Psychology Extended Essay

The Effects of Technology in the Classroom Environment on Academic Performance

To what extent does technology in the classroom environment positively affect student's academic performance?

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Introduction

The role of technology when educating students is a source of constant study in an increasingly digital-based world. Indeed, with the development of new technological devices, it is equally as important to determine how they are best implemented in the classroom to avoid their misuse. Students are constantly surrounded by technology, but within the school environment, it is commonly present as a learning tool in the form of individual devices such as computers, tablets, or cell phones. However, some believe that technology may have dangerous consequences on the learning process when used as a multitasking tool. Scientists have discovered that downtime is essential in the creation of memories and that multitasking cognitively strains the brain (Richtel, 2010). Thus, in the classroom technology would negatively affect the creation of memories as well as the development of student's cognitive ability, which is the brain's learning, memory and problem-solving abilities (Michelon, 2016). However, whether psychological studies support or oppose this conclusion provides the research question for this essay: to what extent does technology in the classroom environment positively affect student's academic performance?

To determine the effects of classroom technology on academic performance, multiple psychological studies that investigate the effects of technology and internet usage on the brain will be discussed. These experiments will provide a foundation on technology's wider effects on cognitive ability. Subsequently, numerous further studies focus on the use of technology in the classroom environment and its impact on academic success. Thus, the extent of technology's positive impact on the classroom environment can be identified.

The Effects of Technology on Cognitive Activity

The effects of technology on the physical brain in terms of cerebral activity is still an area of study today. Small, Moody, Siddarth, and Bookheimer (2009) aimed to identify connections between engaging in cognitive tasks on the internet and the resulting brain activation patterns by using MRI scans. They hypothesized that participants who are sufficiently versed with the internet would have impacted cerebral patterns, and the action of searching the internet would result in the activation of specific neural circuits related to "integrating semantic information, working memory, and decision making…" (Small et al., 2009, pg. 117). In the experiment, 24 participants were selected from a pool of 76 volunteers with ages 55 to 78. Participants filled out a survey to indicate levels of internet competency and were divided into two groups in accordance with previous internet ability to analyze the effects of internet usage on individuals with differing internet exposure. While in the MRI scanner, participants would complete two different cognitive tasks to obtain information: reading a book or conducting an internet search. To mimic the cognitive task of reading a book and searching the internet while remaining in the MRI scanner and limiting head movement, the participants viewed the image through goggles and used response buttons to either flip the page displayed on the screen or choose sites on a webpage. MRI scans from each task were analyzed externally and images of the combined brain scans were returned for analysis. The results indicated that the group with more previous internet experience had "...more than a twofold greater spatial extent of activation…" than the group with less prior exposure, specifically in areas of the brain related to making decisions and complex reasoning (Small et al., 2009, pg. 121). Thus, internet usage may be more mentally stimulating

than traditional methods like reading and prolonged experience with the internet may relate to heightened decision making abilities.

However, there are many limitations present in the study due to the small sample size that only represented the matured brain. Thus, the effects of technology usage on immature brains may be different. The use of MRI scanning may also have limited the data since goggles and buttons were used to mimic the cognitive environment of reading and internet searching. In reality, this may not fully reflect the effects of reading on the brain as the use of goggles inhibits the experience of reading a book by introducing a further technological element. Furthermore, the survey used to split the sample into two groups was subject to biases of the participants' ratings of their internet prowess. Moreover, the very nature of the groups limit the study as the difference in cerebral activity may not be due to the differences in internet usage. Those with less of a tendency to use the internet may have held other lifestyle differences that would cause the discrepancy in data. In short, the choice to stay away from technology may not have been the cause of the differing brain activity analyzed in this study.

Technology's effects on human cognitive ability was investigated further through Storm, Stone, and Benjamin's (2016) experiment on the impacts of internet access on an individual's ability to answer questions from memory . The hypothesis was that one's reliance on internet access would be affected by the extent of recent internet activity. Their experiments were constructed in two phases where the experiment and control group had differing conditions in the first phase and the same conditions in the second. In each phase, participants were asked trivia questions and instructed to provide answers as quickly as possible. The purpose of the first phase was to induce a recent internet exposure in the experiment group by forcing them to use the

internet to answer the trivia questions while restricting the control group from any internet access (Storm et al., 2016). Immediately following, the second phase opened internet access to both groups to measure the effects of the experiment group's internet usage. Those with recent internet activity in all experiments were more likely to use internet access despite manipulations to the second phase by adding obstacles to internet access such as slower internet and establishing distance from the participant and the internet source (Storm et al., 2016). Therefore, a history of internet usage affects present decisions to use the internet, such as in the classroom.

Despite the experiment's attempts to lower bias by clearing search history between phases, possible inherent biases can still be identified in the participants themselves. For all experiments, the mean age of university undergraduates was 19 to 21. Therefore, the results only reflected a small age range with similar living conditions. Furthermore, all participants were granted course credits which can serve to influence data collected as some may have only participated for personal purposes. Finally, the largest source of error is in the trivia questions themselves as the very nature of the questions may have appealed more to some participants than others. By using "history, sports, and pop culture" questions, some participants may have known more from memory in a certain subject and would not need to look up the answer on the internet while others who are not invested in such topics would require the internet (Storm et al., 2016, pg. 718). Thus, the usage of internet may vary depending on the participant's personal biases towards the prescribed questions. In addition to experimental data, a Need for Cognition scale (NFC) form developed by Cacioppo, Petty, and Kao (2013) was filled out by participants to analyze the participant's individual tendency to seek cognitive endeavors. The results indicated

an increased NFC in the control group leading one to conclude that personal biases towards critical thinking would have impacted the internet usage as well.

Through both Small et al. and Storm et al.'s experiments (2009; 2018), one can conclude that technology has an effect on cognitive ability. However, Small et al. (2009) determined that technology usage promoted an increase in cognitive stimulation while Storm et al. (2016) focused on the possible negative effects on memory retrieval. Moving forward, understanding that technology impacts cognitive ability, the specific effects of the classroom implementation of technology will be investigated through evaluating studies that both support and oppose its usage in education institutes.

Advantages of Technology Implementation in the Classroom

In an investigation regarding the effects of implementing technology through a digital-based classroom environment, Ozerbas and Erdogan (2016) aimed to determine implications on academic performance as well as the student's individual technological abilities . The experiment was conducted on 58 seventh grade students in Ankara, Turkey where 32 students of one class served as the experimental group and 26 in a separate classroom were the control group. As the independent variable was a 'digital classroom', regional math curriculum was taught using computers for both the students and the teacher and a smart board among other technological devices common in digital classrooms. The control group taught the same curriculum with printed documents without the aid of technology. To analyze the effects on academic success, a test on the material studied was administered before and after the experiment. In a similar manner, Miltiadou and Yu's (2000) "Online Technologies Self-Efficacy

Scale" was used to determine changes to the students' ability to use technology. After a 4-week learning period, the results of the tests indicated an increase in academic performance when comparing the classroom who utilized technology to the control group that used traditional learning methods (Ozerbas & Erdogan, 2016). However, no significant impact to technology self-efficacy was identified. Ozerbas and Erdogan hypothesized that the cause for the rise in academic performance was due to the "concretization of abstract math subjects through the use of computer software" (2016, pg. 209).

Although the experiment maintained an independent and dependent variable through the separation of classes, this also introduces limitations and bias. Firstly, the tests used to establish pre and post experiment academic levels were created by the researchers themselves and was thus subject to their personal biases as to how the mathematics should be applied. Furthermore, the test only contained twenty-four multiple choice questions which may not serve to accurately reflect the student's understanding. Another source of limitation is the fact that only math at the seventh grade level was analyzed which did not provide an adequate scope of the school classroom population. Therefore, the results of this experiment may not be applicable to other subjects. Additionally, no analysis was attempted to determine other possible factors such as parental aid or group activities that may have affected the results.

In continuation of technology's positive effects on learning, Huang, Shadiev, Sun, Hwang, and Liu (2016) explored the implications of introducing technology as a learning aid into junior high classrooms by analyzing the effects of a tablet with an annotation pen on students learning English as a second language . The experiment lasted six weeks with two participating classes. Students' cognitive levels were assessed before and after the experiment to

be compared. Throughout the six weeks, participants from the control and experimental group were assigned three separate topics where the control group completed the activity using traditional textbooks and writing materials and the experimental group used a tablet PC and a digital stylus (Huang et al., 2016). Additionally, the stylus could also record audio, provide an online dictionary, and share notes with other students. The results of the pre and post test scores indicated that the technology implementation did not have a significant effect at the basic level of understanding, but created a difference in performance as the level of difficulty increased (Huang et al., 2016). Huang et al. (2016) attributed the multifaceted platform of the tablet pen to the increased learning of the experimental group; specifically, how the pen served as a visual and auditory platform. Furthermore, students could retrieve and share annotations with more ease in the experimental group than the control group because of the technology. Thus, technology had a major impact on the cognitive processing speed as it enabled the students to learn material to a higher extent in the same given amount of time.

However, there was still many limitations to this study, as the sample size was not substantial for a thorough analysis. Since the control and experimental group only contained 30 and 28 participants respectively, Huang et al. (2016) deemed it necessary to only split the students into high and low cognitive abilities. Thus, in analysis of the data, the lowest of the high level group and highest in the low level group may have had similar scores which provided an obvious limitation to the data. Moreover, the tests used to analyze the student's cognitive levels prior and after the experiment were also not created by an expert in the psychological field. In fact, they were made by a junior high school teacher whose affiliation with the experiment was

not indicated in the paper. Therefore, bias may have been introduced in the creation of the test as the teacher may have formed questions with biases towards certain students.

With the implementation of technology as a support to the learning process comes the introduction of multitasking to the school environment. In some cases, multitasking may serve to enhance the classroom experience as discovered through Wood, Mirza, and Shaw's (2018) experiment. With the hypothesis that off-task multitasking would occur and would correlate with academic performance, the experiment analyzed the off-task activities of 107 participants taking an introductory psychology course. Technology was implemented through three separate 40 minute online demonstrations of psychology labs which students would complete on their individual devices and apply their learning through group work directly following (Wood et al., 2018). Data was collected through four surveys, one taken before the first demonstration and the final three after each subsequent demonstration. The first survey included questions regarding the participant's initial beliefs on technology usage in class while the surveys following demonstrations assessed how time was used during the demonstrations. Observational data was also collected during the final demonstration on 20 random participants by placing observers behind and beside the participants. Notes were taken regarding the duration and on off-task multitasking. The results indicated that although multitasking levels increased with each demonstration, the performance also increased implying that multitasking positively correlates with academic excellence (Wood et al., 2018). However, multiple possible errors in this experiment affect this conclusion.

Firstly, the participants were all aware of the experiment during the demonstrations which may have had an effect on their activity during class. Participants that know they are being

watched act differently than if they were anonymous. As the participants were doing the experiment for course credit, this may also have impacted on the results. The systematic error present in the experiment would also have an effect on the results. Two obvious sources of error were in the survey and the group discussions after the demonstration. As the survey was filled out by the students themselves, it was subject to their personal biases and they may have filled out the form inaccurately to better portray themselves as dedicated students. This would have affected the multitasking data collected for the first two demonstrations by lowering the percentage of off-task multitasking. Therefore, when comparing the data, it would show an increase in multitasking due to the deflated percentages from the first two demonstrations compared to the final demonstration supported by observational data. The second source of error is the inclusion of group work immediately following the multitasking. By introducing another variable, it may turn the causation of increased academic performance from increased multitasking into a correlation. Thus, the group activity may have affected the academic standing as opposed to the multitasking under study.

Negative Effects of Technology in the Classroom Environment

While the positive effects of technology as a learning tool was investigated, other studies concluded that it ultimately served to distract the student from learning which negatively impacted academic performance. For example, another experiment on the effects of multitasking focused specifically on the impacts of instant messaging in the classroom. A survey was developed to identify how university students perceive multitasking through the use of instant messaging and its effects on their academic performance (Junco & Cotten, 2011). Junco and

Cotten (2011) sent out the survey electronically to the emails of four American university populations, received 4,491 responses and analyzed the results. Answers to survey questions were presented as a scale where participants indicated their respective use of technology and how they perceived its impacts on completing their schoolwork. The results indicated that 93% of participants have multitasked schoolwork and instant messaging simultaneously while 57% of participants believed that the instant messaging prevented them from completing their schoolwork (Junco & Cotten, 2011). However, the study indicated that the participants report that other tasks contributing to multitasking did not induce as significant of an impact on academic performance which may infer that multitasking itself was not the cause of lowered school activity. Unfortunately, the experiment does not analyze the reason for this observation.

Despite the inability to determine the effects of other sources of multitasking, the study did attempt to widen the sample by conducting a nation-wide survey, but only 11.4% of those contacted responded. Thus, Junco and Cotten (2011) did not effectively create the wide sample intended which was a definite source of limitation. Additionally, as instant message was the sole variable investigated, the study forgoed analysis of other possible impacts on multitasking. Finally, as the test was developed by the researchers themselves, it was subject to their own personal biases which may have affected the collected data.

An additional study also examined the effects of technology as a distraction in the classroom environment. In Saudi Arabia, Attia, Baig, Marzouk, and Khan (2017) investigated how technology in the classroom is perceived by university students as well as other possible sources of distractions. 265 medical and science university students were surveyed with a questionnaire that rated potential distractions in the classroom. In total, the survey indicated 24

external sources of distraction and 17 internal, or self-induced, distractions and was distributed in classrooms where the students used personal technological devices (Attia et al., 2017). By compiling the survey results, Attia et al. (2017) concluded that the primary source of distraction in the classroom was the student's personal cellular devices. 67% of students identified cell phone use as a distraction and additionally, 21% of those who identified the distraction also found it impacted their ability to learn in the classroom. Thus, the study concluded that technology use in the classroom can negatively affect student learning.

In analysis of the study, numerous sources of error arose through bias and limitations. Firstly, all participants took part in the study through convenience sampling which excluded much of the population and introduced inherent bias in the questionnaire answers. Specifically pertaining to the questionnaire itself, although the study claimed the survey was validated, it did not cite a method of validation. Therefore, bias ultimately came from the identified 'distractions' as all the possibilities were selected previously by the creator of the questionnaire being administered to the students to complete. The reported distractions was thus limited by the questionnaire creator's personal biases as what the participants were able to report was limited to the distractions indicated on the form.

To specifically examine the effects of cellphone usage in the math and physical science classroom, Miah, Hossain, and Rahman (2017) conducted an experiment to determine how they were used by second to fourth year university students. A survey developed by the researchers based off of pre-established literature was administered face-to-face with 130 participants where they were asked to answer 19 questions on a five-point scale regarding the impacts of cell phone usage on their learning. Results indicated that although the cell phone posed some negative

effects, it was overwhelmingly reported as a useful study tool (Miah et al. 2017). Thus, the educational potential of cell phones in the classroom may be a source of development by educational institutions and cell phone companies. However, the study did indicate that students had the tendency to misuse mobile devices in the classroom and proposed that measures should be taken to control how they are used in a learning environment.

Although the results highlighted the positive impacts of cell phones on a student's educational experience, limitations and biases still had an effect on the collected data. Firstly, as the surveys were conducted in person, the responses may have been subject to the biases held by the interviewer. For example, the quality of the interviewer's interactions may have influenced the data collected either way. Furthermore, face-to-face collection of data may have also limited the sample size available as the surveys would have required more effort per person than if it was individually filled out. This is reflected in the relatively small sample size. As all the participants were from the mathematics and sciences department, this added further limitations to the conclusions made through the experiment.

Discussion

Technology's present role in the classroom is becoming increasingly diverse with implementations resulting in differing effects on student academic success. However, the studies analyzed often tend to portray technology as a benefactor or a potentially damaging tool. According to Attia et al. (2017), Junco and Cotten (2011), and numerous other studies, the usage of cell phones in the classroom leads to a decrease in academic performance from multitasking and decreased concentration. However, others like Miah et al. (2017) believed cell phones can be used as an educational tool as opposed to the otherwise strictly negative perspective. Besides cell

phones, other studies investigated the use of other types of technology commonly used in the classroom like computers and tablets. These devices, according to Ozerbas and Erdogan (2016) and Wood et al. (2018), promote a 'digital classroom' environment that stimulates a deeper understanding of the teaching material. Supported with similar experiments, technology seems to positively impact the classroom environment when implemented in an effective manner. Thus, technology's effect on education ultimately depends on how the students utilize technological devices and whether the tools are abused or support their learning.

However, psychologists like Storm et al. (2016) believe that the wider use of the internet as a resource is impacting individual's ability to retain knowledge which would have wide implications in the school environment. For example, Sparrow, Liu, and Wegner's (2011) experiment investigated participants' reliance on the internet to answer trivia questions. They concluded that the internet was becoming a type of transactional memory, which is "a combination of memory stores held directly by individuals and the memory stores they can access because they know someone who knows that information" (Sparrow et al., 2011, pg. 776). The internet is transforming into a form of memory storage and according to Sparrow et al. (2011), it thus prevents the storage of information. In the case of a student, the internet may discourage learning what is taught in the classroom if the internet is relied on to teach the material.

Conclusion

Ultimately, the impacts of technology in the classroom seems to be dependent on how the technology is implemented. In situations where the technology is directly utilized to learn the material, it serves to positively affect academic performance to a large extent. However, when

abused, devices can be detrimental through providing a distraction or negatively impacting multitasking. Thus, in such a way, technology can negatively affect the success of a student.

Yet, the implementation of technology is becoming an increasingly common tool in classroom learning. The potential of technology is indisputable as in all studies, technology did have a significant effect on academic performance, whether positive or negative. Therefore, measures should be taken by school institutions to ensure that technology will be used to support student learning through technology policies or other types of intervention. With the advancement of technology comes the potential to increase the quality of education and it is the duty of educators to utilize technological devices as a tool to support learning through an awareness of its possibility to distract and a knowledge of implementation strategies.

The extent of technology's impact on student academic performance is dependent on how it is implemented in the classroom. Internet access can be both a valuable resource or a source of distraction and thus, it can provide a positive impact to some extent. Moving forward, further psychological study should be conducted to determine superior strategies to implementing technology to ensure that its fullest potential can be utilized to benefit education.

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