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ICT Integration in Learning of Physics in Secondary Schools in Kenya: Systematic Literature Review

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Abstract

ICT integrated active learning has proven to tremendously improve learners' educational outcomes and their classroom engagement unlike the traditional classroom approach. This can be attributed to the fact that active learning shifts the learning process and activities from teacher-focused to become more learner-centered, and is guided by the learning ability of the students. Through this, learners get to experience the learning process in their own pace. So despite the existence of differences and multiplicities in terms of learning styles and achievement levels in a classroom, through active learning, the learners are in full control of the learning process and they can engage with the learning materials at their own level of understanding, review confusing concepts, or break the sessions' learning content into bits that they can easily comprehend. For instance, in teaching and learning of Physics, the instruction methods have been demonstrated as the major reason for the decline of its performance and less populous among students in Kenya. This paper, therefore, explores the need to enhance the teaching and learning of Physics in secondary schools by adopting learner-centered teaching methodologies, and providing a systematic review of frameworks for the integration of technology towards enriching active class learning. Then we leverage these insights coupled with field experience to derive and design a framework for ICT integration in teaching and learning of Physics in developing countries (case of Kenya). The hybrid framework will be learner-centered and will eliminate the learner barriers that exist due to personalities, temperaments among others. The review adopted the scoping review technique to map the key concepts underpinning the study to the main sources of the literature.

Keywords

Technology Based Learning, ICT Integration in Learning, Active Learning,

Learning Physics, Learner-Centered Teaching, Education Technologies, E-Learning Frameworks

1. Introduction

Physics has been considered as a pillar that supports development in both developed and developing countries, as it plays a central role in leading the nation towards technological advancement, promoting national wealth, improving health and boosting industrialization (Argaw et al., 2016). According to Mulhall & Daniel (2019), Physics is stereotyped to be complex in nature that is in terms of teaching and also learning the subject. Learners in secondary schools have a belief that Physics is difficult, irrelevant and boring (Owen et al, 2018). This is because Physics seems to be less descriptive but more mathematical. Carter (2018), asserts that this can be attributed to the disconnect that exists between the teachers and students due to miscommunication between the student and the teacher. It also results in teachers being unable to identify the individual needs of learners and the challenges they face. Angell et al. (2008) on the other hand note that students perceive physics as difficult because they have to deal with multiple concepts at the same time. Some of these concepts include experiments, formulae and calculations, graphs, and conceptual explanations. This argument is similar to Redish (1994) who demonstrates that Physics as a subject needs learners to use various methods in order to understand and interpret tables, numbers, graphs, equations, diagrams and maps.

Physics needs one to have good knowledge and comprehension of algebra and geometry, and to go from specific to general and vice versa. As a result, learning Physics becomes difficult for many students especially those with lower mathematical competencies (Linder et al., 2014). In order to have better learning outcomes in Physics Sukarmin et al. (2017) argue that there is need to develop a learning strategy that identifies and considers learners' interests, goals and motivation in the design of the subject's instructional objectives and delivery. This way, the negativity surrounding physics, lack of enthusiasm towards it and the difficulty of using mathematical formulae among the learners can be minimized (Aykutlu et al., 2015). The use of creative experiments in teaching has also been observed to increase the level of understanding and retention of attention of students during the learning of Physics (Shishigu et al., 2017). Using a case of Turkey, Bogusevschi et al. (2020), affirm that using these student-centred approaches we can significantly promote the effective teaching and learning of Physics.

According to Ekici (2016), student's learning is influenced by their perception towards the subject context. Uwizeyimana et al. (2018) report that in Rwanda, the barriers towards effective learning and teaching of Physics are related to traditional teacher-centered teaching approaches which are commonly practiced in

Physics classrooms in Secondary schools. This is also the case in Kenya where teachers continue to use these traditional teaching approaches that are not inherently designed with the capability to increase student motivation and performance in Physics (Kipyator, 2017). Thus there is an urgent need to review these traditional approaches to teaching of Physics and deriving and adopting robust student-centered approaches in teaching Physics particularly in developing countries such as Kenya where performance of Physics is devastatingly poor. The student-centered pedagogies such as problem based learning, class experiments, co-operative learning, the use of project, inquiry based learning, collaborative learning, and interactive question and answer sessions engages the students and assist them in developing skills like decision making and problem solving, team work, and presentation (Zafar & Khan, 2017). This approach also enables the students to discover new knowledge and learn actively as opposed to passively waiting for the teacher, and enables the student to focus on how the new knowledge aids in problem solving or the value it adds (Rieckmann, 2018).

In other words, traditional instruction is predominantly teacher-oriented and lecture method based approach where the teacher does most of the talking and directs student's learning (Assen et al., 2018). This makes the learning process unidirectional as the students passively receive what the teacher instructs. The discussions and activities among the learners' and their peers are seldom employed (Bin Noordan & Md. Yunus, 2022). With no cooperative skill being leverage in the teaching, students are not able to listen and comprehend Physics concepts as there is massive teaching and minimal effective engagement with students (Hoogerheide et al., 2016). The process of teaching in the traditional teacher-centered approach involves pouring information over the learners' mind which can be perceived by the learners as dull and boring, due to its lacking in creativity and interaction, and involving the learner in critical thinking (Cohen, 2018). Traditional teaching adapts whole class question and answer approach which often increases conservation between the teacher and the high achievers leaving behind the rest of the class therein promoting rote memorization (Gemechu, 2019). New and emerging digital technologies when incorporated into the classroom successfully, have the ability to revolutionize the quality of teaching and learning (Madichie et al., 2019).

While the Kenya's Ministry of Education has considered integration of ICT in teaching and learning in primary and secondary schools, the extent to which ICT has been integrated in the teaching and learning of sciences in Kenyan secondary schools stands below 32% (Tondeur et al., 2015). According to Habbler et al. (2016), incorporation of ICT's has helped improve students' understating of some Physics concepts for instance the use of ICT simulations as compared to the use of non-ICT teaching activities. In addition, virtual experiments and virtual environments saves experimental time and resources, allows students to repeat experiments with ease, and provides experiences that would not otherwise be available to students (Uwizeyimana et al., 2018). Ayere et al. (2010) confirm that, there is significant improvement in Physics scores when ICT is integrated in its teaching. Nonetheless, Maharaj-Sharma et al. (2017) indicate that it is not necessarily the sole presence of technology that influences the effectiveness of learning, but instead the pedagogical practice of putting that technology into use. Thus there is need for robust frameworks and guidelines for integrating ICT in teaching and learning. The core of this paper is to review such frameworks. ICT integrated active learning has proven to effectively enhance learning outcomes and learner engagement unlike the traditional classroom approach (Scott & Dube, 2014). This is due to the ability of active learning to transform the learning process and activities to shift from being teacher dominated to become more learner-centered, and is guided by the learner's learning ability. This way, the learners engage more in the learning process of Physics and most importantly they learn in accordance with their pace of learning. Furthermore, the learning instructor gets to give their learners individual attention and also provide them with "just-in-time' teaching based on their needs as opposed to one-size fits all approach that is accustomed to traditional learning setting. So despite the differences and multiplicities in terms of learning styles and achievement levels in a classroom, through active learning the learners are in full control of their learning and they can engage with the learning material at their own pace, review confusing concepts, or break the sessions' learning content into bits they can easily comprehend. This gives the learner an opportunity to know more about the subject's learning resources, to work with their peers and to discuss the learning contents.

Michalec & Hafferty (2015) argue that factors like personal attributes and the formal or informal structure of the classroom can cause low or poor participation of learners during a Physics. It is because of this that educators have aimed at coming up with numerous strategies that aim at increasing student participation. Studies such as Draft (2017) indicate that students fail to benefit from lessons and miss on some concepts when they are just passive members in the classroom and fail to participate during the lesson. This is an illustration that critical factors that deal with participation in the classroom environment are not being emphasized enough in order to increase student participation.

Different learners have different temperaments and personalities which in one way or another affects their learning, ICT based active learning gives a solution to this challenge that is it gives an opportunity for learning beyond the aforementioned barriers. The same applies for traditional classroom settings where it is easier for teachers to notice lack of participation among extroverts and it becomes difficult to identify the same among introverts. However, computer aided learning, that is the ICT integrated learning, has proven to motivate learning and learning engagement for both introvert and extrovert students (Costa et al., 2018). For active learning to be effective, a supportive and accommodative classroom environment needs to be created to achieve higher participation rates and to show trust amongst students through visible encouragement from peers and instructors for them to comfortably express their opinions (Michalec & Hafferty, 2015). The role of the teacher is essential in this type of environment since they have to ensure cooperation within the classroom through activities that create a positive climate and to ensure that dialogue is carried out with respect. Wagner et al. (2017) established that pedagogical components like the course, topic, lecturer and teaching style could influence students' participation.

To this end, there is an urgent need for a structure to adopt active learning approach towards improving learning of Physics in secondary schools. Thus, this study reviews frameworks for learning of Physics that integrate ICT and that supports active learning, and then propose a framework for ICT integration for active learning of Physics that is learners centered and that eliminates the barriers of learners' due to personalities and temperaments. The other parts of the paper are organized as follows: Section 2 defines the problem and presents the theoretical framework adopted in this study, Section 3 presents the methodology and the findings and results are presented in Section 4. The discussion is present in Section 5 and finally Section 6 concludes this paper.

2. Problem Definition and Theoretical Framework

2.1. Problem Definition

Physics is among the three science subjects offered at the secondary school level in Kenya. It is an undeniable fact that the knowledge obtained from Physics can be applied in any technological and engineering work making its role in a developing country like Kenya quite substantial and critical. Most students in secondary schools especially in form one and two normally have very little interest in learning Physics which makes it to register low candidate enrolment during the Kenya Certificate of Secondary Education (KCSE) as compared to other sciences (Ngari et al., 2017). Arguably, this is due to a stereotypical belief that Physics is a difficult subject that has seen many schools opting not to offer it as a KCSE examinable subject altogether. According to Liu et al. (2017), students' difficulty in learning Physics is mostly due to inability to associate mathematical concepts with Physics knowledge. Evidently, there is need for such learners to be identified and that the teachers provide them with a personalized learning that is unique to their personalities, learning abilities and interests. In addition, assessment of learning outcomes in Physics follows similar models as most subjects where the learner is taught and evaluated at the end of the topic or sub-topic, or during mid-term and end-term exams. This suggests that there is a possibility of a concept which may not have been understood to take several days before the misconception is detected through sit-in continuous classroom assessments or end topic quizzes more so in introvert dominated classes. When misconstrued concepts keep accumulating in a given subject for instance in Physics this means that the learner continues to acquire a wrong concept opposed to the one anticipated by the teacher. When the misunderstanding gap may increases, learners tend to build negativity towards both the subject and the teacher, and some even withdrawing from learning the subject. Students have interest and get motivated when they learn concepts that make them link classroom experiences with real life experiences that is, outside the classroom environment (Lam, 2015). In this regard, advancements in technology such as ICT can be leveraged to support these learners. Notably, ICT integration can exhilarate timid and slow learners that the teachers may be neglecting with an assumption that they are disinterested in learning. Consequently, teachers in these cases may have low motivation to teach Physics. The benefits of integrating ICT in teaching include incorporating text with activity explanation, use of virtual experiments, enhance interactive learning, use of models to describe and simulate phenomena and graphical representation of real time data.

Notably, teachers employ teaching and learning methods that have majorly resulted in poor performance in Physics as a result making the subject to be disliked by a majority of students in secondary schools as compared to other science subjects. Therefore, this paper, explores the need to enhance learning of Physics in secondary schools by adapting a new paradigm of learner-centered teaching methodologies and do away with the traditional teacher-centered methods. This approach will break down the perception of difficulty and abstractness of some topics in Physics and bridge the gap and the mismatch that exists between the teacher's point of view and the learners' perspective.

Thus, the purpose of this paper is to provide a systematic review of frameworks for the integration of technology towards enriching active class learning. We then leverage these insights to design framework for ICT integration in teaching and learning of Physics in developing countries. Specifically, the objectives of this paper are:

1) To establish the impact of active learning through ICT integration on learning out comes in Physics in secondary schools.

2) To establish the influence of Physics teachers' competence in ICT integration in active learning on learning outcomes in Physics in secondary schools.

3) To review framework for ICT integration in active learning towards improving classroom participation and learning outcomes in Physics.

2.2. Theoretical Framework

A learning theory is defined as a logical framework of how we come to be cognizant of learning (Begg, 1999). Notably, in this study behaviorism, and connectivism learning theories have been identified as the pillars underpinning the learning environment to cater for the needs of different learners with different learning abilities to meet the set educational objectives. Firstly, these different learning theories are of key significance since they are global frameworks which explain learning process, how it occurs across individuals with different potentials and capabilities and they are aimed at assisting all learners by creating instructional environments. Secondly the distinctive nature of these theories can be a justification for the integration and e use of ICTs as teaching and learning tools in the educational setting. In addition, the study utilized the main learning theories that describe the learning process and provide teachers with instructional techniques to enhance learning.

Teachers ought to be cognizant of the significant role learning theories play and understand that when selecting a paradigm to adopt, they will be guided by factors like; the type of learners, the available ICT techniques and the subject matter at hand in a pedagogical milieu. The integration of technological tools for teaching and learning should be informed and guided by the principles of the specific learning theories. Behaviorism theory is based on Skinner's (1988) stimulus and response theory. The learner is conditioned to respond to a stimulus in a manner that is anticipated by the teacher. According to Clark & Mayer (2016), learning in this type of theory is not completely the learner's responsibility but it is the teacher who steers the learning and the learning content t, assesses and reinforces the learner's response.

A change of behavior in the learner will be an indication that learning has taken place and this happens mostly through rewards that is either positive or negative rewards (Altuna & Lareki, 2015). Behaviorism theory can be adopted in the integration of ICT into teaching and learning whereby ICT is the stimulus which will then provide learners with opportunities to repeat and practice the content they learnt which will realize the principles of behaviorism. In an environment that has ICT resources,, the stimuli in this case can be different technological tools that the learner engages with during the learning process in order to acquire knowledge. Computer-Aided Instruction (CAI) based on behaviorist principles is used to teach facts, information and skills associated with subject-related material (Dede, 1990). In conformity with behaviourist procedures, these applications engage the learner by providing activities which they must interact with until a desired response is achieved.

CAI applications are an effective way of delivering content through repetition and practice as this stimulates learners to put in use their critical thinking skills and also their creativity. In other words, learners' knowledge revolves around technology that is, they use technology to learn what the technology knows and what is contained within it (Siemens, 2017). The tools used by the learners play the role of the tutor; they contain the subject content, the objectives which are to be achieved, and reinforcements to be used during the assessment. Learning occurs within the pace of the learner, and the immediate feedback and reinforcement are significant in terms of mastery of content in that they are proof of whether learning has successfully occurred or not and whether or not the goals that were set have been achieved. With regard to this study, adopting ICTs basing on behaviorism theory is of great significance since the behaviorist procedures and principles are still relevant in the learning environment.

ICT can be viewed as a tool that delivers learning materials and serves as a tutor which conveys the facts to the learner. The machine controls the learner's interaction with it and issues step-by-step instructions. The learning process confirms Dede's (1990) assertion that the behaviorist instructional approach makes learners passive and does not take into consideration their mental actions which plays a role in ensuring that learning has taken place. In view of the fact that Secondary school teachers try to integrate ICTs in various subjects, their teaching is a fusion of various principles of the different learning theories available. Whereas behaviorism theory tends to explain how people learn through reaction to stimuli, it is critiqued for its inability to focus on the thinking process (Von Glasersfeld, 1974). These concerns together with the changing trends, new inventions and the proliferation of new ICTs, the study opts for a paradigm shift from behaviorism to connectivism learning theory to complement the weaknesses of behaviorism. Connectivism is considered a relevant learning theory for the digital era due to its ability to accommodate both learning objectives and knowledge construction (Downes, 2008; Siemens, 2017). In this learning theory, learners form connections with the information flow between them and the network members. Through this interaction, García-Gómez Antonio (2020) maintains that learning occurs through interaction amongst learners which is achieved through peer collaboration, sharing opinions and critiquing each other by means of dialogue. Siemens (2017) asserts that, connectivism points out how learners make use of the knowledge acquired through a personal network. Connectivism explains the new developments in learning and accounts for the shortages of behaviorism theory.

Connectivism theory is built on the principles of other learning theories which entail perceiving knowledge as transmitted facts, the need for unique cognitive skills to process information successfully, and collaboration in distributing the information (Bell, 2011). Nonetheless connectivism still accentuates the creation of networks for connection and access to current knowledge. This theory is considered significant and relevant for its being socio-technological nature which means that it allows teachers and learners to connect and form networks of learning communities and platforms for accessing, interaction, sharing, thinking and distributing current knowledge (Kop & Hill, 2008). Connectivism theory is relevant in this study in the sense that it prompts teachers and learners to establish networks and nodes for knowledge acquisition and sharing in real time, which will empower them and their peers. According to Steffens et al. (2015), the learning process entails connecting specialized nodes or sources of information like people, organizations, libraries, and websites and data bases. These nodes are crucial entities that can boost the teacher's development by providing them with up-to date information especially where the in-service training of teachers is inadequate due to fiscal challenges.

Through a network of interactions, learners can engage themselves in self-directed learning whereby they adjust their learning actions and are able to achieve their set goals. These interactions result in a learning process which is greatly influenced by cognitive, affective and emotional factors. Šumak et al.

(2011) indicate that in the context of connectivism an ICT teaching and learning success is dictated by teachers' ICT competencies and their attitudes in the classroom. This assertion confirms that teachers are indeed in control and central figures in ensuring that ICTs are integrated in the teaching and learning situation. In the connectivist environment, teachers play a key role of guiding learners in relation to what content is needed by the learner. The diversity of networks and transfer that occurs through the process of connecting influences the learning process. Furthermore, the learning process is cyclical in such a way that learners connect to a network in order to share and find new information, modify their beliefs then connect to the network once more to again share these new realizations and discoveries and the cycle goes on (Newby & Ertmer, 2013). McLoughlin and Lee (2008) observed that the learning process in connectivism is characterized by connecting information sets and helping learners to see the connection between events and ideas. Since knowledge is dynamic and is based on multiplicity of opinions, learning can therefore be viewed as a process of connecting specialized nodes or information sources (Siemens, 2017). According to the Connectivism theory, the two most important skills that contribute to learning are, the ability to pursue and strive for current information and the ability to filter secondary and extraneous information. To execute these skills, Learners need guidance from a teacher or a facilitator which the online learning environment and cultural diversity does not provide as it gets difficult for the teacher to coach the learner.

According to Bell (2011), connectivism aims at inspiring teachers and learners to make changes to their activities. According to Kerr et al. (2006), there are three main facets that make up good learning theory. This means that a good learning theory should; contribute to theory, should provide a significant new perspective on how learning occurs, and should represent historical alternatives accurately. Connectivism fails to meet these facets as it falls short on explaining how learning actually occurs and as a result it misrepresents the current state of established alternative learning theories such as behaviorism and constructivism. Connectivism subscribes to the Vygotskyan theory (Vygotsky, 1978) because there is an element of informal learning in a digitally mediated setting as well as the use of the zone of proximal development. Connectivism as a theory has tenets and among these key tenets is that knowledge resides in a distributed manner across networks. It presumes that all learning institutions provides all learners with the required technology to facilitate connectivist learning activities of forming diverse networks on connections, communication, sharing and collaboration with one another. ICTs have the potential of improving the quality of teaching and learning, and this can best be achieved by adopting the approach of connectivism theory since this theory creates the required connections necessary for the learning process which is to acquire, share and distribute knowledge. Despite the shortcomings of connectivism, it is presently the most appropriate and relevant learning theory to explain the educational use of ICTs in the networked society characterized by loads of information, new technologies and changes in human behavior. Adopting connectivism does not translate to doing away with the previous learning theories just because connectivism relies on societal changes and the creation of networks for the distribution of knowledge it also derives its principles and techniques from already existing disciplines and established learning theories.

3. Methodology

This study employs document analysis guide technique that enables us to focus on relevant literature to the study and that would provide theoretical understanding of the phenomenon under investigation. Cohen et al. (2013) urge that researchers should use document analysis guide for purposes of methodological triangulation which is a technique that facilitates validation of data through cross-verification. The scoping technique review was adopted to map the key concepts underpinning the study to the main sources of the literature. Three research questions guided the study and they include;

1) What is the effect of ICT integration in active learning on learning outcomes of Physics in secondary schools?

2) How do competencies of Physics teachers in ICT integration in active learning influence learning outcomes of Physics in secondary schools?

3) What are the available frameworks for ICT integration in active learning towards improving classroom participation and learning outcomes in Physics?

The relevant data were compared, analyzed and synthesized, which yielded three major themes running across and throughout the available body of literature as shown in Table 1 below.

4. Findings and Results

4.1. Teaching and Learning of Physics in Kenya

In Kenya, Physics curriculum implementation is affected by several factors like the perception that Physics is highly mathematical, most of its content are abstract, existence of the difference in language levels between the teacher and the instructor, and shortage of appropriate books and relevant Physics apparatus (Cunningham & Villaseñor, 2016). It is also worth noting that, if it were up to the students, they would rather do away with physics and continue with the remaining science subjects since physics is the less popular science subject among students in Kenyan secondary schools, (Ngari et al., 2017). As such, majority of schools only offer it at the form one and form two level of secondary school education. Moreover, Physics is perceived as difficult and thus majority of learners hold negative stereotype towards the subject leading to them performing poorly in this subject (Khaoya, 2015). Remarkably, students' achievement in Physics in KCSE has remained alarmingly low at 39.0 and 26.6 percent between 2013 and 2018. That is, in five years the performance of Physics has only gotten worse dropping by 12.4 points (Kunga, 2021). This is despite the intervention programs aimed at improving its performance by the Kenya's Ministry

Table 1. Methodology.

Step/Activities	Outcomes	
1. To Identify the research question(s).	a) The effect of ICT integration in active learning on learning outcomes of Physics in secondary schools. b) Competencies of Physics teachers in ICT integration in active learning influence learning outcomes of Physics in secondary schools. c) Available framework for ICT integration in active learning aimed at enhancing classroom participation and learning outcomes in Physics.	
	Primary Search Key Terms	**Secondary Search Key Terms**
2. To ascertain the key terms and use them to find pertinent studies (this step had two activities i.e., the primary and secondary search).	a) ICT and instructional design frameworks. b) Active learning leveraging ICT. c) ICT leveraging learning interest. d) Physics teachers' Competencies in ICT integration.	a) Learner focused frameworks b) Task focused frameworks. c) Technology focused frameworks. d) Instructor focused framework. e) Teacher ICT competencies.
3. Select the related studies.	a) The primary searches produced twenty-six journal articles, three conference papers, one working paper and one book chapter 2. b) The secondary search produced eleven journal articles, one book chapter, one conference paper, one report and three books.	
4. Extract the major themes and constructs.	a) Learning frameworks Incorporate check points in every stage, flexible, cost effective & has clear objectives. b) Instructional design model provides ICT components and pedagogical principles to bring out maximum learning outcomes. The integration of technology with pedagogy has improved and boosted the teacher's array of skills and opened up a various options of learning resources for students to access. c) Some instructional design models neglect learner's needs, interest and silent on transformation of learning policies.	
5. Integrate, summarize and report the finding.	This review of the study does not suggest that we do away with the contributions of the ubiquitous learning frameworks. Instead it proposes to build a framework that will bridge the gap (weaknesses) in the existing learning frameworks and at the same time embrace the strength of the existing frameworks.	

of Education Science and Technology (MOEST). Such interventions have included Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) program and the government economic stimulus program to equip selected secondary schools with well-equipped laboratories (Boniface, 2013). It is, therefore, imperative that a more robust and result oriented approach is incorporated in learning and teaching of Physics that puts the learner at the center of learning.

Active learning paradigm has been shown to meet this need as evidenced by (Buthelezi, 2018; Hodges, 2018; Sanders et al., 2017) that demonstrates that active learning significantly improves learning and learning outcome as compared to traditional methods such as lecture-based methods, memorization and recitation techniques and teacher-centric classrooms. For instance, according to Salem (2017), active-learning instructional methods equips students with solid conceptual foundation in subject content, and help them to reason effectively and master problem-solving skills. Active learning is designed to engage learners in different classroom activities to enhance learners' interaction with peers and the instructor, emphasizes rapid feedback, and guide students to express and reflect on their own reasoning processes, which are fundamental in teaching and learning of technical subjects such as Physics (Lumpkin et al., 2015).

Active learning involves students' effort to actively construct their knowledge, ICT enhances active learning since it improves students' participation in the classroom, and the learners retain the learned concepts in their memory for a very long period (Abeysekera, 2015). Furthermore, the use of ICT in Physics incorporating active learning approaches could be encouraged in secondary school as this would assist students in making accurate and reliable measurement, understanding abstract and concepts perceived in Physics as difficult, and promotes individualized learning of Physics (Wu et al., 2019). Keith and Wolff (2014) affirm that, ICTs provide learning institutions and other institutions with a great opportunity to utilize and adopt technology in order to complement and support the teaching and learning process. Comparably, ICT has the ability to assist the learner to bring about knowledge and the capacity to adjust to the rapidly, complex, ever changing learning environments, and to foster new skills and abilities through technological literacy and myriad of teaching and learning resources (Salem & Mohammadzadeh, 2018). It is argued by (Conklin, 2011) that, with ICT integration in learning of Physics, students may develop a different perspective of Physics that may foster positive attitude towards Physics. Šorgo and Živkovic (2015) point out that effective integration of ICT in Physics provides enabling environment that allows meaningful classroom interaction among students. This necessitates the building of an ICT integrated learning framework that will put into consideration both the learners' and instructors' goals. In addition, ICTs will not only come up with a new framework that can promote a revision and upgrade teaching and learning practices but also reinforce the use of blended learning technique such as collaborative, project-based and co-operative learning (Raffone & Monti, 2019).

4.2. Active Learning Leveraging ICT

The integration of technology with pedagogy has reinforced the teachers' repertoire of skills and availed on a wider scale various types of learning resources that can be accessed by students (Pyykkönen et al., 2013). This has been observed to provide the highest level of independent learning, and this mode of learning also motivates learners with more ability to work on increasing their knowledge and skills beyond the standard curriculum. UNESCO (2011) reports that the teaching method adopted by teachers should be appropriate for the acquisition of relevant and necessary knowledge that can be utilized in particular societies, e.g., inculcating the community's core values and transmitting its cultural legacy from generation to generation. Quintana et al. (2015) observe that in using ICT as a learning tool, students do not just acquire an in-depth knowledge of their school subjects but they tend to understand how to give rise to new knowledge, since ICT increase learners' motivation and engagement. Also Guzel (2011), concluded that the effectiveness of the use of computer through the teaching process has improved the teaching of mathematics, by allowing students to explore and reach an understanding of mathematical concepts.

Active learning is a buzzword that entails teaching technique that is mainly promoted by learner-centred as opposed to content-centred instruction (Buthelezi, 2018). Sanders et al. (2017) view active learning as basically that which students are involved in various activities and are thinking about the activities they are engaged in. It also means that instead of students being passive receivers of information, in this case they actively take part in the learning process through activities that promote development of critical thinking (Hodges, 2018). Active learning may involve activities within and outside the school environment i.e., within the classroom environment, active learning may occur though a range of activities, including role-playing, small group work, integration of multimedia images and sounds, guided classroom discussions, and writing exercises (Maher et al., 2015). According to Wu et al. (2019) active learning can be effectively integrated in the classroom setting in various ways in order to intensify the learning experience of students. Active learning is almost the opposition of traditional lecture method whereby the instructor is regarded a facilitator (Rotellar & Cain, 2016). In active learning, technology makes it possible to check the level of content understanding which is very essential since it has the ability to give immediate feedback from the learner's assessment (Plump & LaRosa, 2017). A number of approaches have been proposed to foster a high level of student engagement. Based on the engagement theory (Kearsley & Schneiderman, 1998), during the learning process, learners ought to be engaged in learning through various activities like interacting with other learners and be engaged in various tasks.

Gaffney et al. (2013) observe that in active learning in a physics classroom, students have their expectations and target objectives which they tend to work on and nurture so as to realize and achieve them. This proves that most students who are enrolled in courses that incorporate active learning strategies that display a wide array of positive changes in their conceptual understanding. Freeman et al. (2017) note that adopting active learning in a Physics lesson, for instances the use of small group problem-solving tasks in classrooms yielded far much better learning outcomes as opposed to simply listening to lectures. Furthermore, when students are deeply engaged in the learning process these active learning techniques can lay the groundwork for them s to learn more from subsequent lessons by rendering concepts more immediate or relevant. Students who are engaged put more effort and have a better learning experience (Finn & Zimmer, 2012). Learning Physics through active learning enhances collaborative learning among the students and increases the level of student´s participation in the classroom through electronic network etc. Active learning also promotes activities whose effects are relevant past the course. In addition, Khan et al. (2017) confirms that when active learning was integrated in a physics course at college level, the content understanding level was observed to increase from 40% to 60% in comparison to traditional teaching methods. Lumpkin et al. (2015) confirm that the active learning strategies aid in boosting student engagement and play a very key role on student learning when implemented effectively throughout the course. Engagement is quite essential in active learning since it has the ability to develop students' critical thinking skills which can be useful in addressing issues of sustainability at different spatial scales and in multiple sociocultural contexts (Straková & Cimermanová 2018). According to Hollie (2017) learning in students successfully takes place when students are involved in the process and when they acquire their knowledge through a discovery process.

Through active learning, students have the opportunity of shifting from merely t hearing theories and calling that learning to being fully engaged in activities that involve decision-making and acquisition of different types of knowledge (Kim et al., 2013). Active learning makes it possible for students to explore how apparently similar issues that may require varied approaches in different sociocultural contexts. According to Kucherenko et al. (2015), in the learning experience complex issues do not have simple, one-dimensional answers; rather, solutions occur in a multi-dimensional space where variables are not as independent as they appear. Incorporation of examples from varied locations and at multiple spatial scales also internationalizes the curriculum, which can personalize its relevance to a diverse student body and help prepare students for the labor market in a globalized world (Zhao, 2012). Conklin (2011) remarks that increased student engagement boosted higher-order thinking skills when integrated with ICT tools. This is because such a learning environment enhances creativity than an instructor-centred environment where teachers are seen as the only source of knowledge. de Villiers (2007) demonstrates that when creativity is used in the mode of instruction it fosters creativity among learners. Collaborative learning and team work are associated with the social constructivist approach to learning (Lam, 2015).

When ICT properly integrated, it not only develops active learning, but also enhances collaborative learning (Quintana & Zambrano, 2014). Ra et al. (2016) maintains that learning which is ICT-enhanced promotes collaboration, in the sense that it supports cooperation, communication and interaction where students learn to work with their peers through team work or on joint projects.. Technologies that are currently being invented are interactive in nature and support learning through hands-on involvement and have the ability to provide immediate feedback. According to Chan (2015), new media interactions, animations and simulations, enhance transformation traditional learning material, and so education will change even further, as traditional books can be supplemented by multimedia accumulations created by local educators and customised to the situations in their own classes. Technologic innovations also assist in enhancing students' active engagement in class activities (Holmes et al., 2015). An example of ICT enabled active learning is the clicker. Swenson & Rhoads (2019) reiterated that clicker technology which is an audience or classroom response system, has gained popularity in the past few years by virtue of engaging the millennial learner who is in pursuit of an interactive learning environment. Through these devices, students are actively engaged in classroom activities without being afraid of being put on the spot to respond to a question (Deng, 2019). When a polling question is posed during a lecture, the learners' responses are then tallied and projected for the entire class.

This kind of feedback makes students aware of the areas in which they need remediation in course content, and this also provides the teachers with an insight into where to lay more emphasis on the course content according to the learner's needs (Donia et al., 2018). Clickers can also boost the preparedness and attentiveness of the learners in class (Hunter Revell & McCurry, 2010). In addition, McLoone et al. (2019) attempted to uncover the extent of student satisfaction with the use of clickers in an undergraduate health-assessment course. Most students reported contentment satisfaction with the use of the clickers and were happy with the kind of feedback and the interaction that they got from the clickers. Classroom participation declines when the class size and class diversity is high or increases, which as a result creates passive modes of learning, due to feelings of shyness, peer pressure etc. (McLoone et al., 2019). Computing technology comes in handy by creating a "safe haven" for student participation, but the successful introduction of tools into the class-room, already a dynamic and tool-rich setting, presents challenges.

Beatty & Albert (2016) report that the challenge that the lecturer faces is majorly knowing whether students have understood the basic concepts and to keeping them actively engaged during the learning process. Provision of immediate feedback to students poses some challenges, but with the utilization of clickers, immediate feedback is readily obtained which can be used to assess students' understanding (Abdurrahman et al., 2018). Acero et al. (2017) indicates that an active learning environment facilitates interaction and collaboration between the student and various aspects that is; students and content, student and student, and students and teachers, since active learning encourages students to take a central role in their own learning. Therefore, incorporating clickers in the learning instruction was found to engage students in the learning process thus making them to actively participate throughout the lesson as opposed to just being passive listeners (Abdurrahman et al., 2018).

The augmenting aid that the use of clickers brought in the learning environment is its ability to give back immediate feedback and to measure student understanding (Stowell et al., 2010). In agreement with Papadopoulos et al. (2018) clickers are beneficial in reinforcing teaching and learning experiences, and can be used to ascertain that students grasp basic concepts. Stowell & Gostjev (2018) motivates teachers to regularly use clickers to enhance active learning and to observe changes among students. Smith & Knight (2020) further stresses on that using clickers could promote active and deep learning, since students are provided with an opportunity to discuss the question among themselves in small groups. The respondents confirmed that using clickers in class boosted their attentiveness and also came in handy in that they could request for clarification in case certain concepts were not clear (Abdurrahman et al., 2018). They became more focused during the lesson since they were aware that they could be asked questions. This can be seen in the results, where 84% of the participants stated that using clickers in the classroom environment enhanced their classroom attentiveness. Majority of the respondents (86%) also indicated that clickers increased their classroom participation since the whole class got a chance to interact and improve the class's overall performance. According to Papadopoulos et al. (2018) clickers increase student engagement and improve their learning. This mostly occurs when students are encouraged to debate answers amongst themselves before attempting to provide a solution in class.

In spite of these advantages that clickers provide and their impact on promoting active teaching and learning, they have not been fully utilised in the Kenyan context (Beatty & Albert, 2016). The extensive introduction of interactive whiteboards (IWBs) is another innovation that encourages active classroom participation (Šumak & Šorgo, 2016). IWBs have almost completely taken the place of 'ordinary' whiteboards and are being put into use by teachers and pupils. According to (Young et al., 2017) most teachers have found IWBs to be highly motivating as a teaching resource. Studies such as (Smith & Knight, 2020) indicate that whole-class teacher-led sessions have positive developments, including teachers' engagement with surface features of interactive teaching. Studies like (Hebing, 2017) indicated that the use of IWBs in the classroom environment has boosted literacy and numeracy in United Kingdom classrooms. Even with these advantages, IWBs have a shortcoming of fitting to pre-existing instructional practices which makes t students to feel excluded from the use of this 'interactive' resource (Fluckiger et al., 2016). This does not come as a surprise, since the attempt to utilize new technologies is not being backed up by an understanding of their impacts on pedagogy is (Chan, 2015).

Burford et al. (2020) report that the role of the teaching staff changes in that they will not only be imparting knowledge to learners but will be required to enhance critical thinking skills, promote information literacy, and nurture collaborative working practices to prepare students for the rapidly changing world where there is no job guarantee and people tend to change their careers. Technology can support constructivist learning environments when it is incorporated as a learning tool instead of being the object of instruction. It can assist the teaching staff to discover students' prior knowledge and base instruction on problem solving. Dano et al. (2019) postulates that the implementation of ICT integrated teaching and learning requires balancing different sets of competences to include technological, pedagogical and content knowledge. Much of the earlier research and theories about the use of technology in teaching and learning involved viewing technology as being separate from both content and pedagogy. As described by Dzikite et al. (2017), to successfully implement the integration of ICT into teaching and learning requires a thorough understanding of the complex relationships between technology, content and pedagogy ought to be developed and using this understanding to develop suitable context specific teaching and learning strategies.

4.3. ICT Integration and Teacher Competence

Teacher competency entails a teacher knowing the type of pedagogy to incorporate in a learning environment. This aids in the determination of fundamental concepts and necessary skills required for the mastery of the subject (Langer et al., 2016). Such competence helps the teacher to link technology with the content and relate it to real life situations that learners can relate to which facilitates a better understanding of the content. For the successful enactment of ICT integration of teaching and learning, there should be adequate personnel that have the necessary competences (Dzikite et al., 2017). Dano et al. (2019) note that successful implementation of ICT integrated teaching and learning depends largely on the competence of the teacher. According to Gropen et al. (2017), teaching staff with good mastery of content enjoy their teaching subjects making it effortless for them to integrate technology in their teaching and as result becomes easy for students to grasp the content. Where such skills are missing, it would be difficult to adequately deploy ICT in teaching and learning (Hennessy et al., 2022). Research studies indicate that it is the teacher who is the main determining factor of the success or failure of ICT implementation is successful or not is the teacher (Almerich et al., 2016).

While most researchers report that effective use is due to the presence of ICT give credit to the, others on the hand give credit to the teacher's knowledge levels and beliefs of knowledge (Hennessy et al., 2022). The UNESCO ICT Competency Standards for Teachers (2008) identifies four key competencies that ensure the success of ICT integration in teaching namely; pedagogy, collaboration and networking, social issues and technical issues. Pedagogy focuses on teachers' instructional practices and their curriculum and requires that they develop applications within their teaching subjects that utilize ICTs to support and extend teaching and learning. Collaboration and networking acknowledges the communicative abilities of ICTs to extend learning past the classroom environment and the implications for teachers' development of new knowledge and skills (UNESCO, 2008). Social issues show that technology comes with new rights and responsibilities including equitable access to technology resources, care for individual health, and respect for intellectual property. Technical issues on the other hand include aspects of the lifelong learning theme through which teachers update their skills on hardware and software as new technological discoveries come up (UNESCO, 2008). Though these competencies are required for a supportive environment and successful self-sustaining implementation of ICT integrated teaching and learning, the guidelines are not specific on the aspects that are essential for implementation of ICT integrated teaching and learning like the relationship between content and technology (Bin Noordan & Md. Yunus, 2022).

Salem & Mohammadzadeh (2018) assert that in spite of technological equipment being present, they will be of no use unless the teacher has competency on how to properly integrate ICT in teaching and learning. Literature such as (Gil-Flores et al., 2017; Musili, 2015) further indicates that there is an existence relationship between teaching staffs' knowledge and skills and other teacher-related factors. According to Salem & Mohammadzadeh (2018), when teaching staff have no technical skills, they tend to be anxious in case they get across a technical problem, then they would not know how to go about it or avoid it. Rabah (2015) notes that before an institution can successfully integrate ICT in teaching, it needs to ensure that the teaching staff acquire appropriate ICT and pedagogical skills. Such skills enable the teachers to have the self-drive and enthusiasm to integrate ICT in teaching and learning. The teaching staff's own pedagogical knowledge plays an important part in shaping ICT-mediated learning opportunities (Blundell et al., 2020). The technological pedagogical knowledge refers to teaching staff's getting to understand the link between the existent technology teaching and learning strategies.

Koehler et al. (2014) argues that having technological pedagogical knowledge does not make a teacher an effective implementer of ICT integrated teaching and learning which calls for the addition of content knowledge that results in technological pedagogical and content knowledge (Koehler et al., 2014). This leads to an understanding of using technology to support pedagogical techniques in teaching specific content subject. Alkhasawneh & Alanazy (2015) postulate that the implementation of ICT integrated teaching and learning requires balancing different sets of competences to include technological, pedagogical and content knowledge. Much of the earlier research (Mishra & Koehler, 2008; Dede, 1990) and theories (Skinner, 1988; Siemens, 2017) regarding the utilization of technology in teaching and learning entailed looking at technology separately from both content and pedagogy. As described by Colvin and Tomayko (2015), to effectively implement ICT integration in teaching and learning, an in depth comprehension of the complex relationships between technology, content and pedagogy, and using this understanding to develop suitable context specific teaching and learning strategies.

4.4. ICT Instructional Design Frameworks

In the sphere of ICT, instructional learning frameworks can effectively be incorporated to achieve an active learning platform for teaching and learning of Physics; and to explore learning and performance challenges in diverse settings (Sortrakul & Denphaisarn, 2009). Furthermore, when instructional learning model is enriched with ICT, the student engagement in the created learning environment is observed to be more active compare to the traditional classroom instruction. The learning frameworks advance the learning paradigm shift from being teacher centered to being learner-focused. Branch & Kopcha (2014) affirmed that there is a shift of focus from talk and chalk teaching to teaching using ICT. Instructional designers have developed hundreds of teaching and learning frameworks that satisfy their needs. The main objective of developing instructional design framework is to endorse understandings of instructional design reality and monitor instructional design performance (Lee & Jang, 2014). In spite of the fact that lots of instructional design framework have been developed for both general and specific usage, there are a few major differences still exists between them which assists the instructors to implement the instructional design framework better according to their purposes (Branch & Kopcha, 2014). In this study, the reviewed learning frameworks have been classified into four categories based on the set strategies of the instructors teaching approaches, procedural frameworks and learning needs they accomplished. These categories are; learner focused frameworks; task focused frameworks; technology focused frameworks and instructor focused framework.

4.4.1. Learner Focused Frameworks

The learner focused frameworks have the ability to assist teachers to construct meaningful learning in a technology enhanced learning environment. They provide procedures for the application in a small sized learning environment, since they are to be applied in the classroom environment. In this category, the teacher and the learner analyse and determine who, what, where, and why the objectives are set up, and aid in assessing learning activities across various contexts (Gustafson & Branch, 1997). In addition, these frameworks require minimal resources and individual effort unlike teamwork which makes them easily applicable by the instructor since they cannot have prior knowledge about instructional design. There are various instructional design frameworks under this category, including: Knirk and Gustafson framework (Knirk & Gustafson, 1986), Dick and Carey model (Dick et al., 2005), Kemp framework (Akbulut, 2007) and ADDIE framework (Nichols Hess & Greer, 2016).

i. The ADDIE Framework

The ADDIE framework is an acronym for the main processes which entail analysis, design, development, implementation, and evaluation of learning programs and stems from instructional design framework (Nichols Hess & Greer, 2016). The framework displays a generic, systematic framework to the instructional design process and expounds on targeting specific technology for learner requirements. The framework is unique in that its sets plan and defines individual roles and the follow ups in order to make the achievement of the set objectives a reality. The framework involves the target audience in setting the objectives with the view of acquiring the maximum learning out come through the use of a well-judged teaching strategy. One of the major pillars of this framework is that, it incorporates check points in each and every phase and thus allow room for verification of functionality of a program before implementation. The framework involves creation of activities and blue prints based on the objectives. The framework is flexible and allows for continuous enhancement where areas of weaknesses are detected. The proponents of ADDIE framework argue that it provides the step by step sequence of events in teaching a given individual lesson and allows for objectives and task to be clearly defined (Clark & Mayer, 2016).

To establish a more comprehensive frame work, the author would have considered extending the study to capture both the pre-test and post-test, overcome the shortcomings of putting teachers to the task of identifying the learners need upfront. And only focusing on post-test which provide minimal useful information that can be of use for improving the instruction. Moreover, the extended study would have also explored the use of technology as a pedagogical approach and addressed the limitations of linear approach when dealing with learning outcome that do not have a predetermined end. By and large, this will consolidate the model and it will no longer focus on training as the only way to solve a problem or acquire a learning experience. These suggestions are in line with Peterson (2003) who observed that the ADDIE framework does little if anything to encourage further innovation, and is 'silent' on the use of technology as a pedagogical tool and makes no attempt to identify the most appropriate approach to solve a given problem.

ii. The Kemp Framework

This framework advocates for a learner-centered approach towards instruction and enables one to come up with the necessary instruction even with little resources and minimal instruction design (Akbulut, 2007). Contrary, to the common linear or phase presentation of instructional design activities, the framework is composed of nine elements arranged in a circular manner (clockwise) that are part of a cycle of planning, design, development and assessments. The framework calls for a process which is iterative, can be revised, and is extremely flexible, since the nine activities are independent of each other and do not need to be conducted for every project. The nine elements are, instructional problem identification and goal specifications of an instructional course, examination of learner's characteristics based on instructional decisions, subject content identification with task analysis related to goals and purposes, instructional objective specifications, instructional units arranged in logical and sequential order for learning, instructional strategies designed to attain the set objectives of the lesson, plan and develop instruction, evaluation instruments for measuring course objectives and resource selection for instruction and learning activities.

iii. The Dick and Carey Instructional Design framework

Dick et al. (2005) provide a systematic, interrelated view of instruction. The framework identifies a dynamic relationship between context, content, learning, instruction and role players in order to achieve desired learning outcomes. The framework identifies learners' entry behaviour and determine the relevant skills to be used to complete a given task and in addition it also analyses the target audience. The framework digs further to analyse the performance objectives based on the stated instructional goals in relation to the learner's entry behaviour. This helps to establish what a student can do after finishing a given instructional task. The framework further, incorporates the criterion development competency by the learner, to disclose whether the learner has the requirement to learn the new skill.

The framework put emphasis on developing of instructional strategy, as this will inform the sequencing, organizing and how the delivery of the information will be effected. In addition, the framework integrates the check-up measures, through formative evaluation and at the end construct and have a summative assessment. The framework is effective in designing instruction in the sense that stakeholder designers play a significant role to ensure that relevant, feasible learning systems that satisfy all learning objectives are developed. This framework, therefore, provides relevant insight and contribution towards an all-inclusive eLearning framework. The driving force of this framework is the fact that it is goal oriented and works as a system by starting with goal in mind (Zafar & Khan, 2017). The framework puts into consideration the learner's prior knowledge and preconceived notions. Due to the interconnected nature of the framework, it addresses most of the learners' needs and expectations, however there is need that in future the author considers how framework objectives could be achieved within a relatively shorter time and all the variables in the model should be explicitly accounted for.

iv. The Knirk and Gustafson Instructional Design Model

The Knirk and Gustafson (1986) design model entails three processes which includes problem determination, design and development. The problem determination stage deals with identifying the problem and setting instructional goals. The design stage entails coming up with objectives and specifying strategies. Lastly, in the development stage, materials are developed. The problem determination stage is the onset t stage in the Kirk and Gustafson Instructional Design Model and focuses on two processes: problem identification, the performance gaps and the primary goals (Pappas et al., 2015), and the setting of goals (Sortrakul & Denphaisarn, 2009). Establishing the entry behavior of the learner is essential in this process as it relates to the knowledge base, communication skills, learning styles and the health and wellbeing of the learner. It also gives an insight on the issues to be addressed through the needs assessment and task analysis (Pappas et al., 2015).

4.4.2. Task-Focused Frameworks

Tasked focused category of frameworks on the other hand pay attention mostly on instructional materials development, i.e., on the production of interaction tools or for presenting content which supports instruction (Gustafson & Branch, 1997). This genre of frameworks lays an assumption that the instructional product is necessary and it should have a product instead of being selected or modified already existing materials. These category of frameworks place considerable emphasis on demonstrations and assume that the product must be put into use by different managers. Some frameworks classified under this category include; Bergman and Moore Framework (Bergman & Moore, 1990), Van Pattern framework (Skehan, 1996), Interservices Procedures for Instructional Systems Development (IPISD) framework (Branson, 1978), Instructional Development Institute (IDI) framework (Jordan, 1974) and Diamond framework (Diamond, 1998).

i. The Bergman and Moore Framework

Bergman and Moore (1990) framework was designed to guide and manage the production of interactive multimedia products and a variety of high technological interactive instructional products. The framework focuses on blending technology in education. The framework includes specific reference to interactive video (IVD) and multimedia (MM) products, the framework comprises of six major activities: analysis, design, develop, production, author, and validation. Bergman and Moore framework make use of a request for proposal (RFP), which initiates the development process and promotes the analysis activities like identification of the audience, tasks, user environments, and content. It is important to note that validation entails comparing the finished products with the objective in order to increase the effectiveness by assessing and revising instruction. The framework emphasized on teamwork especially during development of sophisticated IVD and MM products.

The exceptional feature of the framework is that, one activity's output provides the input for the subsequent activity and highlights the importance of evaluating the output from each activity before commencing on the next. The buttress of the framework is the adoption of extensive checklists, focus on technology. While the framework priority is on new delivery systems, the model was however not developed for academic purposes thus assumes a front end analysis and does not represent new conceptions of the instruction design process. The product based nature of the model implies that an initial analysis of the objective has been performed resulting in the need of an interactive multimedia product. Whereas other models take a systematic approach which gives the user multiple options towards meeting a specific objective, the Bergman and Moore model begins at the production face of the media thus assuming that validity steps have already been taken proving that a multimedia based solution is warranted.

ii. The Van Patten's framework

Van Patten developed the ISD framework which has nine phases, each having a deliverable, one or more person's responsible for its execution evaluation. These phases are: analysis, design, development, pilot test, review, production duplication, implementation, and maintenance. Analysis includes problem definition, audience identification, determining resources, and specifying the goals of the effort. The design phase involves preparing the "floor plan" and "pen and ink" renderings of the design specifications.

The development phase has four sub phases; defining each topic, coming up with examples for each definition, developing practice exercises for the examples, and everything that needs to be developed. Phases four and five, pilot test and review, are described together as an interactive loop that is repeated until the instruction is judged well enough. Phase six, production, is the step in which all materials are put through final production and prepared for duplication. Duplication is viewed as the task of building an inventory of material in preparation for its distribution. Phases eight and nine, implementation and maintenance, are described together as an interactive loop that take place as long as the product is still in use.

iii. The Diamond Framework

This framework is typically applied to advanced curriculum development applied in higher education institutions (Diamond, 1998). The framework believes in a team process with significant input from university personnel. Diamond also emphasizes on sensitivity to political and social issues existing on the campus and within academic departments. The framework raised a concern that the proposed development effort should be consistent with organizational priorities and missions is another critical concern to Diamond. The framework is divided into two phases. Phase one involves examining the feasibility and desirability of launching the project. Instructional issues such as enrollment projections, level of effectiveness of existing courses, and institutional priorities, in addition to faculty enthusiasm, are all weighed before commencing development. Phase two begins with determining the objectives, then concurrent assessment instruments and procedures are designed along with selection of instructional formats and evaluation of existing materials for possible inclusion. Finally, coordination of logistics for implementation is done, followed by full scale implementation including evaluation and revision.

iv. The IPISD framework

The Interservices Procedures for Instructional Systems Development (IPISD) framework was developed by the Army, Navy, Marines, and Air Force with the main goal of utilizing a common approach to instructional development (Branson, 1978). The motivation was to facilitate shared development efforts and improve communication with contractors engaged in instructional development across different branches of the military. The framework has five phases: analyse, design, develop, implement, and control. Basically, the IPISD framework is one of the most highly detailed framework of the ID process generally available. IPISD approach is designed specifically for military training in the various skills. The nobility of this framework is that, it accommodates extremely detailed level of specification. However, the price of this specification is its lack of generalizability to other environments. Thus, the framework puts emphasis on the last phase in which the quality control and relevance over an extended period of time is examined. Its major strength is the extensive specification of procedures to follow during the ID process.

It can be a reference for learners who wish to become instructional developers or managers of ID contracts. The major limitations of IPISD framework is its narrow instructional focus and linear approach to ID. Furthermore, the level of analysis and prescription it specifies could be done only by a heavily staffed and highly financed organization. The utilization of the framework demands a long term commitment of substantial resources.. The IPISD framework will find little use outside of the military, the government, and a few large corporations having major job training programs.

v. The IDI Framework

The Instructional Development Institute (IDI) framework is among the most publicized IDI framework in existence. This system framework was developed by the University Consortium for Instructional Development and Technology (Jordan, 1974). It is inculcated in many professional preparation programs, and has been the focus of a national workshop for large numbers of public school personnel. The framework was put in place as a tool for public school personnel who desired to tackle large-scale instructional problems, the IDI framework is problem oriented, specifies team development, and assumes distribution or dissemination of the results of the effort. The IDI framework is essentially linear in its approach. The framework has three stages (defining, developing and evaluating) and nine steps. In essence, the framework is conceived as being useful at all three levels of detail stages, steps, or elements. The basic strength of this framework is its three levels of detail. This permits its initial presentation to non-developers in a simple form that can be elaborated as their knowledge increases. Its basic limitation is the implication of a linear step-by-step development process beginning with definition of a problem, which the framework claims must be finished in a serial way, but in actual practice overlap is rather common.

4.4.3. Technology-Focused Frameworks

Technology focused framework provide ICT components and pedagogical principles to bring out maximum learning outcomes. According Tondeur et al. (2015) the e-learning frameworks and components exist with the emphasis on the setting out essential elements to influence e-learning with other factors in order to create a meaningful learning environment. The frameworks in this category include; The Functionality framework (Patten et al., 2006), the e-learning P3 model (Khan, 2015), Khan's eight dimensional e-learning framework (Khan, 2015), SAMR model (Puentedura & Louw, 2012), TPACK framework (Mishra & Koehler, 2008) and ASSURE model (Faryadi, 2007). The instructor focused category of framework is based on the available infrastructure or delivery system to design the course or entire curriculum.

1) ***The Substitution Augmentation Modification Redefinition (SAMR) Framework***

Hamilton et al. (2016) developed SAMR model as a learning framework assist instructors to come up with more meaningful and useful ways of selecting and using technology in the classroom. This model not only provides the instructor with a successful technological integration but it also helps in designing and evaluating distant learning activities (Hamilton et al., 2016). The framework is a ladder, which is based on scaffolding. Learning activities that fall within the lower end of the ladder (substitution and augmentation) are perceived to promote while those that fall within the upper end (modification and redefinition) transform learning (Puentedura, 2013). Hockly (2013) affirms that, technology itself does not enhance learning, but rather the use to which it is put. The framework has a close relationship to blooms taxonomy that motivates teachers to strive for higher level thinking skills in the classroom. Technology enhanced classrooms give support and structure to students who need scaffolding and provide enrichment to those students who thrive on challenges. This results in a task centered learning environment that is predictable, whereby students understand what's expected of them and how to achieve and attain the expectations. The clout of this model is, its flexibility that allows instructors to select up to what level they'd like to integrate technology in their classes. The SAMR framework seemed easy to follow steps that provide great examples of how to scaffold the integration of technology into teaching and learning on the paper, however in my view the author would have strengthened the technology use in the model by clearly defining how technology is helping us advance the stated curricular objectives. In other words, the framework pinpoints how a learning activity has changed while silent about how to determine the value of that change and the role of the learners in the learning process.

2) *The ASSURE Framework*

The ASSURE framework is an instructional system or guideline that can be adopted by instructors to design technology and media integrated lesson plans (Faryadi, 2007). This Framework makes learning to be learner focused and aims at attaining the overall learning objectives. The framework embraces an instructional design guide that makes use of the constructivist perspective, which integrates multimedia and technology to improve the learning environment (Lefebvre, 2007). The framework is to be used within the classroom environment by the instructors since it as meant to be used for a few hours of instruction and by each student (Smaldino et al., 2008).

The framework does not need high complexity of delivered media, deep ID knowledge, or high revision of designs (Gustafson & Branch, 1997). The major pillar of this framework, is that it was designed to plan for and deliver instruction with technology and media, which makes it appropriate for planning distant education.

At the same time, it is learner centered in the sense that t the first step in the process is to consider and identify the characteristics of the learner, and also has an emphasis on the participation of the learner, hence practical and easy to use framework. Nonetheless, at the inception stage the model does not clarify certain instructional problems, such as learning constraints, new behavioral outcome hence exposes a scanty and deficient analysis in comparison to other instructional models like the ADDIE framework. In addition, ASSURE model assumes that there exists an ideal, organized learning environment, where all learning media and facilities are readily available for use. There is possibility that, if the author of the model would have extended the depth of analysis and specify the learning media and facilities, then the model would fully address the limitations.

3) ***The TPACK Framework***

The Technological Pedagogical and Content Knowledge (TPACK) framework is one of the learning frameworks that underscore the employment of ICT in teaching and teach (Koehler et al., 2014). The framework focuses on creating awareness that technology should be incorporated into teaching putting content knowledge and pedagogy into careful consideration. This framework lays emphasis on the importance of teachers being competent in terms of technology and to understand why they need to be. Mishra and Koehler (2008) proposed the conceptual framework of TPACK building on technological knowledge, the content knowledge and the pedagogical knowledge.

TPACK framework advocates for integration of Technological Pedagogical and Content Knowledge. Even though these three areas are easy enough to identify, defining the boundaries of different sets of knowledge is an area of conflict. However, if the author had broadened the study, there could have been a higher probability that the study would help to unfold the connectedness among the various knowledge aspects, highlighting the significance and dominance of content knowledge in comparison to pedagogical and technological knowledge. This will in turn wipe out the perception brought forth by the model that three areas of knowledge exist in isolation. Notably this would build the model, by expanding its content and subject area unlike the current model that is applicable specifically to language teaching since it focuses on content-specific pedagogies and this will help instructors in stating the learning goals. Having put these limitations into consideration, the framework will therefore be pertinent in teaching various disciplines and take into account students centred approach measures which are of great concern in modern pedagogy.

4) ***Functionality Frameworks***

This framework was developed by Patten, Sánchez and Tangney (2006) as a framework for categorizing ICT software applications found on mobile hand-held devices that are used for educational purposes. The framework is able to track student progress on specific skills. The framework accommodates referential applications that enable students and teachers to access contents and store documents in various formats. Students can repeat the lesson anytime; anywhere and this could even assist students to listen to the lessons they have missed. Teachers could as well use these applications to listen to their own lessons to improve their presentations. Another component of the framework consists of interactive applications that engages learners in activities based on question and answer activities which come along within formation and images. This framework accommodates, collaborative applications undertaken to develop a learning environment of knowledge sharing by utilizing the features of hand-held devices as well as desktop computers (Chen et al., 2008). The features of these devices provide teachers with options that are crucial for student-centred and active learning in the classroom.

Patten et al. (2006) indicate that the potential of the ICT software and applications for encouraging knowledge construction can only be realized if the technology is used in a manner that matches the pedagogical underpinnings of collaborative data collection and micro-worlds software applications. The framework allows, micro-worlds software applications to be used beneficially on laptops and desktop computers. Teachers can use 3D software applications like educational Lectra-3DModaris fit and Gerber technology to enable students to construct their own artefacts and prototypes through experimentation in virtual constrained environments of real world domains. Having said that, I believe that the model would have achieved better results, if the author would have scaled up the scope of the study to factor in the processing power of hand held devices and digress the focus of the interactive application from drill and test type to skills and competencies. Moreover, this would bridge the model gaps and make it ideal teaching model for the 21st century since it merges two perspectives of functionality and pedagogy into one framework.

5) ***People-Process-Product Continuum (P3) E-Learning Framework***

According to (Khan, 2015) e-learning P3 Framework gives an insight on the stages of the e-learning process, the purpose and the outputs of role players who include directors; project managers; research and design coordinators and instructional designers (Khan, 2015). The activities involve the project teams in the output of a project plan placing relative importance on pedagogy. The goal is to ensure that role players maintain pedagogical features according to the project plan and in that case maintain learner requirements as the main point of focus. The framework pin points the e-learning process system design of the P3 framework through each stage, and it can be seen that the learning and pedagogical principles are key elements in the framework. It is evident that adherence to learning needs through pedagogical principles is a common responsibility to be carried out by all role players and not the responsibility of a specific project member. The framework pin points that the e-learning system is designed in such a manner that it's major focus is on planning and learning requirements (Khan, 2015). Therefore this framework contributes positively to the proposed framework in terms of the pedagogy requirements.

This design provides opportunities to develop well designed, learner-centred engaging, interactive, affordable efficient, easily accessible, flexible and meaningful e-learning environment. The P3 framework provides a comprehensive procedure of the e-learning process and helps to identify the roles and responsibilities for the design, development, evaluation, implementation and management of e-learning and blended learning products (Rezaee et al., 2016). P3 framework can be used to examine critical issues in an e-learning environment and provides valuable insights in terms of what needs to be adjusted or improved.

6) ***The Khan's eight dimensional E-learning framework***

Khan et al.'s (2017) eight dimensional e-learning framework aims at creating a flexible, open, effective, and distributed learning environment which caters for a variety s of learners. Khan's research identifies eight dimensions or components to build and support an effective learning environment to structure learning (Khan et al., 2017). These eight components are: institutional; pedagogical; technological interface design; design interface; evaluation; management; resource support; and ethical considerations which are random and not as steps in the framework. This framework deliberates on analysis and investigation using components of the eight dimensional framework, resources and technology together with instructional design principles.

This framework, Khan's (2015) is flexible which makes it possible to be applied to any learning environment dimension provided that proper planning has been carried out and adequate instruction methodologies are selected. Khan et al. (2017) believe that this e-learning framework is effective since it places focus on learner support and adheres to a structured design process where emphasis is on analysis, design, evaluation, and implementation. According to Khan, the paradigm shift from traditional teaching to e-learning requires instructors to have a different mind-set. Khan's framework makes provision for learning regardless of the scope of the learning requirements.

4.4.4. Instructor Focused Framework

Instructor focused framework is characterized by large-scale team development and a linear development process. Examples in this category include Gerlach and Ely framework (Gerlach & Ely, 1971).

1) ***The Gerlach and Ely Design Framework***

Gerlach and Ely design framework shows a teacher's orientation towards the concept of instructional design. This framework stresses on defining teaching goals and acquiring desired learning outcomes. In this framework, the onset of instructional design is the learning objectives and the content.

The framework also has strategies for picking out and integrating media within instruction. As a result, this recognizes the teachers' view that content of instruction comes first since content and objectives are interdependent and when put simultaneously t they become the first task of instructional design. The framework is made up of five steps, the first step is the specification of content and objectives, followed by entry behavior assessment of learners, the third step involves determination of strategy, organization of groups, allocation of time, and allocation of space and selection of resources. The fourth step is performance evaluation and the last step is feedback analysis (Gustafson & Branch, 1997). The model is a prescriptive framework that is well suited to primary, secondary and higher education sectors. Gerlach & Ely while designing this model had the classroom teacher in mind, suppose they considered advancing the study to arrest its shortcoming of putting more emphasis on instructional materials and resources and overlooking the process of identifying instructional problems by pre determining the need for course content.

5. Discussion

The literature established a significant number of shortcomings in learner focused frameworks, for instance, ADDIE framework put teachers to the task of identifying the learners' need upfront. This connotes that the framework focuses on summative evaluation only, hence the framework has difficulty in cases where the process of acquiring skills and competencies is of greatest importance. Moreover, the framework is 'silent' on the use of technology as a pedagogical tool which is key in boosting learner's curiosity and interest to take part in active learning (Aldemir et al., 2018). The linearity of the framework postulates further that all the learning outcomes have a predetermined end, which in most cases is not the reality (Bin Noordan & Md. Yunus, 2022).

On the other hand, Kemp Framework lacks satisfactory instructional analysis information and clear criteria on what measures to be followed regardless of the element the instructor opts to commence with (Hodell, 2015). This leads to more confusion and lack of direction especially to novice instructional designers. As such, this kind of framework may not support a technology enriched active learning where learners' curiosity and active participation is expected and learning tasks are clearly identified. Besides, the model calls for constant planning, management of process, and evaluation of the instruction to ensure that instruction is effectively delivered. Unlike an active learning framework that puts into consideration the personality difference that may in turn affect the pace at which learners grasp different concepts, Dick and Carey framework assigns a shorter time for achieving the set objectives and at the same time variables in the model are not concretely accounted for.

Similarly, Knirk Gustafson frameworks, also overlook the learners behavioral traits, learning approach to be used, the importance of the concept and application of content learnt. Furthermore, the evaluation and development is not a prime concern in this framework. With regards to tasked focused frameworks, it is notable that, Bergman and Moore framework pays no attention to the needs analysis but emphasize on the production phase (Sala et al., 2015). Whilst, Van Pattern framework does not have clear operational details and specific procedures for performing the activities. The Diamond model, is a linear and time consuming to implement, and limits creativity (Reimeris, 2016), besides being biased to higher education. Another framework in this category is IPISD framework that has a narrow instructional focus and linear approach to instructional lay out. This challenge can be addressed by adopting IICTALF allow a three dimensional focus instruction and instructional strategies.

Furthermore, the level of analysis and prescription specified by the IPISD framework requires a heavily staffed and highly financed organization. Thus, the utilization of the framework demands a commitment of substantial resources on a long-term basis. Finally, the last framework in this category is IDI Model, whose drawback is the repercussions of a linear step-by-step development process beginning with definition of the problem, which the framework claims must be finished in a serial way, but in actual practice overlap is rather common. The SAMR framework pinpoints how a learning activity has changed but silent about how to determine the value of that change and the role of the learners in the learning process. As for ASSURE framework, at the inception stage it does not clarify certain instructional problems, such as leaning constraints, new behavioral outcome hence exposes a scanty and deficient analysis (Daniyan, 2015).

In addition, the model assumes that there exists an ideal organized learning environment, where all learning media and facilities are readily available for use hence does not specify the learning media and facilities. This is contrary to the principle of IICTALF, where materials are prepared and tested to establish challenges the learner may face. The TPACK framework on the other hand does not pin point the connectedness among the various knowledge aspects, nor bring to light the significance and dominance of content knowledge in comparison to pedagogical and technological knowledge (Ontiveros-Karr, 2017). While TPACK framework advances the use of technology in learning, it falls short of indicating how the learner should use the ICT knowledge to improve their participation and learning outcome in Physics. Thus, the TPACK model cannot safeguard an integrated active learning environment since it assumes that the three areas of knowledge exist in isolation.

Though functionality framework is among the technology focused frameworks, its major limitation is that it is more drill and test oriented rather than focusing on skills and competencies in Physics that can be achieved through an ICT active learning platform (Lu & Cecil, 2016). Similarly, it is important to observe that the P3 framework put no emphasis on the learners' needs and the development of the content where the epicenter of ICT based active learning is the learners' improvement in terms of learning outcomes. In addition, it is worth noting that t the Khan 8-dimensional model is silent on the transformation of learning curricula, policies and strategies. Thus, such a framework cannot effectively convey the goals of a curriculum to the learners. The instructor focused framework such as Gerlach and Ely framework is noted to put emphasis on instructional materials and resources and overlook the process of identifying instructional problems (Salifu, 2020). The model, therefore, reinforces administrators and instructors in the maintenance of existing organizations and staffing patterns instead of re-examining the entire basis of how schools should operate. This contradicts the focus of active learning that takes into consideration the learners problems.

6. Conclusion

Different learners have different temperaments and personalities which affect their learning in one way or another. ICT based active learning potentially provides an opportunity for learning Physics across these personality barriers. Notably, in traditional classroom settings, it is easier for the instructor to notice when the extroverted learners are not involved in the learning activities but gets difficult for them to notice when introverted students are not taking part in the learning activities. However, through computer aided learning also known as ICT integrated learning, both introverted and extroverted students are motivated to learn and are engaged in the learning process. Thus this paper urges that there is a need for a structure to adopt the active learning approach to improve the learning of Physics in secondary schools in developing countries like Kenya. To this end, this paper provides a systematic review of frameworks for the integration of technology in teaching and learning of physics towards enriching the active learning experience. Then we leverage these insights coupled with field experience to derive and design a framework for ICT integration in teaching and learning of Physics in developing countries. Such proposed framework will be learner-centered and will eliminate the learner barriers that exist due to personalities, temperaments among others. The framework should be a hybrid framework that harmonizes the reviewed frameworks by reinforcing their strengths and bridging their weaknesses and emphasizes the process of acquisition of skills and competencies by the learners. The new framework will thus enhance the curiosity to actively participate in classroom activities irrespective of learners' individual differences.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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