The Impact of a Proposed Science Curriculum based on Digital Technologies on Students' Achievement and Motivation towards Learning Science

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Abstract

The aim of many educational programs is to integrate digital technology education into all educational schemes. The goal of this study is to figure out whether using digital technology has an effect on learning chemistry subjects in schools. On top of that, this study focuses on researching the motivations for studying chemistry by employing digital technology. The study sample comprised 60 students from 7th grade in public secondary schools. One out of the two classes were used as the experimental group, while the other was served as the control group in a pre-and post-test quasi-experimental design. Traditional teaching techniques were primarily being executed in the control group, whereas digital technology-based teaching was focused on by the same teacher in the experimental group. A post-test was given to evaluate the degree of learning outcomes and accomplishment at the completion of the curriculum content. An in-depth questionnaire survey was also administered to get a good idea of how interested students are in using digital technology in their scientific learning education. Based on the findings, it was observed that the experimental group had a higher average success rate and higher learning achievement. The students in the experimental group showed higher motivation to learn science using digital technologies. The use of digital technology is an excellent method for active learning that both supports and increases academic accomplishments. This study will add to a small amount of previous research in this area by contributing to the limited number of studies that evaluate the efficacy of integrating digital technology in the teaching and learning process.

Keywords

Digital Technologies, Learning Chemistry, Students’ Motivation, Experimental Design.

Introduction

The concepts of technology and education are prominent issues especially accelerating in the current 21st century. This is due to the reason that in many nations, technology has now replaced the roadway as the method of transmission of information. Today, technology integration has undergone transformations that have revolutionised our society and how people think, perform, and live (Ghavifekr & Rosdy, 2015). In order to better prepare students for living in a knowledge-based era, schools, as well as the rest of the educational institutions, must include technology integration in their teaching syllabus (Young, 2011). The integration of computer-based networking that integrates into everyday classroom educational practices is referred to as the adoption of information, communication, and technology (ICT) in the teaching and learning process. Teachers presently play a critical role in utilising ICT in their everyday lectures. This is because the advancements in information and communications technology have provided us with highly collaborative and innovative teaching and learning environments (Chakraborty et al., 2018). The purpose of the integration of ICT is to enhance and raise the instructional effectiveness, convenience, and cost-efficiency of instructional teaching while also connecting virtual learning communities that are prepared to deal with contemporary globalized issues (Ghavifekr & Rosdy, 2015).

Integration of digital technology is not a simple procedure but an ongoing and continuous practice that supports education and learning resources (Afshari et. al., 2009). Technology-based teaching and learning processes that reflect the integration of educational technologies are often referred to as ICT integration in education. Students are acquainted with technology; therefore, it is best for them to study from the inside of a technology-based setting. The inclusion of ICT in the school's environment, especially in the classroom, is therefore crucial. ICT (or any other form of technology) may result in a successful learning process that incorporates the assistance and adoption of various ICT features and functionalities (Heitink et. al., 2016). It is absolutely accurate to state that nearly all areas of topics' origins originate from mathematics, science, languages, the arts, and other prominent disciplines. ICT also offers supportive resources for teachers and students wherein successful learning is a focus; they include computer-assisted learning (CAL) to meet those goals (Gilakjani, Ismail & Ahmadi, 2011). Teachers, however, cannot replace computers and technology as a complement to the teaching profession. Some teachers, however, see complements as an addition to the teaching and learning process rather than as a necessity. The implementation of ICT in education is important for the reason that, with the addition of technology in educational practice, both teachers and students may engage in teaching and learning even if they are away from one another.

ICT may be adopted in many settings to improve the process of teaching and learning, helping both students and teachers to become more knowledgeable in various academic subjects. Technology-based teaching and learning provide a number of fun and fascinating methods to approach education, including the use of instructional films, motivation, data management, databases, brainstorming ideas, guided exploration, music, and the World Wide Web (www) (Ismail, Jogezai & Baloch, 2020). Students would as well profit from ICT integration since they do not have the syllabus and tools they have to contend with when studying. Such hands-on experiences are used to assist students in getting a grasp of the topic in technology-based education. Additionally, teaching methods that use effective, innovative, and engaging techniques allow teachers to create instructional strategies that culminate in students' student active engagement. Preceding studies showed that the integration of ICT in education would increase the students' learning skills while simultaneously boosting their ability to utilise active learning strategies (Shaaruddin & Mohamad, 2017; Canaleta et. al., 2014; Wang, 2015; Keengwe & Onchwari, 2011).

ICT plays a key role in helping students improve their logical knowledge in science and maintaining their progress in the study since technology has a great effect on the learning process and the material that goes into creating good learning practices when using learner-centred methods and creating learner-centred learning opportunities (Al-Rsa'i, 2013; Skryabin et. al., 2015).

ICT chemistry experiments may be helpful for facilitating scientific learning by providing both cognitive and practical information. For the most part, students are taught to remember formulas and basic information as a preparation for them to sit for tests without gaining a greater grasp of the underlying ideas and rules that connect the many chemical elements (Su, 2011). In addition, misconceptions about chemistry and other opposing views hold down effective learning outcomes (Ayyildiz & Tarhan, 2018; Lucariello & Naff, 2013). The primary aim for chemistry teachers is to enhance students' comprehension of chemistry ideas and practical abilities instead of just imparting lower-level chemical information (Blonder et. al., 2013; Blackie, 2014). Many teachers have investigated techniques for incorporating multimedia into the classroom teaching strategies (Banister, 2010; Wu et. al., 2013; Yang & Baldwin, 2020) to help students accomplish their learning outcomes (Smetana & Bell, 2012; Rutten et. al., 2012; Scalise et. al., 2011). It is often said to be the result of students' lack of comprehensive understanding of scientific learning, as well as common misunderstandings and fallacies (Su, 2011). We utilize ICT in our experimental chemistry class to aid students' curiosity and learning. The ICT program provides an excellent foundation for students to explore innovative information and promote professionalism. There is an inverse relationship between the learning motivation and performance of students as well as the readiness of their course materials (Serdyukov & Hill, 2013; Sun & Chen, 2016, Razak & Alakrash, 2020). This explains why it is crucial for teachers to have an excellent and well-planned schedule of ICT chemistry projects.

New learning techniques are required in the wake of fast global changes due to the advancement of digital technologies. They will ultimately dispense with the conventional teaching method in favour of ICT-driven learning experiences. With the introduction of this new kind of ICT-integrated environmental teaching and learning strategies, the students will have more freedom while doing environmental functional chemical studying without the need to be in the experiment lab. Relative to the rapid growth of ICT, education systems have a lot of room for improvement. Developments in teaching resources affect the priority of learning since digital ICT tools are capable of transducing two-dimensional concepts into three-dimensional concepts. To engage students, our ICT learning activity design has got them to participate, from single to many technological advancements. ICT experts should develop cognitive learning strategies for the successful use of ICT tools. ICT-integrated knowledge and individual manipulations are all that is required to master any amount of knowledge. The learner can interpret current information layouts, actively pursuing functional learning and the practice of knowledge while constructing IT-mediated relationships promoting intelligent learning and practise (McQuiggan et. al., 2015, Alakrash, 2021). ICT with innovative scientific understanding will be applied in the age of information technology. This study aims to facilitate new scientific discoveries and instructional uses of ICT learning in order to meet educational goals for learning chemistry. Designing the experimental chemistry method incorporates instructional tools that could be Flash Animations, coupled with experimental equipment and multimedia technological advancements such as audio and visual arts. There are many distinct subprocesses involved, in which we use innovative ICT materials to help students develop a better understanding of content, as well as better communication involving teachers and students.

The Current Study

The current study seeks to answer the following research questions

1. What is the impact of using digital technologies on seventh-grade students' learning chemistry?
2. What is the level of motivation towards using digital technologies in learning Chemistry?

Methodology

In this case, a quasi-experimental approach was used. Questionnaires use a variety of parameters to measure various aspects of student learning performance, and then statistical analysis is done to assess learning performance and attitudes. The research is done through four stages: before testing, primary classroom instruction, post-test assessment, and questionnaires. It is anticipated that all study techniques, including before testing and post-test checking, classroom research, self-reflection surveys, and statistics on students' problem-solving skills and improvement, would enhance students' competence for critical thinking and allows students to become more efficient.

For ease of discussion, 60 students from an Arab international school in Malaysia (Future steps school) were chosen to participate in this experimental study. The students were split into two groups, each of which comprises 30 students in the second academic year of the year 2020-2021. The experimental group consists of 30 participants, and the teaching methods combined with digital technology are used to instruct the group. In group 2, in which all participants are in the control group, is instructed to use conventional teaching techniques without the use of any digital technology. As seen in the following discussion, the similarities and differences of two groups of students who received 30 hours of the nine-week ICT-based chemistry program coursework throughout the duration of the academic year have been highlighted. Through our ICT-integrated environmental learning framework, we conduct statistical terminology, including such "Control variables", "Dependent variables", "Independent variables", and "Covariate variables". (1) Control variables: Crucial to reducing distraction and obtaining accurate experimental findings, these parameters must be controlled. Involving the same teacher, incorporating the same material, as well as the same teaching hours, and using the same assessment methods reduce the differences in our study. (2) Dependent variables: When teaching experimental research methods, it is mandatory for students to write, analyze, and deliver their experimental reports. Teachers use performance in exams to see how much progress their students have achieved. Another option is to give a questionnaire in addition to administering achievement tests in order to measure the students' learning attitudes. (3) Independent variables: Personal data such as student enrollment, attitudes toward technology, and regularity of ICT adoption will be addressed, as well as group divides such as experimental and control groups. As the main control variable before each unit, the teacher will conduct pre-tests on students' performance.

Seventh-grade students' units of atoms, elements, and the periodic table were assessed in pre-test and post-test. Five prominent chemistry academics reviewed the proposed test structure. Cronbach's technique was used to evaluate the validity of the test. The internal consistency of the entire questionnaire and subscales was measured using Cronbach's coefficient. The pre-test and post-test coefficients were over 0.70. In order to document the changes in achievement and to identify disparities, the identical test was used for both the pre-test and post-test. 30 questions are included in the questionnaire for measuring students' learning motivation. Likert scale is often used (1=strongly disagree, 2=disagree, 3=neither degree nor disagree, 4=agree, and 5=strongly agree).

To increase the validity and reliability of the material, we engaged with two science educators, two science philosophers, and two educational psychologists to provide professional advice and evaluate the preliminary and updated versions of the survey. Construct validity refers to the factor analysis evaluation of 25 pre-tests. The initial factor analysis findings for the KMO data (0.906) and 2 data (3363.094) of the Bartlett spherical study (degree of freedom 435) are substantial. Thus, they are considered acceptable for factor analyses. The accumulative explanatory variation of 60.759% from the original Eigenvalue is more than 1.0. In all instances, Table 1 displays statistical data, including averages that are omitted, scale variance, and adjusted item-total correlations. It can be observed that if any item is removed, the dependability coefficient changes after Cronbach's. We understand that these things should not be deleted. Each thing has been fixed. The correlation between the items and the total is higher than 0.440. The greater the consistency of each item between its initial relationships with the rest, the greater correlated a coefficient gets. All information gathered before and after the courses is properly documented, and some statistical analysis is performed using the SPSS 23.0 Windows programme. Due to the sample sizes in the groups are small, the Mann–Whitney U-test, a nonparametric technique, was employed in this research to contrast pre- and post-test results. Nonparametric techniques are particularly suitable when sample sizes are small, like in this case (Whitley & Ball, 2002).

Results

1. Technology-based Curriculum Experiment

i. Pre-test Analyses

In order to demonstrate the substantial differences between the mean of the class in the pre-test, SPSS 22.0 was utilized for the study since the independent t-test formula produces significantly different results. This is much more relevant since the rejection of the null hypothesis requires procedures to be performed to test credit risk and for R-squared to be equal to 0.05 and df =48. (2.021). This is so because rejecting the null hypothesis suggests that there is a distinction between the two sample means. When the hypothesis is supported, there is a significant difference between the groups in terms of the means.

Table 1 Pre-test results of experiment one

	Group	N	Mean	SD	S. Error	U	Sig
Pre-test	Control class	30	3.30	17.67	2.41	29.698	.000
	Experimental class	30	3.50	2.463	2.22		

The table above indicates that there is a statistical difference between the two groups. The control class has a mean of 30.3 with a standard deviation of 17.7, whereas the experimental classes have a mean of 32.5 with a standard deviation of 2.4. The findings from this study do not reveal any notable difference between the two groups before the pre-test. The results, therefore, show that the alternative hypothesis is accepted, and the null hypothesis is rejected.

ii. Post-test Analyses

In order to demonstrate the significant differences between the mean of the class in the pre-test, SPSS 22.0 was utilised for the study since the independent t-test formula produces significantly different results. Steps should be conducted to verify the validity of the null hypothesis and ensure that results are close to 0.05 and df=29 (2.021). It is another way of saying that the observed difference between the means indicates there is a difference between the classes. Reversing the hypotheses implies that the two classes are the same when it comes to their means.

	Group	N	Mean	SD	S. Error Me	U	Sig
Post-test	Control class	30	32.30	2.639	2.41	83.698	.000
	Experimental class	30	39.50	2.459	2.22		

The table above illustrates a large statistical difference between the two groups, with the control class mean being 32.3 with a standard deviation of 2.63 and the experimental classes mean being 39.5 with a standard deviation of 2.46. This indicates that the two groups diverge greatly in the post-test. This explains why the null hypothesis is rejected and the alternative hypothesis is accepted. The substantial difference in mean scores between the two groups shows that students acquired a better understanding of the Unit of Atoms, elements, and the periodic table via the use of digital technology. As a result, the integration of digital technologies in learning technology has been shown to be beneficial.

Students' Motivation to learn Chemistry using Digital Technology

Pre-test Analyses

In order to demonstrate the substantial differences between the mean of the class in the pre-test, SPSS 22.0 was used for the study since the independent t-test formula produces significantly different results. This is much more relevant since the rejection of the null hypothesis requires procedures to be performed to test credit risk and for significance to be equal to 0.05 and df =48. (2.021). This is so because rejecting the null hypothesis suggests that there is a distinction between the two sample means. When the hypothesis is supported, there is a significant difference between the groups in terms of the means.

	Group	N	Mean	SD	S. Error	U	Sig
Pre-test	Control class	30	3.30	.967	2.41	29.698	.000
	Experimental class	30	3.50	.463	2.22		

The table above indicates that there is a statistical difference between the two groups. The control class has a mean of 3.30 with a standard deviation of .967, whereas the experimental classes have a mean of 3.50 with a standard deviation of 2.4. The findings from this study do not reveal any notable difference between the two groups before the pre-test. The results, therefore, show that the alternative hypothesis is accepted, and the null hypothesis is rejected.

Post-test Analyses

In order to demonstrate the significant differences between the mean of the class in the pre-test, SPSS 22.0 was used for the study since the independent t-test formula produces significantly different results. Steps should be conducted to verify the validity of the null hypothesis and ensure that results are close to 0.05 and df=29 (2.021). It is another way of saying that the observed difference between the means indicates there is a difference between the classes. Reversing the hypotheses implies that the two classes are the same when it comes to their means.

	Group	N	Mean	SD	S. Error Me	U	Sig
Post-test	Control class	30	3.30	2.639	2.41	83.698	.000
	Experimental class	30	3.95	2.459	2.22		

The findings of the experiments show that the mean score of the experimental group (M= 3.95) is higher than the control group (M=3.30). This indicates that using digital technologies in learning chemistry increases their motivation to learn Chemistry. The finding indicates that students are highly motivated to use digital technologies in learning Chemistry. Students stated that they like to use digital technologies in learning chemistry, believe that using technology to learn Chemistry is enjoyable, fun, effective and interesting. Students stated they will learn Chemistry using technology more than the traditional way and will look forward to coming to class to work and learn chemistry using technology. On the other hand, students didn't agree that using technology in learning chemistry is a waste of neither to improve their learning process.

Discussion

A large amount of research on chemistry education has shown that many countries across the globe, for so many years, have employed teaching and learning methods that have failed to provide essential learning and personal skills enhancement in chemistry. To be really taught in the present century, people need to be creative and innovative, deep and critical thinkers, as well as capable of collaborating in groups while also being skilled communicators and leaders. Hence, we must design and develop new teaching strategies and approaches that may help students grow the qualities they want to improve. A new teaching method focusing on problem-based learning has recently gained in popularity for cultivating the qualities that lead to effective learning (Magnussen, Ishida & Itano, 2000; Davidson & Major, 2014; Hoidn & Kärkkäinen, 2014; Downing, Ning & Shin, 2011).

Despite the fact that the students in both the control and experimental groups had matching backgrounds, the students in the experimental group performed substantially better when they did the post-test. This final outcome describes the effect of ICT-based learning on students regarding their knowledge in chemistry.

Various resources and learning practices are being provided by digital technology in the field of science education, and students have the ability to complete multiple assignments and activities while maintaining their own understanding. These technologies are designed to create involvement in social, educational atmosphere (Private messaging/Online Chat), as well as the students, particularly social networking sites (Facebook, Twitter, YouTube, Instagram, Snapchat), would benefit from the growing use of the technology (Al-Rsa'i, 2013). In addition to the continuous use of mobile devices, technologies are designed to combat the main barriers which the individuals accountable for the education and the upgrading of scientific ability knowledge among the public (Shwartz, Ben-Zvi & Hofstei, 2005). Digital technology is seen as playing an important part in ongoing learning practices since it allows for easy accessibility to all new information anywhere in the globe, irrespective of geographical or time constraints

(Kalogiannakis & Papadakis, 2017). As a result, digital technology offers an expanding array of tools for handling digital information and make it available to a diverse set of materials that facilitates the digital age (Keim et. al., 2010), making it a crucial resource for people in the communities to grow their intellectual and technical skills and stay consistent with developed countries.

This research found that technology-based teaching and learning leads to better outcomes. Since integrating digital technology tools and equipment are known to help set up an engaging and productive learning environment for teachers and students equally, the school are more prone to utilize them in their teaching pedagogy. This study's findings were supported by Livingstone (2012), who found that students' learning will be enhanced with the use of digital technology in school. Yet, in the majority of these teacher performances, digital technology is shown to assist with classroom management due to the higher levels of attention and cooperation among students. Additionally, this study demonstrated that students would be able to learn more successfully when courses are structured to be more engaging and entertaining. As a result, the participants acknowledged that using digital technology may positively improve the student learning process. According to the results of research conducted by Zhang (2013) on Internet use in EFL Teaching and Learning in Northwest China, teachers have a favourable attitude toward the adoption of the Internet in the educational system; teachers only have limited understanding about Internet use in teaching and learning; Up until now, they are unable to successfully incorporated full digital technology tools into teaching and learning; teachers' understanding of digital technology and network technology is extremely restricted. Similarly, the first two statements were consistent with the results of this study, which found that most of them do believe digital technology incorporation for students in learning is hence beneficial. Due to the fact that students can gain competence to communicate and convey their views and beliefs; digital technology allows students to become extra creative and be more imaginative as their understanding concept would generally expand; digital technology allows students to acquire various skills in learning when they are able to obtain required data and insights.

Conclusion

The aim of many educational programs is to integrate digital technology education and ICT into all education blueprints. The goal of this study is to find out whether utilizing digital technology has, in fact, do deliver an effect on chemistry learning among school students. As well, to research the motives for studying chemistry by adopting digital tools. The research sample comprised 60 7th grade students from an Arab international school in Malaysia. The research employed a pre-and post-test quasi-experimental design, with one out of the two classes were randomly allocated as the experimental group, and the other was set as a control group. The topic was delivered by the same teacher in both classes, in which the teacher used digital technology-based teaching in the experimental group and conventional teaching techniques in the control group. A post-test was given at the completion of each class session to assess the degree of student learning and performance. In addition, a questionnaire survey was issued to each participant to evaluate their desire to use digital tools in scientific instruction, particularly in the subject of Chemistry. The acquired findings indicated that the experimental group's average performance was considerably greater as compared to the control group and that the experimental group had substantially fewer problems related to technical terms and concepts and possessed fewer problems with lack of knowledge compared to the control group. Furthermore, students have a high degree of enthusiasm for studying science using technology. Digital technologies are an excellent active learning strategy that boosts engagement and productivity among learners. This study adds substantially to the few studies that have examined the efficacy of using digital technology in learning and teaching.

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