong by assisting them with further explanations of the questions. During the instructional period the pupils paid attention especially during the demonstration period by the teacher. It was observed that some of the pupils raised their hands and asked questions especially during the writing of multiplication sentences to describe the array of the objects. The pupils were also collaborating to solve problems with their team mates during the performance of the assigned activity by the teacher. Groups were made to finish their current level before they moved on to the next

level in the answering of the questions written on the blackboard by the teacher. The teacher associated points with the various groups and individuals on the leaderboards.

It was observed that the pupils were very keen to the marks they received after they finished with the performance of an assigned mathematics activity. This was evident in how curious they were to know the marks of both groups and individuals after the teacher finished transferring the points from the score book to the leaderboards. It was further observed that some pupils (as shown in Figure 4.6), during their break hours, reported back to the classroom early before the bell for ―break over‖ was rung to continue with their assigned tasks in order to complete their current level and move on to the next level. The teacher also allowed the _strong' pupils in the various cohorts to help the weak pupils during the collaborating learning and also at the pupils' free time. This effort encouraged peer tutoring as the pupils helped their colleagues to understand mathematical concepts in their own unique way. The pupils demonstrated competence in answering mathematics questions and this was as a result of 10monkeys App giving them the opportunity to redo already finished activities. Other positive attitudes they accrued were self-confidence, concentration and patience and they also improved upon their skills in using the Edmodo learning management platform.

Figure 4.6: Pupils using an instructional material to learn.
Source: Fieldwork (2015)

Gamified Teaching Strategy 4: Additions (sums 0 - 99)

1. Teacher started teaching by reviewing relevant previous knowledge of the pupils.
2. Teacher clearly wrote the topic of the lesson and its objectives on the black board and explained them to the pupils.
3. Teacher reiterates and further explains the levels to be completed in order to achieve the various objectives of the lesson.
4. Teacher reminds pupils about their study on additions (sums 0-18) which they learnt in the first term and told them they were going to extend the numbers from 18-99.
5. Teacher demonstrates arranging 3, 4 and 5 separate bottles horizontally. Teacher told the pupils he was going to sum the bottles.
6. Teacher wrote mathematics sentence of the bottle arrangement on the board as 3+4+5=
7. Teacher together with the pupils started counting the bottles out loud and till they got the sum of the total number of the bottles.

8. Teacher completed the addition sentence by adding the sum of the added figures as 3+4+5=12
9. Teacher rearranged the bottles and called out one of the pupils to come and write the addition sentence of the arrangement on the blackboard.
10. Teacher rewarded the pupil who was able to give correct answer to the arrangement of bottles with points in his score book.
11. Teacher instructed pupils to move into their various cohorts, distributed bottle tops to the cohorts and wrote addition sentences on the blackboard for the pupils to arrange the bottle tops to satisfy the sentence on the board. Teacher gave points to successful groups and encouraged the unsuccessful groups to collaborate well and solve the questions.
12. Teacher wrote 1 digit addition sentences as home assignments for the pupils.
13. After the period was over, Teacher asked the pupils to put away the instructional materials and prepare for the next subject.

Blended Lesson Strategy

The subsequent lesson on addition (sum 0-99) took place at the ICT lab. The detail of the teaching strategy is described in this section.

1. Teacher took the pupils to the ICT lab and asked them to log on to the Edmodo platform.
2. Teacher assigned the pupils to work individually in performing mathematics activities with 10monkeys app on additions.
3. Teacher supervised and assisted the pupils as they work on their assigned activity.

4. Teacher awarded points to the pupils for showing up and participating in class. These points were later transferred on the leaderboard which was hanged at the back of the class.

Anecdotal Report

The researcher observed that the pupils in the Primary Two again turned in their homework and the teacher awarded them points for submission on the score sheet. The pupils were given the opportunity to rework on the questions they had answered wrongly in their homework after the teacher had finished marking. The demonstration by the teacher during the instructional period caught the attention of the pupils which engaged their attention. The researcher observed that most of the pupils confidently raised their hands and asked questions during the instructional period. During the group activity period, the researcher observed that pupils in the various groups were eager to complete their assigned task and advanced to the next level of activity. This was made known to the researcher by the collaborative attitude of the various group members. Points and badges were given to the pupils by the teacher and were transferred from the record book to the leaderboard. The researcher saw improvement in the skills of the pupils in the handling of computer software as most of them were able to open the browser and navigate to the Edmodo page and logged in. using ICT resources in the teaching of mathematics in this primary two class saw improvement in the pupils‘ skills in handling the computer.

3. Unit Three

The entire Unit Three of the Primary School Mathematics syllabus deals with Numbers and Numerals. The activities described in this unit involve collecting and handling data, estimating and measuring capacity and weight, measurement of length, multiplication of numbers. The teaching strategy of collecting and handling data and multiplication of numbers are the discussed by the researcher in the next section.

Gamified Teaching Strategy 5: Collecting and Handling Data

1. Teacher started teaching by reviewing relevant previous knowledge of the pupils.
2. Teacher clearly wrote the topic of the lesson and its objectives on the black board and explained them to the pupils.
3. Teacher reiterated and further explains the levels to be completed in order to achieve the various objectives of the lesson.
4. Teacher explains what is meant by data and its collection and handling.
5. Teacher demonstrates by arranging bottles, stones, and exercise books of the pupils in front of the class. Teacher together with the pupils counted the number of books, stones and bottles and wrote the figures obtained on the black board.
6. Teacher informed the pupils that each figure represents the number of objects arranged in front of the class and those figures could be used as data representative of the arranged objects.

7. Teacher again and together with the pupils counted the number of males and females present in the classroom and wrote the obtained figures as data representative for them on the blackboard.
8. Teacher draw squares on the blackboard as block graph to represent the data obtained.
9. Teacher assisted pupils to do a mini project on collecting data on the number of subjects and periods allocated for each subject on the time table of the class.
10. Teacher asked pupils to represent their findings with squares as block graph in their exercise books.
11. Teacher supervises the activities of the pupils and assisted the pupils who needed further clarification on the assigned activity.
12. Ability of the pupils to collect the data was a completion of level 1 and representing the data as block graph was a completion of level 2.
13. Teacher award points on his score sheet and transferred them later on the group leaderboard.
14. Teacher assigned home assignment to the pupils and asked them to submit it the next day.

Blended Lesson Strategy

Since the Edmodo store has no app on data collection and handling, the teacher allowed the pupils to continue practising with lessons on already taught mathematics topics.

1. Teacher took the pupils to the ICT lab and asked them to log on to the Edmodo platform.

2. Teacher assigned the pupils to work individually on any of the taught topics they have learned with the 10monkeys app.
3. Teacher supervised and assisted the pupils as they work on their chosen activity.

Teacher awarded points to the pupils for showing up and participating in class. These points were later transferred on the leaderboard which was hanged at the back of the class.

Anecdotal Report

The researcher observed that the pupils in the Primary 3, like those in Primary Two, could read their questions and accord the appropriate answers to the questions. The pupils were active and attentive during the demonstration period of teaching. The ability for the pupils to do well in the mini project activity suggested that they understood what the teacher taught them in class. Although the pupils performed their assigned task, the idea of them winning points catalysed their performance of the assigned activity. The researcher during the observation heard some pupils challenging other pupils in different groups that, their groups will win more points and badges than the other groups. This form of group challenge encouraged the pupils to collaborate well during the performance of group activities. The researcher saw improvement in the performance of homework and pupils social attitudes in class. Pupils in Primary 3 appeared to have shown much improvement with their use of the ICT resources in the learning of mathematics.

Gamified Teaching Strategy 6: multiplication of numbers

1. Teacher started teaching by reviewing relevant previous knowledge of the pupils.
2. Teacher clearly wrote the topic of the lesson and its objectives on the blackboard and explained them to the pupils.
3. Teacher reiterated and further explains the levels to be completed in order to achieve the various objectives of the lesson.
4. Teacher reminded the pupils about their study on multiplication when they were in the Primary 2 in the previous academic year.
5. Teacher explains what is meant by multiplication.
6. Teacher demonstrates by arranging bottles in a rectangular array and together with the pupils counted the number of objects in each case.
7. Teacher writes a multiplication sentence to describe the array of objects.
8. Teacher rearranged the bottles and explained to the pupils that a product of numbers does not change when the factors are rearranged.
9. Teacher further used different instructional material to explain the concept of multiplication.
10. Teacher allows pupils to sit according to their respective cohorts and assigned them activities based on multiplication.
11. Teacher distributes instructional materials to the various cohorts and assigned them multiplication activities to perform (Figure 4.7a).
12. Teacher supervises the activities of the cohorts and assisted the pupils who needed further clarification on the assigned activity.

13. Teacher wrote three categories of question on the blackboard and the pupils were instructed to perform the next activity only when he/she successfully complete answering questions from the previous level(s).
14. Teacher gave marks to the activities of pupils who finished and asked those who completed the levels successfully to progress to the next level.
15. Teacher award points on his score sheet and transferred them later on the group leaderboard.
16. Teacher assigned home assignment to the pupils and asked them to submit it next day.
17. After the period was over, Teacher asked the pupils to put away the instructional materials and prepare for the next subject.

Blended Lesson Strategy

At the ICT lab during the next lesson on multiplication, the teacher asked the pupils to:

1. Log in to the Edmodo platform.
2. Teacher assigned the pupils to work individually in performing multiplication activities with 10monkeys app.
3. Teacher supervised and assisted the pupils as they work on their assigned activities.
4. Teacher awarded points to the pupils for showing up and participating in class. These points were later transferred on the leaderboard which was hanged at the back of the class.

Anecdotal Report

The researcher observed that the pupils in the Primary 3 turned in their homework and points were given to those who submitted their homework early. Pupils in this class also were attentive during the demonstration period given by the teacher. The level of engagement of the Primary 3 pupils was known by the way they participated in the class by asking the teacher questions and also answering questions posed by the teacher. The pupils were also seen collaborating to solve problems with their team mates during the performance of the assigned activity by the teacher. Groups were allowed to complete their current level of activity before they moved on to the next level of activity that was written on the blackboard by the teacher. The teacher associated points to the various groups and individuals on the leaderboards. The researcher also observed that the pupils were very particular about the marks they received after they had finished with the performance of an assigned mathematics activity. The teacher also encouraged peer reviewing to allow the pupils to assess and apportion marks to mathematics activities performed by their colleagues. Peer tutoring was also encouraged as the pupils helped their colleagues to understand multiplication concepts in their own unique way. The researcher observed that the pupils had time to improve upon their current level with the use of the instructional materials during their free periods. Figure 4.7b shows pupils using instructional materials to learn during their free periods in order to complete a level. Relating well with other colleagues, competence in solving multiplication questions and the ability to for the pupil to see the need to perform mathematics activity on their own was some of the attitudinal observation the researcher made.

Figure 4.7a: Pupils using instructional material on multiplication table of 3 to perform their assigned activity. Source: Fieldwork (2015)

Figure 4.7b: Pupils using instructional materials to perform an activity to complete a level. Source: Fieldwork (2015)

Objective 3: To evaluate the effect of gamification after its introduction in the study of mathematics.

4.5 Evaluation of the Efficacy of gamification after its implementation in the classroom

The interview and observation sought data on evaluating all the game elements used in the classroom and the effects they had on learning of mathematics. The evaluation data are discussed in this section.

After the implementation of the Stage 1 (define objectives) of Werbach's framework for gamification, the pupils were asked whether they were aware of the goals they needed to achieve during and by the end of the lesson.

All the responses were in the affirmative that they were aware of the goals they needed to achieve by the end of the each lesson. The responses from majority of the pupils were in congruence that their focus was on the short term goals they were to achieve at the end of each level rather than focusing on the *big boss fight* (terminal exams) at the end of the term.

This finding supports Kapp‘s (2012) statement in his gamification framework that ―goals create purpose, focus, and measurable outcome‖. It was also observed that all the objectives of each lesson were boldly written on the board by the teachers. This explains why the pupils‘ answers on their awareness of goals of the lessons were positive.

In the Stage 2 of the adopted framework, some of the interview questions for the pupils and their respective responses focused on:

_Did you receive immediate feedback about your tasks?‘

All the interviewees agreed that they had instant feedback from the task they were made to perform. It was also observed that the teachers responded to the pupils whether they were right or wrong in the successful performance of some of the tasks. Most often, some of the instructional materials they used in solving tasks gave them instant feedback on the performed task. For instance, the multipurpose math board had questions at the front of its leaves and answers at the back of the leaf which pupils‘ easily turned to and checked whether their answer to a question was right or wrong. The 10monkey Application also gave instant feedback to the player whether he or she is right or wrong after the player had chosen his or her answers. This finding explains why the pupils were engaged and were motivated to complete tasks on the gamified lessons because according to Muntean (2011), gamification helps students gain motivation towards studying, and because of the positive feedback they get pushed forwards and become more interested and stimulated to learn.

The teachers‘ responses also revealed that although they gave feedback to the tasks they assigned to the pupils, most of the time the feedbacks were not instant. It was more of delayed feedback since the teacher‘s feedback may be needed by some pupils and at that

same time the teacher was attending to other pupils. This challenge encountered by the teachers on the giving of feedback confirms Short, Stewin & McCann's (1991) statement on group teaching and learning that group learning complicates teaching by adding to the teachers' load and also, the teacher's attention can only be engaged on one group of students at a time.

When the pupils were also asked whether they were aware of their scores during the progress of the lessons and in the gamified lessons all of the pupils answered that they were aware of the scores they had during the progress of the lessons. This finding shows that the pupils were both intrinsically and extrinsically motivated. Intrinsic motivation occurred in the accumulation of points and extrinsic motivation was being made aware they had completed a task successfully. Kapp (2012) asserts that achievements for performance or non-performance create extrinsic motivation and should be used sparingly as their overuse can reduce intrinsic motivation. Thus the pupils were motivated both intrinsically and extrinsically.

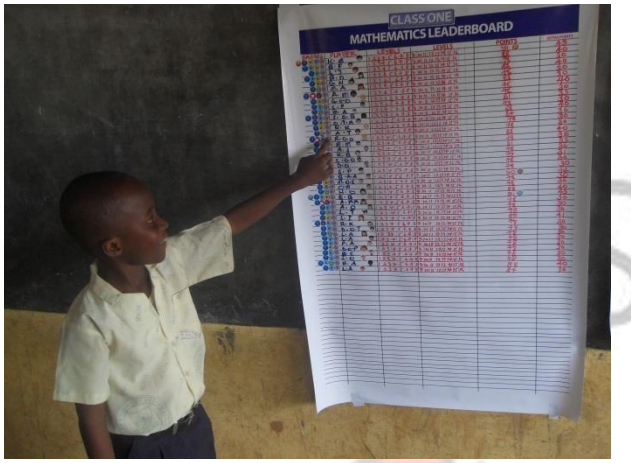


Figure 4.8: A class 1 pupil checking his score and position on the individual leaderboard. Source: Field Study (2015)

Furthermore, the pupils were asked whether they felt they were competing with their fellow cohorts and the responses of the pupils were affirmative to the fact that there was competitions among the various cohorts. It was observed that the desire for a pupil as an individual and his or her group to get more points propelled the pupils to contribute and work tireless for themselves and their groups. The teachers confirmed that these competitions increased the pupils‘ class contributions thus they paid more attention during delivery of lessons in class.

In addition, the instructions and the scoring system of the gamified lessons were evaluated. In this, the pupils were asked whether the instructions and scoring system of the lessons were clear to them.

The pupils‘ responses were in the affirmative that the instructions and the scoring system in the gamified lessons were clear to them. This may be as a result of them being partakers in the designing of the scoring system of the gamified mathematics lessons.

From observation, the researcher gathered that the teachers re-echoed the instructions and the scoring system of the gamified lessons to the pupils more often. The responses of the teacher interviewees about whether the pupils understood the instructions and the scoring system of the gamified lessons also affirmed that the pupils were aware of the scoring system.

The researcher further inquired from the pupils whether they felt that they were able to control the number of points they got for the gamified lessons. In reacting to this question, majority (10) of the pupils said they were able to control the points they were earning after successful completion of task, by choosing which of the tasks to perform to earn more points. It was also observed that the ability of the pupils to select which of the tasks or levels to perform in the gamified lessons encouraged the pupils to accumulate points in such tasks or levels and therefore enabled them to control the points they were earning.

Furthermore, the pupils were asked whether the scoring system offered appropriate rewards for the tasks completed by them. To this, all the interviewees agreed that the gamified lessons offered suitable reward after a successful completion of task. Through observation, the researcher concluded that the knowledge that the pupils had about the reward system and its appropriateness after their successful completion of tasks encouraged the pupils to strive for more rewards; and by striving, completing and achieving more rewards, learning was done. As Rogers (2003:27) puts it ―learning itself is the task‖.

Moreover, the pupils were asked whether they sometimes felt burdened with tasks that did not seem important to them. With this question, 10 of the pupils said ―No‖ to feeling burdened with tasks that seemed unimportant however, 5 of the pupils said some of the

tasks was a burden to them. The ability of gamification burdening pupil with task confirms Sonts' (2013) statement on what gamification is not: that ―Gamification should not cheapen the real learning. Gamified learning can also be and often is difficult and challenging‖, hence some pupils being burdened with task from gamified mathematics lessons.

Inquiries on skills improvement in the gamified lessons were made and with this, these questions were asked: Were the tasks suitable for your skills? To this, all the interviewees responded that the tasks allotted them were suitable to their skills. They added that they played diverse roles during group work. The finding implies that, the tasks allotted to the pupils matched their skills and therefore affirms that, the pupils who sometimes complained that tasks assigned them were burdensome either were lazy or not good team players. This finding reflects the findings of Binkley et al. (2010) that systems thinking, collaboration, and disciplinary knowledge, media literacy, solid epistemic frameworks, higher order thinking skills are important skills that can give students the capabilities needed to negotiate the demands of the 21st century. Using games and game elements connects firmly to these skills and can play an important role in producing an educational system that supports 21st century outcomes for today's students (Binkley et al., 2010).

To the question _Did the tasks get more challenging during the progress of the gamified and blended lessons?, all the pupils affirmed that the tasks became more challenging during the progress of the lessons. Upon further enquiry by the researcher on why the pupils did not stop performing an activity because of its difficulty, the pupils agreed that although the challenge was becoming difficult, yet the quest for attaining points was what motivated most of them to complete each level. This finding confirms statements made by some

researchers on developing suitable gamification framework. One needs to present compelling and meaningful challenges in order to trigger intrinsic motivation (Groh, 2012) and the mind‘s natural curiosity (Malone, 1981). To keep the pleasure of intrinsic satisfaction going, the brain needs an increasing level of challenge and complexity (Willis, 2011). Pupils were motivated by challenges that were just out of reach but attainable (Gee, 2005).

On this question _Did you feel that your skills increased during the progress of the course?‘ all the interviewees pointed out that their skills increased during the progress of the lessons. Some of the pupils added these further comments:

—I have improved upon my math skill because my friends helped me where I did not understand during group work‖.

—The math game we played at the ICT laboratory helped me in —counting‖ because at first, I was not able to count from 1-100‖.

This finding confirms Kapp‘s (2012, 13) statement on well-designed games that —Well-designed games help learners acquire skills, knowledge and abilities in short, concentrated periods of time with high retention rates and effective recall‖. Thus gamification encourages development of individual skills in short concentrated period of time.

When the pupils were further interviewed on whether they sometimes felt that the tasks given were so engaging that they were involved emotionally, all the interviewees responded that they got engaged in the performance of tasks during the progress of the gamified course. It was observed that game elements such as feedback, autonomy, points and rewards, got the pupils engaged. For instance most of the pupils got engaged in the use of

the instructional materials in performing tasks because of the instant feedback they gave and their ability to allow the pupils to repeat and correct wrong answers. This explains Kapp's (2012) statement that strong engagement can be accomplished if there are attainable, personal, motivating short- term goals such as developing a particular skill, a personal quality, social recognition, or academic excellence.

From the discussion of the intervention activities, it was realised that all the interviewees were in agreement that the gamification tools deployed to the mathematics lessons offered suitable reward after a successful completion of task. The situation described also indicates that the tools deployed in the gamified lessons created engagement and fun which stimulated the pupils to learn mathematics.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

The chapter outlines the summary of the study, the conclusions drawn from the findings and the recommendations made by the researcher.

5.2 Summary

The study aimed at introducing gamification in education to improve elementary mathematics through engagement in hybrid learning in the classroom. It also offers suggestions for making the teaching and learning of mathematics at the lower primary more innovative in order for the subject to fulfil its goals.

1. Instructional Media

The chalkboard, multiplication tables, multipurpose maths board and textbooks that were used in the gamified lessons constitute the visual media available for the teaching of mathematics lessons at the lower primary. The intervention lessons however, showed that most of the tools and materials needed for the teaching of mathematics at the lower primary are not too hard to come by and can be obtained very easily from places such as the home, tailoring shops, hairdressing salons and market places.

In place of procurement of expensive instructional materials which has become difficult for the Ghanaian government to provide for all basic schools, teachers can rely on

constructing instructional materials for the teaching of selected topics in mathematics at the lower primary from _waste‘ materials which could be found locally.

2. Teacher Preparation for Mathematics Lesson

Since the study aimed at improving the teaching and learning of mathematics at the lower primary school with gamification, the researcher took the sampled teachers through the development of lesson plans which are concise, working documents that outline the teaching and learning that will be conducted within a single lesson (Butt, 2008).

As part of this, the researcher took the sampled teachers through the writing of the expanded scheme of work and guided them in the formulation of specific objectives, the selection of appropriate teaching methods and strategies, and in developing activities for the various topics which they taught at the different grade levels.

The researcher also took the teachers through the use of gamification that blends mathematics lessons with traditional face-to-face teaching with online teaching with the use of the Edmodo Learning management platform.

It was interesting how the teachers embraced the approach and effectively used it to design all the lessons they taught after the researchers‘ introduction of the gamification and blended learning intervention activities. It was also necessary for the researcher to demonstrate the procedures and techniques involved in executing gamification and blended learning intervention activities. This strategy also included question and answer sessions that enabled the sampled teachers to understand the concepts and principles involved in gamifying mathematics lessons.

3. Impact of Gamification and Blended Learning on Mathematics Lesson Delivery

It was observed that advance preparation by teachers before the lessons were taught enabled them to outline definite goals which are purposeful for the success of a particular lesson. As this study has revealed, the gamified lesson plans designed by the sampled teachers contributed immensely towards the effective teaching and learning of mathematics at the lower primary section of the sampled school. The advance preparation enabled them to procure before hand; all the relevant instructional materials needed for each lesson and also to practise their use in the gamified mathematics lessons. This made them to understand the principles and processes involved in the gamified activities that they took their pupils through in each classroom.

There was enough evidence to prove that the gamified activities made the pupils to interact with their teachers, their peers and the instructional materials. The pupils also discovered concepts and facts unaided or with minimum interference which made the learning of the topics more pleasurable and not boring, thus encouraging the pupils to learn (Lowenstein, 2004). The intervention activities that were introduced also brought about active pupil participation which enabled them to think, feel and act creatively, resulting into the development of desirable values such as tolerance, sharing, cooperation, affection and endurance. It also enabled the pupils to develop skills such as being able to use some instructional materials for the learning of mathematics, logging in the Edmodo Learning platform and Launching of 10monkeys Edmodo App. It was also evident during lesson delivery that the teachers asked good open questions to stimulate the imagination of the pupils and thereby encouraged them to be thoughtful before answering mathematics questions.

4. Impact of Gamified and Blended Mathematics Activities on Pupils

The gamified and blended learning activities enabled the pupils to see major concepts, big ideas and general principles in mathematics as reality. There was more interaction of pupils with their peers, the instructional materials and the gamified processes. The pupils did not only accumulate points during instructional periods but were rather engaged to perform mathematics activities. This led to the pupils being stimulated and motivated to develop positive attitudes towards the learning of mathematics. This was obvious from the way the pupils were seen working on assigned mathematics classwork and homework activities and performing self-assigned maths activities. The gamified and blended activities whipped up the interest of the pupils which enabled them to develop the passion and flair for the study of mathematics. This means that the pupils would be able to practise the skills and values they acquired in solving problems in the future.

1. Major Findings

The key findings that were gathered from the results include the following;

1. Prior to the intervention, the sampled teachers used the lecture method for their normal teaching of lessons but adopted participatory methods when they were trained by the researcher.
2. Lessons were devoid of motivation to spur pupils on, but they became very interesting and engaging during the intervention.
3. Group activities were not incorporated in lessons as was done with the gamification and blended learning intervention.

4. Apart from the classroom there were no other facilities for mathematics. This concept changed as the ICT lab was seen as a resource for enriching their lessons.
5. The sampled school lacked instructional materials used in the teaching of mathematics.
6. The gamification and blended learning intervention enabled the sampled pupils to acquire skills and values such as using some mathematics instructional materials, creating account and logging in the Edmodo Learning platform, launching of 10monkeys App, tolerance, endurance, sharing, cooperation and respect for others which could be carried into adulthood.

5.3 Conclusions

The study points to the fact that prior to the intervention, there were some classroom practices that created gap between the teacher and the learner. The teachers observed were not able to take their pupils through participatory lessons, to help them to fully grasp the concepts and the skills required for developing and fostering creativity among the pupils as outlined in the Mathematics Syllabus.

Remarkably, the use of Werbach's framework for gamification has proven its efficacy not only in the business setting but in the educational setting as well. Werbach's framework for gamification used in the teaching and learning of mathematics at the lower primary served as intrinsic and extrinsic motivator for pupils.

Nevertheless, the findings attest to the fact that gamified and blended mathematics lessons can ensure intellectual, physical, perceptual, social and cognitive growth of children. These

are important for the thinking process, the children's perceptual and emotional growth as well as for promoting environmental and social awareness, and creative development of both teachers and pupils in the sampled school.

5.4 Recommendations

Considering that teaching mathematics can promote the holistic education of the child, the following recommendations are made to encourage active teaching of the subject:

The teachers should plan for activity based lessons which set achievable clear goals and select appropriate teaching and learning materials from the local environment for their lessons. They should also adjust their teaching to meet the mathematical needs of the children at all levels of development since mathematics skill growth is continuous process. Mathematics teachers must organize subject matter into manageable learning units, develop specific learning objectives for each unit, develop appropriate formative and summative assessment measures, and plan and implement group teaching strategies, with sufficient time allocations, practice opportunities, and corrective reinstruction for all students to reach the desired level of mastery. Teachers and pupils in Ghanaian schools must be well trained in the use of ICT learning platforms to facilitate the teaching and learning of mathematics. ICT teachers must help mathematics teachers in the use of online learning platforms to facilitate their teaching of mathematics.

Educational Technologist should conduct extensive research on adapting frameworks of gamification in education.

Studies should be done by the Curriculum Research and Development Division (CRDD) of Ghana's Ministry of Education to keep up with the new educational interventions that will show up as time passes by.

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APPENDIX A

INTERVIEW GUIDE FOR THE PUPILS BEFORE THE GAMIFICATION AND BLENDED LEARNING INTERVENTION

Demographic information about the interviewee

1. Gender:

 Male

 Female

2. How old are you?

The rate at which they avoid attending school

3. How often do you attend school?

Work avoidance

4. Do you regularly do mathematics class assignments?

5. Do you regularly do your mathematics home assignments?

Acting out in class

6. Do you like learning mathematics?

7. Do you like the way your teacher teaches mathematics in class?

8. Does your teacher break lessons into smaller challenging units?

9. Do you receive feedback when you perform a task in class?
10. Does your teacher show you your score after you finish performing a task in class?

11. Does your teacher use instructional material during lesson delivery?

A reluctance to work independently

12. Do you like solving mathematics questions by yourself without help from peers?

On blended learning

13. Does your teacher take you to the ICT laboratory for further study of mathematics lessons?

Poor relationships with colleagues

14. Does your teacher group the class into various groups and assign task to the group during mathematics lessons?

APPENDIX B

INTERVIEW GUIDE FOR THE TEACHERS BEFORE THE GAMIFICATION AND BLENDED LEARNING INTERVENTION

Background Information

1. Gender
2. Are you a professional teacher?
3. If yes to (2), what is your highest professional qualification?
4. If no to (2), what is your highest academic qualification?
5. How long have you been teaching?
6. Indicate the grade levels you taught mathematics after your training.
7. What grade level are you currently teaching?

Instructional experience

8. Do your students attend classes regularly?
9. Do your pupils complain about them not getting understanding in some of the topics you teach in mathematics?
10. Do the majority of your pupils participate in the doing of assignments in mathematics?
11. Do you reward your pupils after they complete an activity you give them in mathematics?

12. If yes, how do you reward your pupils?

13. Do your students receive instant feedback from you on task you assign them in class?

14. If Yes to 12, how do you give this feedback to the pupils?
15. Does your lesson engage your pupils?

16. Do you encourage collaborative learning in your lessons among your pupils?

17. Have you read about or heard of blended/Hybrid learning?

18. If YES, do you incorporate blended learning in your teaching of mathematics?

19. Have you heard of gamification as an intervention in education?

20. Do you set clear and defined goals about topics you teach your pupils in mathematics?

APPENDIX C

INTERVIEW GUIDE FOR THE PUPILS AFTER THE GAMIFICATION AND BLENDED LEARNING INTERVENTION

Concentration

Q1: Did the gamified and blended lessons provide enough stimuli that it was worth attending?

Q2: Did you manage to keep your focus on the lessons and its tasks the whole time?

Q3: Did you sometimes feel burdened with tasks that did not seem important?

Challenge and Player Skills

Q4: Were the tasks suitable for your skills?

Q5: Did the tasks get more challenging during the progress of the gamified and blended lessons?

Q6. Did you feel that you have improved in your skill in performing task in mathematics?

Control

Q7: Were the instructions and scoring system of the lessons clear to you?

Q8: Did you feel that you were able to control how many points you got for the lessons?

Q9: Did the scoring system offer appropriate rewards for the tasks completed?

Feedback

Q10: Did you receive immediate feedback about your tasks?

Q11: Were you always aware about your score in the course?

Q12: Were you aware of the goals you were to achieve for each lesson?

Immersion

Q13: Did you sometimes feel that the tasks given were so engaging that they involved you emotionally?

20 Social Interactions

Q14: Did you feel the competition between the fellow groups (cohorts)?

Q15: Did you and your team member(s) cooperate well?

APPENDIX D

INTERVIEW GUIDE FOR THE TEACHERS AFTER THE GAMIFICATION AND BLENDED LEARNING INTERVENTION

The interview items for the teachers were created based on the following 6 questions:

Q1: How did you expect that using game elements would affect your teaching and the pupils‘ learning process?

Q2: How did the pupils accept the game elements in the lessons?

Q3: Which game elements met your expectations for the lessons the best and which not so well? Please explain.

Q4: What would you change in your next gamified lessons?

Q5: What are your suggestions for designing lessons with game elements?

Q6: Was there anything else that you learned in the process of the lessons that was not asked?

APPENDIX

E

Observation checklist used.

The observations were done using modified observation checklist adopted from the criteria for game enjoyment and game flow by Sweetser and Wyath (2005)

Criteria	**Course Element**	T2 Class 1			T1 Class 2			T3 Class 3		
		wk 1	wk 2	wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9
Concentration	Provide opportunities for pupils to work with different tasks.									
Challenge Player Skills	Task given should vary in difficulties and should meet the skills needed to perform the tasks.									
Control	Pupils should be able to control how they would want to receive their points.									
Clear goals	Pupils should know the goals for each lesson before and during the progress of the course.									

Feedback	Pupils should receive feedback on any task they perform in the classroom and on assignments.									
Immersion	Pupils should be immersed during the delivery of lessons and performance of task.									
Social Interaction	Provide an environment for social interaction among pupils in class.									

F

APPENDIX

Definition of Badges used

Good heart Badge
For voluntarily collaborating in other to help a colleague

Thumbs Up! Badge
For Pupils who have been consistent with their progression in the course

Good Job! Badge
For Excellent task performance

Trophy Badge
For successfully passing the terminal exams (Big Boss fight)

Star Badge
For outstanding performance

Scholar Badge
For showing in depth understanding in the completed lessons

Team Badge
For being a team player

Speed Badge
For finishing a task at a faster rate

GOLD TROPHY
Award for placing 1st in the gamified course

SILVER TROPHY
Award for placing 2nd in the gamified course

BRONZE TROPHY
Award for placing 3rd in the gamified course

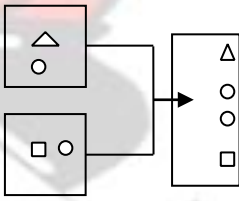
Samples of Avatar Used

Female Avatar

Male Avatar

H

APPENDIX

UNIT	SPECIFIC OBJECTIVES/GOALS	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1.5 **ADDITION:** **SUM UP TO 5**	The pupil will be able to: **Goal 1:** Count and tell how many objects are in two groups of objects put together. **Goal 2:** Write addition sentences for two groups of objects and put together using the 'plus' and 'equal to' symbols.	**Level 1** Putting two groups of objects together **Level 2** Addition sentences	**TLMs**: Bottle tops, seeds, sticks, shells, stones. Guide pupils to form groups for two given numbers (0 – 5), put the groups together and find how many they make altogether. E.g.  Guide pupils to identify the plus sign (+) as addin numbers and equal to (=) sign as the symbol for same as. and same as 2 + 1 = 3	**Challenge 1.** Let pupils: Find how many objects are there in two groups of objects put together. **Challenge 2** Use the plus and equal to sign to perform operations.

UNIT	SPECIFIC OBJECTIVES/GOALS	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION

UNIT 1.5 (CONT'D) **ADDITION:** **SUM UP TO 5**	The pupil will be able to: **Goal 3:** Find the sum of two numbers up to 5. **Goal 4:** Find missing numbers (addends) in addition sentences.	**Level 3** Addition of numbers 0 – 5 **Level 4** Missing Numbers (Addends) (sum not greater than 5)	Guide pupils to find the sum of two numbers that sum up to 5 using concrete materials. E.g. 2 + 1 = ☐ 3 + 1 = ☐ 2 + 2 = ☐ find missing numbers in addition sentences using ―counting-on‖ method. E.g. 3 + ☐ = 5. Begin with 3 and count how many to be added to get 5.	**Challenge 3** Let pupils: complete addition sentences. **Challenge 4** find the sum of two numbers (sum up to 5). **Challenge 5** Find missing numbers in addition sentences. E.g. 2 + ☐ = 3 ☐ + 3 = 4 1 + ☐ = 5