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Education Technology: Success of Using Technology in Teaching and Learning

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Abstract
This study investigated the hype that is linked with the success of integrating technology in teaching and learning of Biology. Without considering other factors that impact a successful education process, the role of educational technologies in improving educational practices need to be investigated. The current study sought to investigate the impact of incorporating computer technologies on learner academic performance. The study used a randomized controlled trial consisting of three groups, two of which were intervention groups and the other a control group. This investigation utilized one control group and two randomly selected experimental groups of participants (A and B) from a Biology class in an alternative high school. In the first experimental group (A), each student was assigned a laptop, a chrome book, or an iPad which they used without restriction (Unlimited access). In the second treatment group (B), students were assigned tablets, but they remained flat on top of the desk. The control group (C) were not allocated any of these devices. The study took three months and none of the students knew that they were under investigation. Towards the end of the semester, in one of the lectures, students were exposed to a test quiz after the lecture that was delivered in two formats. The first format involved half the participants use laptops with unlimited access while the lecture was underway, while the second group closed their laptops. The test and final scores for their grade in biology class were analyzed and compared. The standard deviation calculated based on their final scores in the Biology class was negative among students who had unrestricted access to technology. This study concluded that unrestricted access to technology may have negative effects on student's performance and graduation rates. Similarly, the use of computers could be detrimental to male students than to female students especially those male students who were enrolled in the school with a very high GPA or score grades.

Keywords: Education technology, technological tools, iPad, Chromebook, Learning Biology, Teaching Biology

1. Introduction

Over the past three decades, the United States has experienced substantive technological advancements that have eminently changed the approaches that are applied in teaching (Gray et al., 2010). In 1984, when the Census Bureau collected the first data on computer ownership and use, only 8% of the country's households had a personal computer. Today, the country has

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experienced more than a five-fold increase in computer ownership per household (Home computers and internet use, 2001). Statistics show that 91% of the computers owned in schools are used for instructional purposes and 98% of these computers have internet access, 15% of them are less than one year old, and 14% are laptops in carts (Gray et al., 2010).

The availability of internet-enabled classrooms and the development of electronic textbooks have led to a rapid increase of web-based curriculum and wireless access to educational materials (Carter et al., 2016). These facilities offer students opportunities to use hyperlinks to access important articles, watch embedded videos, communicate with their instructors, and access the curriculum remotely. However, these devices may be potential sources of distraction in the classroom. As a response, some instructors have banned the use of these technological devices in classrooms and only allowed students to use them for specific instruction purposes (Fang, 2009).

The technological advancements coupled with the availability of internet and Wi-Fi have significantly overhauled the approaches of teaching in both K12 and institutions of higher learning (Murray, 2013). Government policymakers, technology marketing companies, and educational stakeholders have been advocating for an increase in the use of technology in teaching citing its successes in improving learner's motivation and engagement. Indeed, one study depicted that the integration of technology into teaching has far-reaching success (Glance, 2018). Moreover, 74% of educators who participated in an online survey done by Alliance for Excellent Education supported the use of technology in schools as critical to the motivation of learners and a tool of expanding classroom content (Murray, 2013).

However, other studies have demonstrated adverse outcomes associated with the utilization of technology as learning tools. For instance, Carter et al. (2016), realized that students, in an economics class, who were assigned computers recorded low final scores than those who were not. Evidence also suggests that students in the U.S have continued to register low scores on standardized math tests. The study by Salani (2013) argued that this phenomenon is a result of overusing technology, which hampers the development of basic computational skills of learners. The study further contended that students who are overexposed to technology are unable to memorize and automatically recall basic facts in everyday mathematics such as addition and subtraction.

While teachers who have successfully used technology emphasize the importance of computers in teaching, the attitude of science and math teachers towards technology appears to be different. Some have observed that overdependence on technology, especially for middle school students, harms their understanding of basic math concepts and therefore is not an effective instructional tool (Li, 2007). Most teachers who took part in this study indicated that there is no available software that has helped in learning and saving time in teaching or evaluation (Li, 2007).

There is a need to reconsider the relationship between educational technology and teaching. As the discussion above has shown, despite the expansive nature of technology in the world of business, there are many debates on the role of technology in education. ICT has been

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acknowledged to catalyze change in teaching methodologies, approaches, and access to technology. However, Watson (2001), observed that this rhetoric change is associated with the

symbolic function of technology in society, which sits uncomfortably with teachers' professional judgments. Watson conducted a study in educational computing and concluded that technology has yet to find its voice in education. The author suggested that understanding the problems of using information technologies dictates considering more fundamental educational issues especially those that affect the achievement of learning outcomes. Watson further noted that teachers are threatened by the rapid pace of technological changes that affect learning and are unhappy by these changes because many of them focus on what technology can do rather than on what learning can do (Watson, 2001).

Examining the application of technology in teaching and learning in Africa's context, a couple of studies reveal a number of concerns. Turugare & Rudhumbu (2020) for example conducted a study in Lesotho. The study examined the extent to which universities in Lesotho had integrated technology in teaching and learning as well as identify factors that act as challenges and opportunities to effective integration of technology in the universities. Results of the study revealed that the level of technology integration into teaching and learning was overall not quite high. In teaching and learning, the following basic technology tools were being used to support the integration: use of learning management systems, projectors, computers and online activities. Study findings further revealed that limited financial resources, limited investment in new technology, lack of systematic and sustainable approaches for staff development to support effective technology integration were some of the major challenges faced (Turugare & Rudhumbu, 2020).

Another study was undertaken in South Africa. The study investigated the challenges faced by senior secondary school teachers and learners in integrating technology effectively into teaching and learning activities. In-depth and group interviews were conducted with curriculum specialists, teachers and learners. Observations and document review were also used to collect qualitative data. Qualitative data analysis strategies were used to analyse data. The findings revealed unavailable technology policy, insufficient technology equipment, a lack of teachers qualified in technology integration, and maintenance and technical problems as the major challenges affecting the effective integration of technology at school level. Integrating technology effectively requires planning, sufficient time, dedication and enough resources (Ramorola, 2013).

Another study was conducted by Abdullah (2016) in Kenya. The study focused on developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by analysing commonly used external factors. The study found that the greatest challenge in most developing countries Kenya included was the effective ways to integrate technology in the curriculum that would help students to use it.The study recommended that technology should be integrated not as a separate subject, but as a tool to promote learning study skills in the curriculum as part of the daily classroom (Abdullah, 2016).

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While there are challenges faced by the application of technology in teaching and learning, this study intended to examine the success of using technology in teaching and learning of Biology.

2. Methodology

The study employed experimental research design. This utilized one control group (C) and two randomly selected experimental groups of participants (A and B) from a Biology class in an alternative high school. There was a total of 13 students in each group. In the first experimental group (A), each student was assigned a laptop, a chrome book, or an iPad which they used without restriction (unlimited access) for notetaking and all other instructional processes. In general terms, all students in this group were given the responsibility to monitor their use of technological tools. In the second treatment group (B), students were assigned tablets, but they remained flat on top of the desk with the screen facing up. This group was referred to as a modified tablet group and only used them when referring to the e-text related to the content of the lecture. The modified tablet group had the other sites locked. The control group (C) was not allocated any of these devices and was referred to as technology-free.

Towards the end of the semester, participants were assigned to two conditions during a lecture. Half of the students from each of the three groups were selected and exposed to a lecture without using any of the laptops and computers while the remaining half was exposed to the lecture but allowed to use the laptops. All students were then exposed to a test at the end of the lecture. The test constituted of multiple-choice questions and short answer questions. Students took on average 15 minutes to complete the test. The results of the test were analyzed, secured, and compared with the end of semester exams.

This study utilized quantitative data and descriptive statistics in the analysis of data. Analysis of the results was done by comparing the test scores for students who were assigned unrestricted access to computers with those who were not using the one-way ANOVA. To compare the student's outcomes between students who had unrestricted access to technology and those with none, data on the test and final student's score (x), who had a teacher (y) in class period (z) were collected and recorded. These values were subjected to ordinary least squares (OLS) or linear least squares tests to estimate the effects of permitting technology in the student's final score and general performance.

Another type of statistical analysis that was done on students' scores involved analysis based on measures of central tendency that was used to compare the scores of students in classrooms that were assigned technology and those that were not. This entails the calculation of the mean, mode, median, and the percentage of the standard deviation of each group.

3. Results

The study made use of 39 participants enrolled in a Biology class in an alternative high school. The school has the required technological equipment and tools to complete the study such as laptops, and openly accessible internet enabled through a proxy server. The proxy server was able to monitor and save the tools that students used to browse during lectures throughout the

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three months the study was underway. The study enrolled 20 male and 19 female subjects to take part.

Using the one-way ANOVA, the collected data was analyzed with the condition the participants were exposed to treated as a variable between subjects. The condition, in this case, indicates whether subjects were using their laptops during the lecture or had their computers closed. The results for the test demonstrated that students who had their laptops closed performed significantly higher test scores compared to the students who had their laptops open ($F(1,38)+5.00$, $P.<.03$; $F(1,38)=4.38$, $p<.04$ respectively). The results of the final scores in the biology test demonstrated similar trends with students who had unrestricted exposure to computers performed dismally in their academic tasks and test scores. The participants in group A posted a negative drop of 0.18 of a standard deviation, a factor that was not observed in students without technology. The ANOVA analysis demonstrated that the condition (having or not having unrestricted access to computer and internet) had an impact on the final exam scores. Participants with limited access to computers realized significantly higher exam scores compared to students who had unlimited access to the computers and internet ($F(1,20)=6.09$, $P<0.2$; $F(1,20)=10.65$, $P<0.0038$ respectively).

The presented data enabled the researcher to develop critical conclusions relating to the use of technology and student academic performance. The researcher analyzed the proxy data to establish what students who had unrestricted access to computers and the internet were surfing and how this might have impacted their scores on the test and final exam. The log was categorized into content related if the URL of the student matched or was related to the lecture content. All other URLs that were not related to the content of any specific lecture during lecture hours were categorized as unrelated. The time spent on the unrelated task was calculated by determining the overall time students spent online during the lecture periods and dividing it by the time the subjects spent on related and unrelated tasks. In general, the results indicated that, among students who had unlimited access to computers and internet, male participants spent more time online, and browsed more of the unrelated content which subsequently negatively impacted their test scores than female participants. Further all students who only had access to related content, (group B, who had other sites locked) scored higher grades compared to the control group. The chart below demonstrates the mean scores among students who had unlimited access to computers and those without in both male and female participants. The graph demonstrates that males who had unlimited access to computers scored a mean of 69 percent, lower than females with unlimited access. However, the mean for males with no access was higher at 84 percent than females at 82%.

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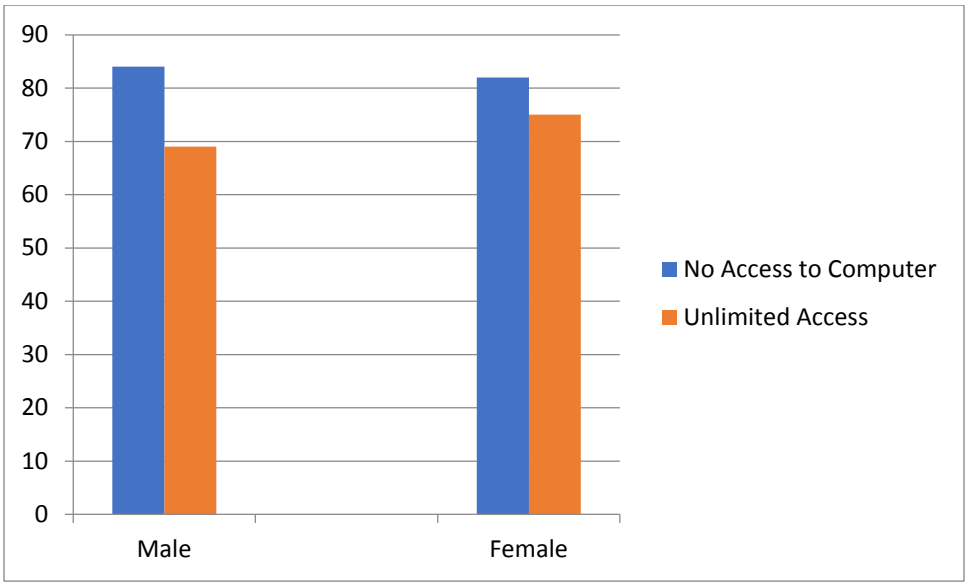

Figure 1 The mean scores among students with unlimited access and those without access to technology in the test

Further, the study showed that five male students who had been enrolled with a GPA of at least 2.7 dropped their GPA to between 1.7 and 2.3. On the contrary, females enrolled with a GPA of 2.7 dropped either maintained or only dropped to 2.3. The results show that male students are more likely to be negatively impacted by the unlimited utilization of technology compared to female students.

4. Discussion

The evidence showed that while students in group A used the computers provided to search up lecture related materials in deeper details, they were also engaging in other unrelated activities such as browsing unrelated content and databases. The results demonstrate that for both the test and the final exam, students who had their attention to lecture related content affected by technology recorded lower grades compared to those who had no technology disruptions. The analysis further demonstrates that students engaged in browsing throughout the semester will score lower grades. This study was consistent with the one done by Carter et al. (2009), which found that computer devices can have a substantial negative effect on academic performance in military students.

The findings of the current study further demonstrate that technologies cannot be shortcuts to successful educational outcomes, and neither can they replace teachers. However, as Toyama (2011) established, technology increases the pedagogical capacity of educational systems; good schools grow to become better while bad schools become worse. While computers have succeeded in engaging students, no technology can provide tailored attention, encouragement, inspiration, or even the occasional scolding for students that teachers can do (Toyama, 2011).

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Ultimately, as the findings demonstrate, allowing unlimited access to technology is likely to negatively impact on the academic performance of the students.

Researchers who disagree with the results of this and similar studies argue that technology might not have been "correctly" used and teachers may not have been adequately trained in how to integrate technology in education. However, it is important to note that a student who is good at basic skills in reading and mathematics will continue being good with or without technology. Such students only need the knowledge on how to maneuver the technology (Cullen, 2018).

Many countries cannot deploy the use of computers to improve the performance of learners. The Organization for Economic Co-operation and Development (OECD) awarded the world an F in terms of using computers as a tool for improving educational outcomes in schools and giving teenagers the digital skills needed in life. This submission was based on a study that was done in Australia which is one of the countries that have heavily invested in educational technology. The results of this study showed no appreciable improvement in student's achievement in reading, mathematics, and science despite significantly investing in ICT. Students who frequently used computers in learning performed poorly even after their social backgrounds and demographics were considered in the study (Glance, 2015).

Another significant literature that supports the findings of the study is the case of North Carolina, which is one of the states that has developed a leading virtual education system in the U.S. Some schools in this state gave their high-achieving eighth-graders in middle school an opportunity to take high school online courses. These students performed much worse, about a third of a letter grade worse than those who took their course face-to-face. Students in the virtual classroom also performed relatively poorly compared to their peers who waited until ninth grade to take Algebra 1 in a traditional classroom. This study observed dismal academic performance in all virtual classrooms. The outcome may be explained by the less developmental capacity of the students to guide themselves in online classes.

The current study was hampered by limited time on the side of researchers and other school programs such as work-based programs and student's absenteeism, factors which might have affected the results. In the future, it is prudent to carry out similar studies for longer periods and to take in to account other factors such as demographics, student's absenteeism, and students with special needs. Since the researcher realized that computers are good for student's engagement and motivation, educators should integrate appropriate learning activities while using technology. There should also be restricted access to computers and the internet for K12 students when performing learning activities. Policymakers, too, should focus on training qualified teachers and advocate for strong administers who are conversant with appropriate educational technologies that are relevant to educational technology.

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5. Conclusion

Some studies have demonstrated that the successes of applying technology in education have been exaggerated (Deardorff, 2016); Li, 2007). The estimate of this investigation observed that unlimited access to technology by students in class lowered the scores by almost a fifth of one standard deviation. However, this does not nullify the important role technology plays in education. Technology has revolutionized education (Murray, 2013). It is through technology that distance learning has been made more available and collaborative learning is made more effective. By only giving computers to students does not change the need for teachers to teach students, neither does it change the need for students to study and learn new skills. They may serve as sources of distractors rather than aid in the learning process. There are reasons why the use of computers and other devices may have led to poor performance in schools. Students may be working on other activities that divert their attention away from class such as surfing the internet, writing emails, browsing social media such as Facebook or even working on class assignments from other classes. Mueller and Oppenheimer (2014) observed that taking notes using computers is less effective than using longhand for successful learning to take place. Multitasking activities during learning tend to affect and lower student's concentration in learning and this case, computers, and other technological devices may act as distractors. They noted that when laptops are used as the only method of taking notes, learning is impaired because these devices result in shallow processing of information. Students with unlimited access to technology and used computers to take notes posted worse performance on conceptual questions than students who took notes by hands (Mueller & Oppenheimer, 2014). Whereas notetaking is a valuable input in learning, students who take notes using laptops tended to transcribe information verbatim rather than processing and reframing it in their own words (Mueller & Oppenheimer, 2014). This is can be damaging in the learning process and may result in lower performance in almost all academic aspects.

While comparing these results with records in the school's registry and admissions office which reflect student's attendance, special needs and other non-academic related activities such as work programs, this study observed that removing technology from learning environment or restricting student's accessibility may improve the quality of education by more than one standard deviation.

This study could not relate its results to a class where technology was strictly used for instruction purposes. Rather, the results obtained from this study related only to students who had options to use computers to take notes. However, it could not establish whether computers led to poor notetaking and that disruption for computers due to surfing of social websites led to lower scores. Given the magnitude of the results from this study and bearing in mind that there is a lot emphasis to use technology in learning, there is a need for further studies to establish relevant mechanisms of using technology in education to achieve profitable results.

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