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Employing Digital Resources to Improve Student Teachers Performance in Science

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ABSTRACT
The study is an action research that focused on the use of ICT-based resources to improve student teachers' performance in selected concepts in science (Matter, Forces and Energy) within the four-year Basic Education Curriculum for Colleges of Education. The study was conducted in the Department of Basic Education, University of Education, Winneba. The sample consisted of 90 student teachers from one intact class. The main instruments for data gathering were tests (pre-test and post-test) on the three concepts of interest. Three research questions were formulated to guide the study. Findings of the study reveal that student teachers performance in each of the three concepts after the intervention. It was also revealed that there were statistically significant differences (P< 0.05) in the performance of student teachers before and after the intervention. The key recommendation made was the integral use of ICT in the daily teaching and learning of science by science lecturers and tutors in the University of Education, Winneba and Colleges of Education. It was also suggested that Universities and Colleges of Education should equip science student-teachers with knowledge and skills on how to access and operate ICT resources and services such as computers, projectors and internet connectivity to promote the effective usage of these resources in science teaching and learning at the basic level of education.

BACKGROUND TO THE STUDY
Globally, the integral role of ICT in the delivery of various services is well acknowledged. From the fields of industry, to transportation, communication and agriculture, ICT plays an increasingly key role in the day-to-day activities of humans. As acknowledged by Eminah (2023), ICTs are currently the mainstay of all human endeavours**.** Information communication technology (ICT) is concerned with the technology used in handling, processing, storing and dissemination of information (Kenny, 2012). ICT refers to a series of services and devices that can carry out such functions as relieving, storing, computing, analysing, transmitting and retrieving information presented to them and allowing for one to one or group communication among humans (Ghavifekr et al., 2014). ICT infrastructure include multimedia, CD ROMS, MP3 players, websites, discussion boards emails, computer aided

assessments, learning management software, blogs and so on (Khan et al., 2015). In the educational sector, ICT has taken on an even more crucial role from the basic up to the tertiary levels of learning. It is used integrally for the provision of various services within the sector such as for delivery of virtual lessons, assessment and continuous professional development. Developments in ICT such as the World Wide Web, electronic mail and Electronic data interchange can be seen as facilitators to cross organisational boundaries when dealing with information intensive processes (Mirzajani et al., 2016).

Some of the uses of ICT in teaching and learning include; ICT as objects, ICT as an assisting tool, ICT as a medium of teaching and learning, and ICT as a tool for organisation and management in schools (Ahmadi et al., 2011). ICTs allow learners to explore and discover rather than just listen and remember (Ghavifekr et al., 2014). Several reports and studies in recent years have placed emphasis on the potentials and opportunities of ICT for improving the quality of education. ICT is perceived as a major tool for the construction of knowledge and serves as an instrument at the educational level that can offer a way to restructure the educational systems and processes, resulting in quality education for all.

Barak and Dori (2009) as well as Fetaji et al (2007) noted that in many jurisdictions, ICT has been used to enhance students' conceptual understanding and performance in science concepts such as reproduction, DNA replication and duplication, chemical reactions and various processes within living cells. Additionally, in Europe, appropriate use of ICT is seen as a main factor in attaining quality education. In view of this, the European Commission is encouraging the use of ICT in learning through its e-Learning Action Plan (Khan et al., 2015). One of the specific objectives of the action plan is "to improve the quality of learning by facilitating access to services and resources as well as remote collaboration and exchange (Mirzajani et al., 2016). ICTs could be used to motivate students in their teaching and learning activities (Ahmadi et al., 2011). To prepare the students for the challenges of the 21st century workplace and community leadership, the integration of information communication technology into teaching and learning process has become inevitable (Kazan, 2015).

Within the Ghanaian context, particularly in the aftermath of the COVID-19 pandemic, educational institutions have used ICT more prominently for undertaking learning based on its numerous advantages. This is in tandem with provision in the pre-tertiary curriculum that identifies ICT as an integral pedagogical tool for Ghanaian educators in the 21st century.

However, ICT is still underutilized within the Ghanaian learning context, Boahen and Atuahene (2021) identified teacher cognition as one of the key factors militating against the effective usage of ICT in lesson delivery in Ghanaian high schools. There is the need to address this unfortunate phenomenon, considering the increasingly crucial role of ICT across the globe in all sectors, particularly education.

Although the teacher education curriculum emphasises strongly on the use of ICT as a key pedagogical tool, the review of the literature does not provide information on the role of ICT in improving student-teachers performance in science. The present study seeks to identify the link between ICT-based teaching and the performance of student teachers in science. This can potentially assist stakeholders on the most effective pedagogical strategies to implement in ensuring the attainment of the intended curriculum. It also seeks to employ the ICT-based intervention to improve the academic performance and thus the attitude of student teachers towards the study of science. Ultimately the study provides information on how the intent of curriculum developers to leverage ICT for improving student teachers' academic performance and output as teachers can be realised within the classroom setting. This thus positions the study as a precursor for the future review of the science curriculum for teacher education in terms of content and the role of ICT in successful curriculum implementation.

Statement of the Problem

Research into students' understanding of science-related topics indicates that ineffective methods of teaching promote misconceptions leading to poor performance as well as loss of interest in science (Adegbola & Depar, 2019; Akarsu & Kariper, 2013; Azure, 2015).

Despite the growing importance of Science in our today's world, many students are losing interest in the study of this vital subject area due to several reasons including poor teaching methods (Veselinovska, 2011). As suggested by Ali et al., (2013), most of the students have developed ambivalent attitudes and perception towards Science and Technology.

Teaching at the various Colleges of Education and the universities that offer education-related courses in Ghana is mostly done through the traditional lecture method (Boahen & Atuahene, 2021). Research indicates that this method dominates most of the tertiary institutions (Deslauriers et al, 2011). Arguably, one of the reasons behind this phenomenon is the absence of requisite teaching resources that could have been used to enhance conceptual understanding. Some of the concepts that students usually complain about and perform abysmally in include States of Matter, Light, Measurement, Compounds and Mixtures. Various studies (Kapici & Akcay, 2016; Özalp & Kahveci, 2011; Driver et al, 2014) in different settings also found out that student teachers held misconceptions in the three concepts (Matter, Forces and Energy) under consideration.

Potentially, ICT could be leveraged to improve students' performance (Ghavifekr & Mohammed, 2015). Westera (2015) also points out that the use of various ICT-based resources such as videos, virtual laboratories, images and PowerPoint presentations promotes conceptual understanding and academic performance This makes the research very pertinent to find the effect of ICT-based training on the performance of student teachers in integrated science.

After teaching science-related courses in the Department of Basic Education and the College of Distance and E-Learning (CoDeL) of the UEW for four years, the researcher discovered a trend of student teachers' poor performance in these three integral concepts in the science curriculum for teacher education.

The observed trend of student teachers' (in the Department of Basic Education, UEW) poor performance in some integral science concepts is worrying, considering the fact these student-teachers are potential teachers at the basic level of schooling in Ghana. The researcher is of the view that the over reliance on the traditional method of teaching science as well as the absence of requisite resources over the years are key contributory factors to the below par performance of student-teachers in science within the Department of Basic Education, UEW. To the best of the researcher's knowledge, not much research work has been done on the role of ICT in promoting student teachers' academic performance in science, in the Department of Basic Education and also in the 46 Colleges of Education, since the introduction of the 4-year teacher education programme. Yeboah et al. (2019) emphasised the over reliance on traditional methods of teaching in the typical Ghanaian setting as a possible factor in students low learning outcomes in science. For this reason, the researcher intends to design ICT-based modules to teach level 200 upper primary student teachers in the Department of Basic Education of UEW to determine its effect on their performance in science.

Purpose of the Study

To determine the impact of ICT-based training on student-teachers performance in some selected science concepts.

Research Questions

1. To what extent will the use of ICT-based teaching strategies improve the performance of student teachers in matter?
2. What effect will the use of ICT–based teaching strategies have on the performance of student teachers in the concept forces?
3. How will the use use of ICT-based teaching strategies improve the performance of student teachers in the concept, Energy?

Null Hypothesis

The following null hypotheses were formulated for the study:

- H01: There is no statistically significant difference between the pre-test scores and post test scores of student teachers in the concept, matter.
- H02: There is no statistically significant difference between the pre-test scores and post test scores of student teachers in the concept forces.
- H03: There is no statistically significant difference between the pre-test scores and post test scores of student teachers in the concept, energy.
- H_{04}: There is no statistically significant difference between the overall pre-test scores and overall post-test scores of student teachers in the concepts under study.

REVIEW OF LITERATURE

Teaching and Learning Technologies

Talking in a positive sense, the impact of technology on education has been phenomenal. Using Internet and computers as an effective medium to establish communication between schools, teachers, students and parents; educational institutes have been able to handle many issues that were previously not handled with ease due to geographical limitations or lack of adequate training technologies (Boote, 2014). The effective use of technology must be supported by significant investments in hardware, software, infrastructure, professional development, and support services (Kreijns et al., 2013). While complex factors have influenced the decisions for where, what, and how technology is introduced into educational institutions (Amer & Jaber, 2012) ultimately, the schools will be held accountable for these investments. While many different terms have been used to describe what students need, such as digital literacy, technological literacy, and 21st century skills, education leaders, nationally and internationally, are beginning to come together around a new common definition of what students need to know, Information and Communication Technology (ICT) Literacy.

Various technologies deliver different kinds of content and serve different purposes in the classroom. For example, word processing and e-mail promote communication skills; database and spreadsheet programmes promote organisational skills; and modelling software promotes the understanding of science and mathematics concepts (Alotaibi, 2011). It is important to consider how these electronic devices differ and what characteristics make them important as vehicles for education (Alkanani, 2012). Technologies available in classrooms today range from simple tool-based applications (such as word processors) to online repositories of scientific data and primary historical documents, to handheld computers, closed-circuit television channels, and two-way distance learning classrooms (Ahmadi et al., 2011). Even the cell phones that many students now carry with them can be used to learn (Niederhauser & Stoddart, 2011). Each technology is likely to play a different role in students' learning. Rather than trying to describe the impact of all technologies as if they were the same, researchers need to think about what kind of technologies are being used in the classroom and for what purposes.

Two general distinctions can be made. According to Bingimlas (2013), students can learn "from" computers (where technology is used essentially as tutors and serves to increase students' basic skills and knowledge) and can learn "with" computers (here technology is used a tool that can be applied to a variety of goals in the learning process and can serve as a resource to help develop higher order thinking, creativity and research skills). Technological aids not only break the monotony to grab students' attention, foster inquiry and increase interest but also improve comprehension and stimulate retention (Boote, 2014). Classes become more interactive, engaging and collaborative as students move from passive reception to active discovery and learning (Shúilleabháin, 2013). Effective teaching is strongly influenced by the manner in which teachers use ICT tools or technologies in the teaching and learning process and not only how the various ICT tools function (Kreijns et al., 2013).

By implication, the teachers' knowledge in the functions of the various ICT tools is not enough for the effective teaching and learning outcome, but the ability of the teacher to practically use the ICT tools is very crucial for effective teaching (Alotaibi, 2011). As such, in the context of science teachers, when these ICTs are integrated into their learning programmes, these teachers will be better able to use these technologies with ease in the classroom which will have a consequential impact on their skills, competencies and overall performance. Mention must be made that technology is the application of human or scientific knowledge to practical problems (Webb & Cox, 2014). In the context of this work, teaching and learning technologies refer to all ICT hardware and software tools that can be used to enhance teaching and learning (Niederhauser & Stoddart, 2011).

ICT consists of the software, hardware, media and networks for the collection, processing, transmission, storage and presentation of information (data, voice, text, and image) and its related services (Shúilleabháin, 2013). They include the use of computers, DVD/CD-ROM, projectors, web-based multimedia training, interactive media, modems, satellites, teleconferencing, webcast (live video streamed over the web), interactive whiteboards and other technological means (Rehmat & Bailey, 2014). DVD/CD-ROM technology enhances learning mobility. A computer and a source of electricity allow learners to carry volume of information on DVD/CD-ROM with them (Baek et al., 2018). It gives the learner, access to quality information at locations where they may not gain access to the library and the internet. The use of interactive whiteboard and software plays a potential role in conjoining the teacher's "personal curriculum" to the knowledge of students in the classroom settings (Bingimlas, 2013).

The use of some music software package (for example, fruity Loops, Acids Xpress and Dance eject) enables students to compose within various contemporary styles of music that are clearly important in young peoples' social and cultural lives (Webb & Cox, 2014). The results of the music design initiatives indicate that this can lead to increase motivation and engagement in school activities. The internet also as an IT tool in education provides the platform for teaching to take place across boundaries (Rehmat & Bailey, 2014). Using such resources as teleconferencing, webcasting, and web-based multimedia has aid teachers to provide teaching to learners from a distance (Alotaibi, 2011). Some universities around the world run online programmes for distance students. The system offers both in-campus and off-campus access to students and gives them opportunity to interact with each other and with their lecturers through webcasting (Boote, 2014).

Videoconferencing systems use a regulated band of frequencies and allows remote participants to be connected live by telephone lines (Baek et al., 2018). Video conferencing systems can support distant collaborative learning. Students can have group discussions and tutorial sections through video conferencing (El-Daou, 2015). Skype is another internet facility that can be utilised by educators to enhance teaching and learning activities. Skype is a software application that also allow students to make voice and video calls and chats over the internet (El-Daou, 2015). Currently, Zoom, WhatsApp and Facebook live video calls are also available to support online interaction between lecturers and students and amongst students thereby bridging the limitations of time and space on teaching and learning. Even though digital tools are rarely developed with the needs of formal teaching and learning in mind (Baek et al., 2018), with the internet now available in most University Campuses in Ghana, educators can take advantage of the vast resources and potentials of the internet to support teaching and learning in so many ways. This will make the training of prospective teachers more real and modern. Aside discussion groups, lecturers can conduct assessments and evaluations via the internet. Students watch videos of what they have learnt on YouTube thereby enhancing their understanding of what they have been taught (Ahmad et al., 2012). The continual use of these tools in a trainee's student years, will enhance the possibility that, these trainees would use them during their career in the classroom, thereby enhancing performance. It is common knowledge that, computers have changed the traditional classroom experience from perceptive learning to a visual, web-based and virtual learning experience (El-Daou, 2015). Moreover, different visual formats facilitate ease of learning and an enhanced retention period for the learners (Ahmad et al., 2012). The different pedagogies available for teachers enable them to improve not only teaching but also create personalised learning plans since all students do not learn the same way (Baylor & Ritchie, 2012).

There is a wide variety of audio/visual/technological tools that can be utilised in different ways to help teachers teach and students learn (Baek et al., 2018). The simplest visual representation is with an overhead projector and transparencies to present text, graphs illustrations, photographs, and cartoons (Ahmad et al., 2012). Video documentaries and audio- tapes are used so that students can actually view and better understand theoretical concepts like human anatomy or the eclipse phenomena (Webb & Cox, 2014). Teachers can effectively use ICT tools such as the computer, internet and mobile phones, the array of teaching aids and online services including email, online chats, Facebook, twitter, forums, blogs, slideshows, search engines, interactive whiteboards, videoconferencing, and so on, to communicate with students, ask questions, solve doubts, answer queries, give assignments, send reminders, coordinate group activities or even have a group discussion out of the class (Ahmad et al., 2012). Such virtual interactions encourage a running dialogue of thoughts, comments, reflection and feedback overcoming limitations of time, distance and even students' shyness (Baylor & Ritchie, 2012).

Teachers can post course material, a lesson presentation or other important information on the internet, enabling students to quickly access them anytime they want (Wong & Li, 2018). This can be replete with links to relevant definitions, background information, audio, images, animation, and so on (something that is missing in traditional books/lectures). This will help arouse students' curiosity and invite them to explore (Abbit, 2011). Teachers can go a step ahead and use an e-group to organise interactive quizzes or even conduct polls that help students understand how their opinions relate to the lessons (Alotaibi, 2011). Different computer programmes like word processors, PowerPoint, databases and spreadsheets help teachers organise, evaluate and present information in a quick and interesting way (Webb & Cox, 2014). Another use of these computer s is keeping track of students' grades/progress. Teachers can use software products and multimedia components to design and deliver rich, engaging and visually stunning presentations (Abbit, 2011).

Students can even view real phenomena and processes with simulations that help them to easily relate to the principles and concepts (Boote, 2014). Educators can also run websites with Learning Management Software (like Moodle, Edmodo, and Canvas) to not only deliver content but also build collaborative communities of learning (Baylor & Ritchie, 2012). These sophisticated tools also support self-paced learning. Options like CDROMs, e-books, podcasts, smart boards, Skype, YouTube videos are also open. The web offers a variety of options for students. They can easily conduct research with Google or Wikipedia, use Microsoft Office for creating a project, air different perspectives for solving a problem on Blogger and share ideas with other students through MSN Messenger/Facebook/Twitter, sometimes even to the extent of collaborating in real-time with another class across the globe (Thomas & Palmer, 2014). This enhances their thinking, problem-solving and creative skills.

Integration of ICT into Teaching and Learning

Technology is a means for improving education and not an end in itself (Bhasin, 2012). Integrating ICT into teaching and learning is not a new concept; computer integration in the classroom is the application of technology to assist, enhance, and extend student knowledge (Shúilleabháin, 2013). However, ICT in education means more than just teaching students (in this context, student teachers) how to use computers. Thus, ICT should also be used to promote information literacy, with the capacity to access, use and appraise material from various sources in order to enhance learning events to solve difficulties and to craft awareness (Adarkwah, 2021; Abbit, 2011). Technology literacy is totally different from being able to integrate technology into teaching to enhance learning. In other words, doing "digitally fluent", means, not only know how to use the technological tools, but how to construct things of significance with those technological tools.

Teachers do not only need to learn about technology, but they need to learn how to use technology to enhance their learners' understanding and critical thinking skills (Baylor & Ritchie, 2012). Enhancing basic information and communication skills like speaking, reading and writing, should rather be the focus of using ICT in education, but not simply being ICT literate (Thomas & Palmer, 2014). A wide range of learning technologies should be selected and incorporated into educational programmes and that technology integration should consider learning pedagogy, the pattern of student teachers ' use of ICT, and the extent of use in teaching and learning programmes (Abbit, 2011). E-learning is an example of the use of these ICT supported teaching and learning methods whose use in educational institutions is gaining momentum with the passage of time (Bosse & Törner, 2015). Teachers acknowledge ICTs as tools for building knowledge mediated by collaborative activities that are relevant for participation in future society and guide towards an authentic problem (Antwi-Boambong, 2020; Granić & Marangunić, 2019). However, Amedeker (2020) revealed that despite the various policies and professional developmement sessions organised for teachers towards the effective usage of ICTs, its actual implementation has remained at the policy level and has had little impact on the actual teaching of science at the classroom level.

Within the Ghanaian Educational Setting, the curriculum has made provisions for the effective integration of ICT by teachers (Agyei & Voogt, 2011). NaCCA (2019) stressed that under the current dispensation, ICT is expected to serve as a key pedagogical tool in the basic school. Thus Adarkwah (2021) recommended the identification and elimination of barriers to effective e-learning in jurisdictions such as Ghana, particularly in rural areas where ICT resources are either unavailable or inadequate.

ICT Integration in Teacher Education

Continuing training and development is necessary to maintain teachers' competencies: for pedagogical and professional portfolio reform, and to learn new skills and approaches (Youssef, 2010). Teachers' ICT training can be of a higher priority than hardware and software availability. Planning for integration of ICT in the curriculum has to include teachers' professional development and ICT infrastructure (Granić & Marangunić, 2019). Agyei and Voogt (2011) stressed on the key emphasis placed on the use of ICT for supporting effective teaching and learning by teachers. However, the training of teachers does not adequately prepare them to use ICT in their classrooms (Agyei & Voogt, 2011). The quality of the school's ICT equipment is immaterial if teachers do not have the required competencies, and authorities should recognise the value of attaining and retaining appropriate skills. As a result of pedagogical and technical advances, teachers require access to continuous skill and knowledge opportunities to maintain their positions in the evolving standards in these fields, and this factor is recognised by all capable educational authorities (Youssef, 2010).

Professional development of teachers sits at the heart of any successful technology and education programme. Teachers' professional development is a key factor to successful integration of computers into classroom teaching (Alkanani, 2012). Adarkwah and Huang (2023), stressed that although young adults' attachment to ICT is expected to boost the usage of this technology in educational delivery, there are various bottle necks that prevent this expectation from being achieved so far as higher education is concerned. Amedeker (2020) observed that ICTs integration in science teaching at the senior high school level is inhibited by lack of effective coordination as well as a flurry of policy implementation procedures.

Many school leaders perceive the lack of ICT related knowledge of teachers as one of the main impediments to the realisation of their ICT related goals (Thomas & Palmer, 2014). One of the pertinent factors contributing to the usage of computer is that teachers need to be computer literate and thus be given appropriate training in computer usage (Wong & Li, 2018). Different people hold different views about computer literacy. They are those who take a literal interpretation of computer literacy. They regard writing and reading computer programmes as the basic skill of a computer-literate person (El-Daou, 2015). Training too plays an important role in a teacher's readiness to use computers (Jung, 2015). With regards to the issue of having attended formal computer courses, it was identified through numerous studies that there is a significant relationship between usage of computers and computer training (Hussain, 2018).

Professional development is one of the most important support in most schools for ICT integration into teaching as it has the greatest impact on the beliefs and practice of teachers and yet professional development time was not budgeted for in many schools (Jung, 2015). Professional development has a significant influence on how well ICT is embraced in the classroom (El-Daou, 2015). As compared to mathematics teachers, science teachers' perceived professional development needs of ICT use in context to teaching and learning is significantly higher (c, 2018). But both mathematics and science teachers rank as professional development needs at the second place (Bosse & Törner, 2015). Teachers; technology skills are thus strong determinant of ICT integration, but they are not conditions for effective use of technology in the classroom (Wong & Li, 2018). For instance Agyei (2015) revealed that even though teachers received professional training on how to integrate ICT in lessons, their usage of ICT was limited to their own professional development at the expense of actual classroom implementation.

Clearly, it is imperative to allow student teachers to apply ICT in their programmes when in school in order to be able to use the technology to supplement their teaching activities (Fortunasari, 2016). Teachers when given time to practice with the technology, learn, share and collaborate with peer, it is likely that they will integrate the technology into their teaching (Goos, 2014; Buabeng-Andoh, 2017). Training programmes for teachers that embrace educational practices and strategies to address beliefs, skills and knowledge improve teachers' awareness and insights in advance, in relation to transformations in classroom activities should be encouraged (Fortunasari, 2016). Training thus makes a positive difference to those who receive it. Teachers who receive eleven or more hours of curriculum-integration training are five times more likely to say they believe they are much better prepared to integrate technology into their classroom lessons than teachers who received no such training (Kenny, 2012). Teachers receiving more training of either type, but especially of integration training, are more likely to use software to enhance instruction in their classrooms (Isisag, 2012).

Professional Development (PD) programmes induce a positive impact not only on developing the information technology skills of teachers, but also on their familiarity with ICT as a curricular tool to some degree while, it had a very limited impact on the classroom practice (Clark-Wilson et al., 2014). While most of the teachers, who enter PD programme, expanded their knowledge, skills, ideas, and their lesson plan repertoire through these learning experiences; only a one-third of them are considered as proficient apprentices at the end of the programme (Bosse & Törner, 2015). Notwithstanding this, PD programme are capable of increasing the technology usage skills, whereas it failed to induce substantial change for the technology integration in the classroom (Kopinska, 2013).

METHODOLOGY

The philosophical assumption underpinning the study is the pragmatic paradigm. Pragmatism as a research paradigm finds its philosophical foundation in the historical contributions of the philosophy of pragmatism (Maxcy, 2003). As a research paradigm, pragmatism is based on the proposition that researchers should use the philosophical and or methodological approach that works best for the particular research problem that is being investigated (Tashakkori & Teddlie, 2003). It is often associated with mixed-methods or multiple-methods (Creswell & Clark, 2011), where the focus is on the consequences of research and on the research questions rather than on the methods.

Pragmatists believe in what works best in any given situation. A major underpinning of pragmatist epistemology is that knowledge is always based on experience. That is to say one's perceptions of the world are influenced by their unique experiences. Since this study seeks to find out what works in relation to identifying and addressing issues regarding the conceptual understanding and academic performance of student teachers in science, it aligns clearly with the focus of the pragmatist viewpoint.

Research Approach

Creswell (2014) explains that research approaches are the plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation. In line with the pragmatist paradigm, the study employed the quantitative research design. Quantitative approach involves gathering numerical data to answer a research question (Rana et al, 2021; Gay et al., 2009). It involves the use of instruments such as questionnaires and tests. The researcher used this approach because the main instruments for data gathering were tests. Among other purposes quantitative approaches are useful for making summaries, finding causes, drawing patterns as well as predictions (Rana et al., 2021). In the study it was deemed appropriate because the researcher sought to determine the influence of an intervention in the form of ICT-based teaching on student-teachers' academic performance. This was to enable a general inference about the impact of ICT on student-teachers' performance to be drawn from an intervention involving a specific group of respondents (level 200 student-teachers from the University of Education Winneba, Basic Education Department) as noted by Babones (2016)

Research Design

The research design is intended to provide an appropriate framework for a study (Sileyew, 2019). Johnson (2008) describes action research as a systematic inquiry into one's own practices as a teacher. An action research design was used for this study. This research design was preferred because the researcher sought to find a workable solution by gathering data and taking necessary action to address an identified challenge within his working environment. Johnson (2012) asserts that action research bridges the gap between research and practice.

In the words of Stringer (2008), action research involves a systematic inquiry to improve social issues affecting the lives of people. In the field of education, it is a preferred method of data gathering and interventions by academic counsellors, educators, administrators and other key stakeholders for improvement in day-to-day school management and attainment of better learning outcomes among learners.

As noted by Mills (2011), action research has gained more prominence in recent times within educational circles. This may be partly due to the fact that researchers are usually active participants in the action and researchers of the action (Burns, 2015). Mertler (2014) further corroborates that action research is research that is conducted by educators for their own benefit.

Action research was the preferred research design because, the researcher was keen to make a change in the conceptual understanding and pedagogical approach of student teachers in his class. This is in line with Atiti's (2008) finding that, action researchers are change agents interested in resolving, dilemmas, predicaments or puzzles and making a change for a preferred future through systematic planning, data-gathering, reflection and further informed action.

Even though the findings of action research are not typically generalizable to other populations, it is possible that the evidence and recommendations can be implemented by instructors who practice in similar situations (Linder et al., 2014).

In undertaking the study, five key phases were followed. These phases of action research as applied to this study are illustrated in Figure 1 4.

The diagnosing phase identifies the problem to be addressed. It is also the stage where the possible solutions to the identified challenges are organised. The Action-Planning Stage is a key stage in the research which was used to plan the strategies for data gathering and implementation of the intervention to attain the desired outcome. In the action-taking phase, the various tools are administered and the intervention is introduced to the research subjects, namely the second-year science group.

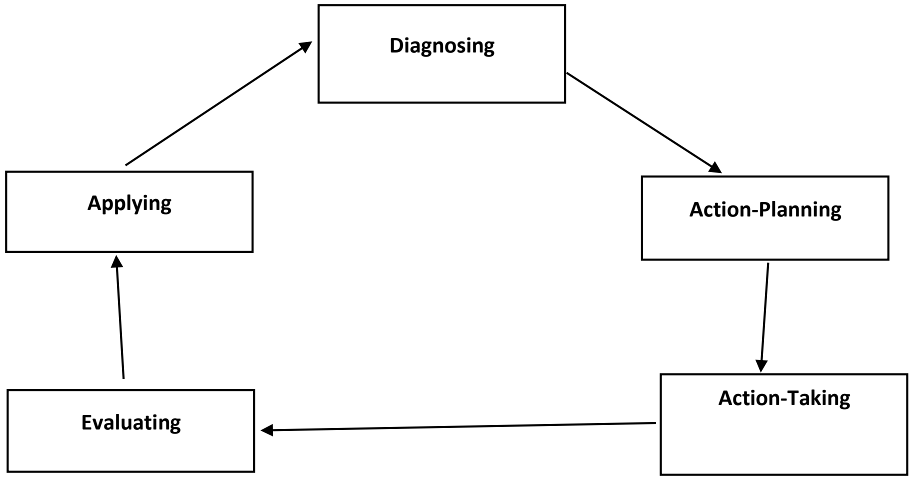

Figure 1: Phases of the action research
Source: Baskerville (1999)

The evaluating phase was used to undertake an appraisal of the intervention in order to determine the impact of the intervention in the form of ICT-based training on the performance of the student teachers. In the learning phase, the results of the appraisal are put forward as recommendations to ensure the desired change in conceptual understanding and hence academic performance of student teachers. In conducting the study, the researcher was mindful of some key limitations that impede the success of an action research as identified by Avgerinou (2014). These include: Observer bias (invalid information resulting from the perspective of the teacher researcher, influence of a researcher's background, personal experiences, preferences, attitudes), response set (tendency to see similar things), halo effect (how initial impressions and observer's knowledge of the participants affect subsequent observations).

Action Plan

The entire study itself was organised into three main stages namely: pre-intervention, intervention and post-intervention stages.

Pre-intervention Phase

The pre-intervention activities involved the administration of the pre-test to find-out student teachers performance in three key concepts in physics within the curriculum for teacher education. Both the questionnaire and pre-test were administered to all the respondents.

Intervention Phase

The intervention phase involved the use of ICT-based approaches to provide instruction in three concepts namely; Forces, Matter and Energy. In teaching each of the concepts, various ICT based resources such as simulation videos, laptop computers, projectors and audio players were used in an interactive manner. Additionally, internet resources such as educational websites and links were also used to provide instruction as well as assessment tasks to the student-teachers. The entire intervention was done within a period of 8 weeks. An average of two weeks was used to cover the content in each of the three concepts. Within each week, three hours were devoted to the lessons in the selected topics. The final week was used to undertake a review of the entire content, address any outstanding challenges of the research subjects and finally administer the post test. Table 1 shows the various ICT-based resources used in teaching each of the three concepts within the eight weeks. It also provides a breakdown of the content covered for each week.

Table 1: ICT resources used for the intervention

Week	Concept Area of Focus ICT Resources Used
1	Pre-test Matter, forces and energy
2	Matter States of Matter Video, Web-linked Materials
3	Matter Properties of States of Matter Power Point Presentation
4	Forces Types and Effects of Forces E-Platform and LMS
5	Forces Laws of Motion Animation, Web-linked Materials
6	Energy Types of Energy E-Platform (Padlet) and LMS
7	Energy Energy Transformation and Animation, Web-linked Materials conservation
8	Post-test Matter, forces and energy

Post-intervention

The procedure for the conduct of the post-intervention activities was similar to the steps followed during the pre-intervention phase. The post-test was given to the research subjects. Figure 5 shows the diagrammatic presentation of how the entire study was carried out.

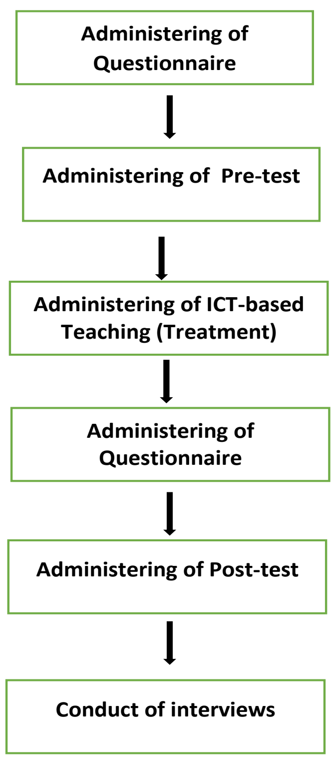

Figure 2: Diagrammatic representation of the research approach/research procedure
Source: Researcher's Diary (2021)

Area of the Study

The study was conducted in the Central Region of Ghana, specifically in the University of Education, Winneba.

Population

The population of a study is the group that conforms to specific criteria and to which the researcher would like to generalise the results of the study (Fraenkel & Wallen, 2003). There were a total of One thousand seven hundred and twenty (1,720) student-teachers in the Department of Basic Education. The target population for the study was the student teachers who were undergoing training based on the new Pre-tertiary Teacher Education Curriculum. Out of the total of 1,720 student teachers in the Department of Basic Education, 329 were in Level 200 (both JHS and Upper primary options). However, the research subjects were selected from one intact class at the Department, specifically Level 200 student-teachers in the upper primary class. The total number of student-teachers in the class is ninety-three (93)

Sample and Sampling Procedure

Since the study was an action research, the entirety of students in one class served as the research subjects. Sampling basically refers to the way a sample is selected from a larger population to be part of a study (Etikan et al., 2016). Purposive and Convenience sampling were the main methods used in selecting the research subjects. Purposive sampling technique, is used when there is the need to select particular participants or groups of participants for a study based on some unique characteristics they possess (Etikan et al., 2016), which in this case refers to second year students offering basic education at UEW. In purposive sampling a group of research subjects are selected based on their proficiency in the phenomenon of interest (Creswell, & Plano Clark, 2011). Convenience sampling was based on proximity to the Department in which the study was conducted.

Homogenous sampling was also applied. Homogeneous sampling is a form of purposive sampling technique used to select respondents that have common characteristics such as age, occupation or gender (Elmusharaf et al., 2016). The sample size was 93, consisting of all the student-teachers within the Level 200 Upper Primary class. The sample selected for the study had common characteristics in terms of the fact that they were offering the same programme and were students of the same class, being taught by the same instructor.

Though the sampling method helps to select research subjects that can provide the needed information, an element of bias could be introduced since the selection of the sample is dependent on the researcher (Oliver, 2006). However, the effect of bias was minimised by ensuring an internal consistency between the goals of the study, and the sample selection criteria (Oliver, 2006). For this reason, a different lecturer was assigned a role to assist in the administering of the intervention as well as the gathering of data using the various tools following the recommendations by Stahl and King (2020).

Instrumentation

Research instruments are the fact-finding strategies and the tools for collecting data (Munir & Ilyas, 2017). The main instruments used in the study were tests, questionnaires and an interview guide. These were employed for collecting data on the research subjects before and after the intervention.

In designing the tools for measuring student-teachers' academic performance, the following steps were followed:

1. Analysis of the science curriculum to identify objectives of the three key concepts, Matter, Forces and Energy.
2. Identification and analysis of key content knowledge expected to be acquired by student-teacher
3. Development of pre-test based on the three key Concepts (Matter, Forces and Energy)
4. Design of the post-test after the intervention

Table 2: Tools used for data gathering

S/N	Instrument	No. of Items	Stage of Administering	Target Respondents
1	Pre-Test	30	Before the intervention	All the respondents
2	Post- test	30	After the intervention	All respondents

Tests

Two main tests were used in the study namely; Pre-intervention test (pre-test) and post-intervention test (post-test).

Pre-test

Collins (2006) has stressed that test questions which are well-developed help to gather useful information on students' achievement. The pre-test was used to augment data gathered with the aid of the questionnaire on student teachers' conceptual understanding. It was basically used to measure the performance of the research subjects in three key concepts in physics (Matter, Forces and Energy) in the new 4-year curriculum for Teacher Education. The Pre-test contained 30 items. The items were mainly close-ended questions, with options provided, whilst a few questions required respondents to write down short answers. These consisted of questions designed under the knowledge, Application and Reasoning domains of learning in a ratio of 4:3:3.

- Knowledge – 40% (12 items)
- Reasoning – 30% (9 items)
- Application – 30% (9 items)

Tarrant et al. (2006) recommend that in developing test items, overly general or ambiguous questions, leading or biased questions must be avoided.

A sample item in the pre-test is presented in the following example:

A. Adzovi wants to fill a vessel with a substance that is light in weight and can easily be compressed. Which one of the following is most suitable for her to use?
   a. A substance in the gaseous state
   b. A substance in the liquid state
   c. A substance in the aqueous state
   d. A substance in the solid state

According to Allen and Nimon (2007), the main weakness of pre- and post-test design is that it cannot detect other possible causes of positive or negative results among the participants. They further state that in cases where a new pre- and post-test is being written, or an existing test adapted, pilot testing is strongly recommended. The pre-test was pilot tested with second-year students of the Komenda College of Education, who were offering the same course.

In conducting a pilot test, common signals of needs for improvement include; Many blank answers to specific questions, Inconsistent answers to related questions, Responses to open-ended questions that reflect lack of understanding and failures to respond to the questions towards the end of the test (Empower, n.d). Based on the pilot test, several changes were made to the test in the form of deletion of incorrect items as well as modification of others.

The Post-test

The post-test was purposely developed to determine the effect of the intervention on the conceptual understanding and performance of student teachers in the selected science concepts. As in the case of the pre-test, it consisted of 30 items designed based on the Knowledge, Application and Reasoning domains of learning. In terms of design, the post-test was similar to the pre-test with modifications to 50% of the items. In developing post test questions, there is the need to ensure all learning objectives are covered. However, the percentage distribution of test items based on the three key learning domains was same for the post test and pre-test.

B. Knowledge – 40% (12 items)
C. Reasoning – 30% (9 items)
D. Application – 30% (9 items)

A sample item in the post test is presented in the following example:

1. Kofi applied the brakes on his bicycle and it came to a halt. What is the name of the force between the ground and bicycle tyres that caused the bicycle to stop moving?
   A. electrostatic force
   B. frictional force
   C. magnetic force
   D. Molecular force

Table 3: Reliability values for the questionnaire, pre-test and post-test

Tool	Cronbach Alpha Reliability Value
Pre-test	0.85
Post Test	0.80

Ethical Considerations

The researcher sought a written permission from the Faculty of Education and the Department of Basic Education to conduct the study within the department. The student teachers were also informed about the study and their expected roles in its success. The consent of all respondents was sought and they were also informed that they could withdraw from the study at any time. In addition, anonymity and confidentiality of research subjects was maintained during the administering of all research tools. The research instruments, were subjected to rigorous validation to avoid any biases as well as the use of offensive, discriminatory, or other unacceptable language. The gender, religion and ethnicity of respondents were kept anonymous to prevent unfairness and partiality during the administration of the questionnaire and tests.

RESULTS AND DISCUSSION

- **Research Question 1: To what extent will the use of ICT-based teaching strategies improve the performance of student teachers in matter?**

This question sought to find out the effect of ICT-based teaching strategies in improving the academic performance of student teachers in the concept, matter. It was answered based on the results of the student-teachers in the pre-tests and post-tests on matter. The breakdown of scores attained by the 90 research participants in both the pre-test and post-test is shown in Table 4.

Table 4: Pre-test and post-test performance of student teachers in the concept of matter

Range	Pre-Test Freq (%)	Post-Test Freq (%)
1 – 4	21(23.3)	0
5 – 8	55(61.1)	8(8.9)
9 – 12	14(15.6)	13(14.4)
13 – 16	0	51(56.7)
17 – 20	0	18(20.0)
Total	90 (100%)	90 (100%)

In the pre-test as many as 21 student teachers attained a score between 1 and 4. In the post test though, none of them attained a score below 5. The number of respondents with scores ranging between 5 and 8 reduced from 55 in the pre-test to 8 in the post-test. Whereas majority of respondents had scores between 5 -8 in the pre-test, the modal score in the post –test was 13 -16. No student-teacher attained a score higher than 12 in the pre-test compared to a total of 69 student teachers who attained scores within the range of 13 to 20 in the post test. The mean score increased from 8.32 in the pre-test to 16. 88 in the post-test as presented on Table 4.

Testing of Hypothesis 1

Hypothesis One:

- H01: There is no statistically significant difference between the pre-test scores and post test scores of student teachers in the concept, matter.

The independent sample 2-tailed t-test was used to test hypothesis 1 at p-value of 0.05 and the results are provided in Table 5.

Table 5: T-test results on pre-test and post-test performance of student teachers in the concept of matter

Compared Group	N	Mean Score	S.D	T	d.f	p-Value
Pre-test	90	8.32	5.04	1.812	89	0.014
Post-test **Effect size value**	90 1.17	14.21				

*P> 0.05

The t-test results in Table 5 reveals that there was a statistically significant difference in the pre-test and post-test scores of student teachers in the concept of matter (t (89) = 1.812, p>0.05). Thus, the null hypothesis was rejected. Further, the Cohen's effect size value (d = 1.17) suggested a high practical significance which shows that in reality there was a high difference between the performance of the student teachers in the pre-test and post-test. As noted by Sullivan and Feinn, (2012) Cohen's effect size can be classified as small (d = 0.2), medium (d = 0.5), and large (d ≥ 0.8).

- **Research Question 2: What effect will the use of ICT–based teaching strategies have on the performance of student teachers in the concept forces?**

The scores distribution of student teachers in the pre-test and post-test on Forces is presented in Table 6.

Table 6: Pre-test and post-test performance of student teachers in the concept of forces

Score	**Pre- Test Freq (%)**	**Post Test Freq (%)**
1 – 4	31(34.4)	3(3.3)
5 – 8	47(52.2)	14(15.6)
9 – 12	12(13.4)	16(17.8)
13 – 16	0	40(44.4)
17 – 20	0	17(18.9)
Total	90 (100%)	90 (100%)

In the pre-test, the highest score attained by any student teacher was in the range of 9 – 12, but as many as 67 students had scores between 13 and 20 in the post-test. Additionally, the number of student teachers who scored between 1 and 4 reduced from 31 in the (pre-test) to 3 in the post test. Also the modal score range changed from 5 – 8 to 13 – 16. The mean score of 14.16 in the post test shows a vast improvement compared to the 6.88 attained for the pre-test.

Testing of Null Hypothesis 2

Null Hypothesis Two:

- H02: There is no statistically significant difference between the pre-test scores and post test scores of student teachers in the concept forces.

The independent sample 2-tailed t-test was used to test hypothesis 2 at p-value of 0.05 and the results are provided in Table 7.

Table 7: T-test results on pre-test and post-test performance of student teachers in the concept of forces

Compared Group	**N**	**Mean Score**	**S.D**	**T**	**d.f**	**p-Value**
Pre-test	90	8.88	4.36	1.770	89	0.025
Post-test **Effect size value**	90 0.98	13.16				

*P> 0.05

The t-test results showed that statistically, there was a significant difference in the pre-test and post-test scores of student teachers in the concept of forces (t (89) = 1.770, p>0.05). Thus, the null hypothesis was rejected. Further, the effect size value (d = 0.98) suggested a high practical significance of the p-value in terms of the differences between the mean scores of student teachers in the pre-test and post test.

- **Research Question 3: How will the use of ICT-based teaching strategies improve the performance of student teachers in the concept, Energy**?

The scores distribution of respondent student teachers in the pre-test and post-test on energy is presented in Table 8.

Table 8: Pre-test and post-test performance of student teachers in the concept of energy

Score	Pre-Test Freq (%)	Post Test Freq (%)
1 – 4	23(25.6)	0
5 – 8	54(60)	3(3.3)
9 – 12	12(13.3)	32(35.6)
13 – 16	1(1.1)	41(45.6)
17 – 20	0	14(15.5)
Total	90 (100%)	90 (100%)

As evident in Table 8, none of the respondents scored below 5 in the post-test, in contrast to the pre-test which recorded a total of 23 respondents attaining scores between 1 and 4. Twelve student teachers had scores between 9 -12 in the pre-test, but this number increased to 32 in the post-test. Whereas only 1 person scored above 12 in the pre-test, 55 participants recorded scores above 12 in the post-test. The mean pre-test score was 8.28 and this increased to 15.72 in the post-test. The entire breakdown of respondents' performance is seen in Table 15.

Testing of Hypothesis 3

Hypothesis Three:

- H_{03}: There is no statistically significant difference between the pre-test scores and post test scores of student teachers in the concept, energy.

The independent sample 2-tailed t-test was used to test hypothesis 3 at p-value of 0.05 and the results are provided in Table 16.

Table 9: T-test results on pre-test and post-test performance of student teachers in the concept of energy

Compared Group	N	Mean Score	S.D	T	d.f	p-Value
Pre-test	89	9.46	4.53	1.686	88	0.028
Post-test	89	14.72				
Effect size value	1.16					

*P> 0.05

From Table 9, it is seen that there was a statistically significant difference in the scores attained by student teachers in the pre-test and post-test in the concept, energy (t (89) = 1.686, p>0.05). Therefore, the null hypothesis was rejected. Further, the effect size value (d = 1.16) suggested a high practical significance of the differences in the pre-test and post-test mean scores of the respondents.

Testing of Hypothesis 4

Hypothesis Four:

- H_{04}: There is no statistically significant difference between the overall pre-test scores and overall post-test scores of student teachers in the three science concepts under study.

The independent sample 2-tailed t-test was used to test hypothesis 4 at p-value of 0.05 and the results are provided in Table 10.

Table 10: T-test results on overall pre-test and post-test performance of student teachers in the selected science concepts

Compared Group	N	Mean Score	S.D	T	d.f	p-Value
Pre-Test	90	8.89	4.64	1.701	89	0.001
Post-test **Effect size value**	90 1.10	14.03				

*P> 0.05

From Table 10, the t-test conducted shows that there was a statistically significant difference in the overall pre-test and post-test scores of student teachers in the various concepts under study (t (89) = 1.701, p>0.05). Thus, the null hypothesis was rejected. Further, the effect size value (d = 1.10) suggested a high practical significance of the differences in the mean scores of the student teachers in the pre-test and post test.

Testing of Hypothesis 5

Hypothesis Five:

- H_{05}: There is no statistically significant difference in the post-test performance of student teachers in Matter, Forces and Energy.

Table 18 gives the summary of the ANOVA conducted to test null hypothesis five.

Table 11: Results of one- way ANOVA on performance of student teachers in the three concepts after the intervention

Compared Group	N	Mean Score	S.D	F	d.f	p-Value
Matter	90	14.21	1.40	0.001	88	0.658
Forces	90	13.16	1.43			
Energy	90	14.72	1.31			

*P> 0.05

ANOVA analysis was performed on the mean post-test scores of student teachers in the concepts of Matter, Forces and Energy. The results indicated no statistically significant difference (F (2, 88) = 0.001, p = 0.658) in the performance of student teachers within the three science concepts (Matter, Forces and Energy). Therefore, the null hypothesis was not rejected. This implies that in actual fact, there was no statistically significant difference in terms of the performance of student teachers in these three concepts after the ICT-based intervention. However, the overall mean scores of student teachers in Matter which was recorded as 16.88 was higher than the mean scores in Forces and Energy which were recorded as 14.16 and 15.72 respectively. This suggests that student teachers performed most creditably in the tests on Matter, followed by Energy.

DISCUSSION OF RESULTS

Influence of ICT–based Teaching Strategies on the Performance of Student Teachers in Science

The observation that ICT usage led to an improved performance is noteworthy. It proves that instructors can leverage on such resources to effectively teach abstract science concepts. It also lays credence to the fact that, it is possible to make use of virtual resources as a substitute for inadequate or unavailable resources for undertaking practical science lessons (Westera, 2015).

In particular, the use of simulation videos and pictures helped to ensure detailed explanation of abstract aspects of the concept forces and energy. In the present study the use of a video explanation the real-life Application of Newton's Laws of motion, helped to improve the respondents' conceptual understanding of net forces and the concept of inertia. This ultimately translated to improved performance in the post-test. Unsurprisingly, 86 out of the 90 respondents indicated that they had gained better conceptual understanding in various concepts after the ICT-based intervention (as revealed in their responses to the questionnaire). Chabalengula et al. (2012) also found out that the performance of students in energy improved after an ICT-based intervention was introduced.

In relation to the concept of matter, a comparison of the responses provided to the questionnaire before and after the intervention reveals a vast improvement in the level of their (student teachers') conceptual understanding. For instance, the number of respondents who understood that all atoms are not the same increased from 23 (prior to the intervention) to 60 (66.7%). With regard to item 3 which demanded respondents to provide the name of any phenomenon that confirms the particulate nature of matter, the percentage of respondents that exhibited comprehension of the concept, increased from 11.1% to 44.4%. Out of the three concepts, student teachers performed best in matter. This tends to suggest that the theoretical approach to teaching the concept was a bane to students' understanding of the concept. Considering the practical nature of science, teachers must refrain from teaching it theoretically or adopting the lecture method of science teaching (Yeboah et al., 2019).

This particular intervention was devoid of the use of science equipment or reagents that have been suggested for use in teaching these concepts to student teachers as enshrined in the new curriculum for teacher education. However, the ICT resources still played a crucial role in ensuring that concepts were thoroughly treated and understood. Agarwal (2013) and Goel (2003) recommended that ICT usage should be integral in the school system.

Notably, the improved performance was recorded after a similar improvement in the conceptual understanding of student teachers. This observation is in line with that of Rittle-Johnson et al. (2001) and Vosniadou (2001) who stated that improvement in conceptual understanding ultimately enhances the academic output of learners. It is important for stakeholders to pay critical attention to an enhanced role of ICT in teacher education. Funds must also be allocated to the purchase of ICT resources for usage by lecturers.

Halim et al. (2014) found out that the concept of forces was one of the science concepts which student teachers found most difficult to understand. The findings of the present study tend to suggest that adequate training of teachers on how to identify and make use of appropriate ICT resources can be an effective panacea to this phenomenon.

Based on the results of the study, it is evident that a number of respondents still recorded low scores in spite of the intervention. A number of reasons can account for this observation. Because ICT usage has a limitation in terms of the extent to which students can interact with teaching and learning resources, teachers must supplement the usage of ICT resources with other teaching approaches such as use of realia, practical activities and collaborative learning (Olawale, 2013; Vosniadou, et al, 2005). This will help to address the challenges of students who are slow learners or have varied learning challenges. Whilst teaching the concept of energy, simulation videos were used to explain energy transformation. Further student teachers were tasked to complete worksheets on the LMS about the concept.

Finally, student teachers were shown PowerPoint lessons containing images depicting energy usage, transformation and conservation. The cumulative effect of the usage of these three strategies was the increase in their mean score from 4.14 to 7.86. Anderman et al., (2012) indicate that the use of different strategies to teach the same concept boosts students understanding and performance. In their daily teaching based on ICT, teachers must avoid using only one ICT mode. Different approaches help to address the diverse needs of students and promotes deeper understanding. Using varied ICT resources also consolidates the gains made by students.

The important role of teachers in the attainment of students' learning outcomes is well documented (Ell & Grudnoff, 2013). Thus, it is imperative for our universities and colleges of education to train teachers who are well-equipped to nurture a new generation of globally competitive Ghanaian school graduates. Therefore, the problem of poor performance of student teachers requires urgent attention. The present study has provided evidence to show that the effective use of ICT by educators can help ensure better learning outcomes, thus contributing to the effective training of student teachers as noted by Desimone et al. (2002).

Limitations

Particularly there are several limitations that characterise action research as a research design for effecting desirable changes within a given environment irrespective of its advantages (Edwards, 2010). A key limitation associated with action research is that since the researcher is evaluating his/her own performance, an element of bias might be exercised in several ways during selection of respondents, data gathering or writing of the final report.

In trying to overcome this limitation, Norasmah and Chia (2015) advocate for teachers to involve their colleagues more actively in data gathering and in the implementation of the intervention. In order to eliminate researcher bias, the researcher employed the services of a colleague science lecturer to administer the intervention and also to gather data through the use of tests, questionnaires and interview guide. Nevertheless, the researcher might have unconsciously exhibited a little bias in the write-up of this thesis. Additionally, 3 out of the 93 student teachers in the class were not involved in the study, due to lack of punctuality and this might have had a slight effect on the data gathered.

Iliev (2010) identified possible methodological limitations in action research with regard to data gathering. Even though the research subjects were at liberty to opt out of the study at any stage, the fact that the researcher was their science teacher might have compelled some of them who would have liked to opt out to refrain from doing so, for fear of victimization. Some of the respondents might have hesitated in providing responses to some questions for fear of revealing their weaknesses to the researcher even though he was not directly involved in the administering of the intervention or the conduct of interviews. In order to address this limitation, the researcher assured them (respondents) of anonymity and confidentiality of their responses.

Recommendations

- Since student teachers are prospective basic school science teachers, science educators must put in place measures to equip them with the relevant ICT skills needed to apply ICT usage effectively in science teaching. This can be done by assigning learning tasks to student teachers that require the use of ICT based resources or approaches such as online researches, preparation and upload or submission of Videos for explaining various science concepts, preparation and delivery of PowerPoint presentations, use of online platforms for submission of class tasks etc.
- Concerned stakeholders such as the Ministry of Education, the Principals of Colleges of Education and Ghana Tertiary Education Commission must ensure the provision of ICT resources such as Laptops, projectors and internet connectivity in all the institutions concerned with the training of teachers for our basic schools.
- Educators in the Universities and Colleges of Education should be made to undergo professional development sessions on the effective utilisation of ICT resources in the training of their student-teachers as captured in the national teacher education curriculum framework.

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