

A Study of the Effects of E-learning on the Learning Effectiveness of Students

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Abstract. The introduction of technology into educational settings has become more prevalent in the twenty-first century. This resulted in the emergence of e-learning, which has become the paradigm for contemporary education. The reasons for this increased application of e-learning have been examined through previous research with a focus on the reasons for the implementation and the effect it exerts on students' learning outcomes. This work investigated the motivation of teachers and students in applying technology in education and studied the impact of technology by analyzing its relationship with the inquiry-based learning process. Finally, the learning outcomes from e-learning were evaluated from three aspects: students' participation, achievement, and satisfaction. The incorporation of technology in students' learning is found to have a positive relationship, demonstrating the effectiveness of e-learning in supporting students' learning progression.

Keywords: E-learning; Learning motivation; Technology; Inquiry-based learning; Learning outcomes.

1. Introduction

There has been a large interest in applying technology in the education field during the past decades. The implementation of technology in teaching and learning has proliferated. This change has led to a new learning mode called e-learning. E-learning is the dissemination of knowledge through the medium of electronic communication. As the Internet and telecommunications technology improves, e-learning becomes the paradigm for contemporary classroom instruction [1]. This expanding popularity of e-learning has triggered scholars' interest in understanding the reason for its emergence and its advantages over traditional modes of learning. There has been massive research exploring the motivation for teachers and schools to incorporate technology into the classroom [2-4]. An extensive effort has been put into examining the effectiveness of e-learning on students learning, as seen from three leading indicators: students' participation, achievement, and satisfaction [1, 5-7]. Besides, there is also research that has discovered the relationship between inquiry-based learning and e-learning and found the positive relationship that e-learning has on fostering the inquiry-based learning process [8]. However, there is little research examining the two aspects of e-learning including motivation, and effect, and discovering the link between the application of technology and the process of inquiry-based learning. Moreover, a majority of work were focused on the effect of technology on high school students, lacking sufficient exploration of that on K-12 education. This paper aims to demonstrate the motivation of teachers and students in participating in e-learning mainly targeted at K-12 education, investigate the inquiry-based learning process and discover the merit of adopting technology in encouraging this learning process.

2. Motivation for the Application of E-learning

2.1 Teacher's Motivation for Using Digital Instructional Tools in E-learning

Teachers' motivations for integrating digital instructional tools in the classroom can be grouped into four main reasons: (1) meeting students' needs, (2) increasing students' engagement, (3) increasing their own productivity, and (4) their perceived value toward technology use [2, 3].

Teachers tend to have higher intentions to use digital tools in the classroom when the application meets students' needs. The steady increase in the desire for information in modern society prompts a

huge demand for technology in the digital age, as evidenced by the prevalent use and rapid upgrading of smartphones and digital apps for communication and entertainment. The popularity of digital media has changed people's lives, and it has become an inseparable part of people's lives due to the convenience it brings. People are relying on digital gadgets heavily. Since the majority of information students gather daily is in digital forms, they have developed high digital literacy and learning habits of acquiring knowledge online. Therefore, using digital tools in instruction can be more relevant to students' learning preferences. Students feel more comfortable when lecture content is delivered through digital platforms or with the use of digital gadgets. They can make use of the helpful tools that digital apps provide. For example, the use of note-taking apps, Notability, and Microsoft Office apps, allow the insertion of notes material in multimodal forms, no matter if the notes are videos, diagrams, websites, or audio recordings. Also, direct editing of documents is achievable through these apps. This is time-saving in comparison to traditional note-taking methods. Besides, the "search" option makes information research more straightforward and faster. The above features of digital tools are perfectly tailored to students' needs and increase their learning efficiency. As a result, teachers apply technology during instruction to fit students' needs.

Teachers are motivated to use digital tools because they effectively increase students' engagement. Engagement is characterized as the "work and time that the students devote in their learning community", which may be seen along a continuum of "behavioral, affective, and cognitive" markers [9]. It is molded by the complex interactions of interpersonal connections, educational environments, and learning activities [10]. Students will participate more when learning activities take place in a digital environment as digital learning is helpful in increasing students' motivation to learn. Students are attracted by the visual and audio features that different digital tools provide, enhancing their interest during the learning process and creating tremendous enthusiasm toward the assigned subject content. As a result, a more engaging learning atmosphere is created when teachers incorporate digital tools during instruction. Furthermore, it has been found that incorporating digital gadgets during lessons can increase students' engagement, especially when students have equal access to those devices [4]. The use of digital gadgets results in a change in the learning environment of students and differentiation in instruction. Students learning experiences are enriched and more personalized. Therefore, there has been increasingly attractive for teachers to include digital devices in lessons and use digital instructional tools during teaching as the digital technology potentially enhances student engagement.

Teachers prefer to apply digital tools in teaching as they can increase productivity in lecture preparation and after-class feedback. Their motivation to use technology will significantly increase if they perceive it is advantageous and will raise their productivity [3]. The large database and wide variety of valuable features from digital platforms allow easy and quick access to relevant material for teachers. They will find it simpler to conduct lesson plans and research for teaching materials with the aid of digital technology. Moreover, digital tools provide a platform for effective feedback. Teachers can collect students' performance data from the computer-generated analysis of classroom assessment activities. This provides insight for teachers to better understand students' learning progress and amend their future teaching plans accordingly [11].

Teachers' intentions to use digital tools in the classroom are influenced by their perceived value of technology. A study reveals that "perceived usefulness," "attitude toward technology use," and "facilitating conditions" have direct effects on teachers' motivation to incorporate technology [3]. When teachers believe that technology is beneficial and that using it would boost their productivity, their desire to employ it will increase considerably. Notably, the perceived usefulness and simplicity of its usage made a great impact on their attitudes toward using technology, suggesting that teachers are more likely to adopt a positive attitude toward utilizing technology when it is considered as enhancing productivity and demanding less effort.

Students' motivation to learn through digital learning can be understood from two learning modes: online learning and learning with technology in a classroom setting. The term "online learning" refers to any method by which educational materials and resources may be accessed over the Internet [11].

The latter refers to the employment of technology as an additional way of content delivery and after-class assessments. The three reasons students are motivated to learn with technology is due that technology: (1) reflects their learning progress and (2) promotes better learning experiences; their choices are also affected by (3) their perceived usefulness of technology.

Generally, digital learning tools provide effective feedback, which benefits both teachers and students. Students learning progress can be examined from formative and summative assessments during or after class. This can be easily done with the use of digital platforms, such as Kahoot, a game-based digital learning platform. Students can get instant computer-generated feedback on their learning progress from these platforms, as well as teachers' verbal and written feedback. The effective feedback system allows students to keep track of their progress and improve their weaknesses in subject areas timely [11].

In addition, when technology is incorporated, students will have a better learning experience in both learning modes. In terms of online learning, students can learn at their own pace. They have more independence and a higher level of accountability for their own learning. Students, especially those with higher self-controlling ability, can have a better online learning experience. In terms of learning with technology in a classroom, it can significantly increase students' knowledge in learning because of the collaborative and interactive features of digital tools. Most digital learning platforms encourage collaboration between learners. For example, Google Apps and Microsoft Office Apps both have the function which allows simultaneous editing of users. Students can therefore cooperate with their peers in group work and learn from the work they commonly access. Students' discourse is encouraged, and they have a chance to work together with their classmates. This can empower students' participation and lead to positive experiences in learning.

Students perceived usefulness of technology could affect their motivation to use them for learning. Suppose students perceive technology to be useful and efficient in helping them to pursue their learning goals. In that case, they will maximize their usage of digital tools to achieve a better learning outcome. According to a study, more than eighty percent of respondents who thought "Kahoot" was effective showed an increase in motivation for online learning [12]. In contrast, if students have a negative connotation of technology to education, they will reduce their usage of digital tools in learning. The perception of technology can be affected by students' accessibility to digital technology, learning stakes, digital competencies, and social norms [12].

3. Application of E-learning in the Inquiry-based Learning Process

3.1 Teacher's Role in E-learning in the Inquiry-based Learning Process

During inquiry-based learning, teachers should strive in creating a constructivist learning environment for their students. This means providing students with access to high-quality content, methods for assessing their knowledge and understanding, and numerous exposure chances when confronted with newly acquired knowledge [13]. Teachers can build their learning plans focusing on three aspects: (1) social negotiation, (2) cognitive apprenticeship, and (3) construction of knowledge through scaffolding.

Social negotiation is required to evaluate students' knowledge reserve and exchange their ideas during the inquiry-based learning [13, 14]. Learning is a social process that is actively constructed through social negotiation. Teachers can create interactive tasks aiming at collaboration among learners and teachers. The tasks should promote and encourage social negotiation and offer a set of intellectual tools to facilitate internal negotiation, which is required for the development of mental models [8]. It should be noted that teachers and students are more of a mentor to each other but not a "purveyor of knowledge" during the learning process [8]. Also, the social negotiation process should support collaborative knowledge construction but not treat it as a competition between learners for recognition.

It is also vital for teachers to foster students' practice of learning with the consideration of cognitive apprenticeship. They should aim for activities that provide opportunities for students to construct an

understanding of the world through “doing”, but not simply “knowing” [15]. Students should be immersed in authentic activities, which are activities that demonstrate real-world situations. Besides, the complexity of authentic activities should increase gradually through scaffolding in a manner that allows learners to transition from low-stakes to high-stakes settings as they acquire knowledge. Moreover, the context must be presented to help learners develop within their zone of proximal development [14].

The amount of instruction, which is the level of guidance teachers provide during the inquiry process, is prominent for practical inquiry-based activities to proceed. According to Furtak and Seidel, in the case of science education, there are frequent exchanges of learning responsibility between teachers and students, as students actively construct understanding but do not passively receive information [16]. One learning approach, scaffolding, has been proven to be influencing question-based learning positively [13]. Therefore, teachers' instructions should carefully scaffold students in constructing knowledge. In addition, the design of classroom activities should be appropriate for the levels of inquiry that each task aims for. There are four inquiry levels: confirmation, structured inquiry, guided inquiry, and open inquiry [17]. It is the teachers' role to provide an adequate and appropriate amount of instruction to actively address students' thinking while ensuring effective learning progress suitable for the level of inquiry.

3.2 The Effect of Inquiry-based Learning on Students

The inquiry-based learning can bring students great effect as follows: (1) foster communication and collaboration skills, (2) cultivate their critical thinking ability, and (3) practice problem-solving capability. In the previous section, we discussed the concept of learning from a constructivist perspective, that learning is considered as a social process involving communication between one another. The implementation of inquiry-based activities in the classroom is always conducted as group work. There are frequent interaction and communication between group members during the inquiry process, with rich information exchange among them. This helps foster students' communication and collaboration skills through negotiation and elaboration.

Meanwhile, inquiry-based learning is tested to be effective in sharpening students' critical thinking skills. They have to address questions while doing the research and frequently examine the reliability and relevance of the information. A study found that technology-related and science-related learning reinforced by guided activities designed in accordance with the inquiry-based strategy had a considerable impact on developing critical thinking skills of students in the correspondence courses [18]. Students' capacity to establish connections between claims and evidence is also improved as a result of participation in discussions, thereby enhancing their critical thinking abilities.

The implementation of an inquiry-based learning strategy may aid students in improving their problem-solving abilities. A study found that the inquiry-based learning technique reinforced by metacognitive strategies and the inquiry-based learning method has great potential in fostering problem-solving abilities in pupils [19]. In addition, evidence suggests that inquiry-based learning can help students become better problem solvers by promoting the development of thinking and the creation of flexible, transferable knowledge [20].

3.3 The Effect of Technology on Enhancing the Inquiry-based Learning process

Technology can be a useful tool for teachers to perform their role in an inquiry-based approach. It provides a platform for social negotiation to take place via the learning process. For online problem-based learning, several online instructing platforms like Zoom, Moodle, Microsoft Teams, and Google classroom, are ideal sites for students to communicate with each other. Their discussion and interaction can be encouraged by the interactive features on these platforms: break-out room in Zoom, discussion forum in Moodle, chat features in Teams, and feedback features in Google classroom. For classroom digital inquiry-based learning, technological tools also provide opportunities to enhance students' interaction, for example, the use of interactive features of Kahoot during classroom activities and the collaborative editing features of Google documents during group work.

In addition, digital technology can be an effective tool in promoting the scaffolding of knowledge. For example, Technology enables teachers to adjust teaching material to multiple learning modalities to meet the various requirement from students. Some students gain from the audio techniques of technological gadgets and applications, while others gain from visual features. By understanding students' needs for effective learning experiences as well as their preferences and interests, teachers can provide rich and diverse learning possibilities inside classrooms through the differentiated scaffolding approach.

Digital technology offers opportunities for students to participate in authentic activities. One of the power tools is augmented reality (AR). AR can be effectively included in lessons that require student access to real-life scenarios. It has various useful applications for question-based learning and may be used to accomplish metacognitive learning outcomes, and also, motivational, cognitive, and emotional perspectives of learning. Technology serves the function of expanding student experiences with content, enabling successful skill practice and regular exposure to knowledge in formats that learners find interesting. The use of AR effectively increases students' engagement during the inquiry process, as seen from its visual features and the innovative aspect it provides during students' exploration.

4. The Learning Outcomes of E-learning

Learning outcomes can be understood as students' achievements after a period of the learning process. It can be utilized as a measurement for indicating the learning effect of learners. Learning outcomes include two categories: (1) learning effect, which includes exam results, the duration for completing the schedule, and academic achievement, and (2) learning gain, which refers to achievement, preferences, and satisfaction during learning progress [21]. The following sections will refer to the two dimensions of learning outcomes in measuring the effectiveness of digital learning from students' participation, achievement, and satisfaction.

4.1 Learning Outcomes as Seen from Student Participation

Students' participation, or student engagement, can be defined as the level of participation students have during the learning process. It is of great importance to note that participation does not simply mean presenting in class. It includes learners' active engagement in the classroom activities and continuous address of the cognitive thinking process. A positive learning outcome can be seen from a positive engagement of students. Notably, a positive engagement means the students are, in the first phase, attending the course, and in the second phase, actively following the teacher's instructions and participating in the thinking process. This can be reflected directly during instruction from students' interaction with teachers and their peers or reflected in the form of summative and formative assessments during or after class.

Enhancing students' participation in technology-based learning can result in various short and long terms outcomes [10]. Some short terms outcomes are an increase in content-specific knowledge, enhancement in the skill for higher-order thinking, and increased motivation. Long-term outcomes include improved personal development, life-long learning, and increased participation in the broader educational community. In order to promote better learning outcomes, it is vital to increase students' participation through the effective application of technology in the classroom.

Technology use in class can effectively increase students' participation rate [7]. In Trimmel and Bachmann's research, they found that the use of technology in classroom settings can result in a higher level of participation, increase students' learning interest, and higher motivation for better performance [22]. Similarly, Fonseca et al. suggest that when utilized collaboratively, the technology is capable of achieving a greater degree of direct engagement with the assigned content, hence enhancing academic achievements [23]. A positive relationship was found between the adaptation of technology and students' participation rates, indicating the substantial positive outcomes of applying technology-based learning in classroom settings.

4.2 Learning Outcomes as Seen from Student Achievement

Students' achievements generally refer to their academic achievements, which can be presented in the form of the course grade. A straightforward method of examining students' academic achievement is by comparing students' test results before and after the digital learning process. An increase in test results could imply the improvement of students' mastery of content knowledge, also showing the effectiveness of learning activities and carefully designed pedagogy that explicitly targets students' weaknesses and makes the most use of the available technical tools.

Fonseca et al. provide substantial support that the use of mobile technologies during instruction improves academic achievement [23]. They examine students' performance before and after the use of AR and find an overall improvement in students' performance in comparison to their previous grades lectured in traditional methodologies. They also spot a high correlation between technology and students' motivation. Gulek and Demirtas indicate solid evidence that utilizing technology in the classroom improves student learning and educational results [24]. Through longitudinal analysis, they found that students who are immersed in technology-based programs tended to receive higher test scores and overall GPAs in comparison to non-technology learners. Based on their research with high school students, Drain et al. came to a conclusion that "intelligent use" of electronic devices is favorable for improving academic performance, as evidenced by grade point average and standardized test scores [6]. Specifically, the results discovered that students with much longer time using digital devices for academic purposes outperformed their peers who reported using their devices for other reasons. Therefore, the implementation of effective digital tools and the use of technological gadgets can successfully benefit students in learning progression, thereby reflected in their improvement in academic performance. However, some research also pinpoints the negative connotation of digital learning to students' academic results, which dominate by the misuse of digital gadgets and poor technology competence [7]. Therefore, it is essential for teachers to carefully design course that suits students' needs while providing appropriate guidance in technology use.

4.3 Learning Outcomes as Seen from Student Satisfaction

Student satisfaction can be one of the predictors revealing the learning outcomes of digital learning. It refers to students' attitudes toward the learning experiences, support, and facilities. A higher-satisfied student generally has positive experiences during e-learning [25]. Several factors may influence student satisfaction with e-learning: age, gender, technology competence, and their previous experience of engaging with technology. Some other factors including students' perceived usefulness, perceived ease of use, quality of e-learning courses, and perceived self-efficacy, are also detrimental to understanding learners' satisfaction with e-learning [1]. Understanding student satisfaction is crucial as it reflects the effectiveness of the design of courses and provides insight for improving the curriculum provision under the context of e-learning.

The implementation of technology, especially interactive media, can result in an increase in students' satisfaction. In Herianto and Wilujeng's study, they examined the impact of interactive multi-media for science education on students' satisfaction, relevance, attentiveness, and confidence [26]. It is found that the use of interactive multi-media increases students' satisfaction for learning, with strong positive feedback on students' satisfaction. This result can also support another study by Zhang, who found that students are more satisfied when using interactive multimedia compared to the traditional form of learning [5]. Therefore, using interactive e-learning tools can positively increase students' satisfaction with their learning experiences.

5. Conclusion

The prevalence of e-learning in the current education field of K-12 education can trace back to the simple reasons behind it-- the motivation for the implementation. Teachers are motivated to apply the use of digital technology tools in meeting students' needs, increasing students' engagement, increasing their own productivity, and their attitudes toward technology use can be explained by their

perceived value of technology. The reasons that e-learning can effectively improve students' learning outcomes can also be analyzed from the motivation that it brings to students themselves. Students are encouraged to study using technology as technology reflects their learning progress and fosters better learning experiences. Also, their preference for digital learning can be influenced by their perception of technology's usefulness.

Using technology in class can be reflected in its value on one learning process: inquiry-based learning. By understanding the teacher's role in this process and its effect on students, technology can be an effective medium in encouraging an inquiry-based learning process. This is due to the cooperative nature that digital tools provide and the various features that these tools have in helping the construction of knowledge. Incorporating digital technology tools in learning can effectively increase students' learning effectiveness. These can be valued from the learning outcomes of e-learning from three aspects: student participation, satisfaction, and achievement. Utilizing technology in the classroom efficiently increases student involvement, resulting in a higher level of participation. Due to their increased engagement, there is a significant positive effect of e-learning on students' achievement. This can be reflected in students' academic results before and after the implementation of technology. Besides, students' attitudes toward their study can be increased through the adaptation of technology, mainly due to the support that interactive multimedia provide. Students are more satisfied through learning in an interactive environment. As a result, using technology in learning and teaching can be effective in increasing students' learning effectiveness. To conclude, this study provides a comprehensive examination of the effectiveness of e-learning. It can be a useful indicator when conducting further analysis of the adaptation and effect of technology on education. It provides insight into the factors reflecting e-learning effectiveness while explaining the reasons for the attractiveness of the use of technology for teachers and students. In future studies, e-learning in K-12 education can be more carefully examined in further investigating its effect and practicality. Schools and teachers can also put into consideration expanding student access to these useful digital tools in enhancing students' learning experiences and study outcomes.

References

- [1] Sun Peichen et al. What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 2008, 50(4): 1183-1202.
- [2] Vermette L. et al. Freedom to Personalize My Digital Classroom: Understanding Teachers' Practices and Motivations, in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Association for Computing Machinery: Glasgow, Scotland UK, 2019.
- [3] Teo T. Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education*, 2011, 57(4): 432-2440.
- [4] Harper B. and N.B. Milman. One-to-One Technology in K-12 Classrooms: A Review of the Literature From 2004 Through 2014. *Journal of Research on Technology in Education*, 2016, 48(2): 129-142.
- [5] Zhang Dongsong. Interactive Multimedia-Based E-Learning: A Study of Effectiveness. *American Journal of Distance Education*, 2005, 19(3): 149-162.
- [6] Drain T.S. Grier L.E. and Sun W. Is the growing use of electronic devices beneficial to academic performance? Results from archival data and a survey. *Issues in Information Systems*, 2012, 13: 225-231.
- [7] Rashid T. Asghar H.M. Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations. *Computers in Human Behavior*, 2016, 63: 604-612.
- [8] David H.J. Thinking Technology: Toward a Constructivist Design Model. *Educational technology*, 1994, 34(4): 34-37.
- [9] Bond M. et al. Mapping research in student engagement and educational technology in higher education: a systematic evidence map. *International Journal of Educational Technology in Higher Education*, 2020, 17(1): 2.
- [10] Bond M. Bedenlier S. Facilitating Student Engagement Through Educational Technology: Towards a Conceptual Framework. *Journal of interactive media in education: JiME*, 2019, 2019(1).

- [11] Hattie J. Timperley H. The Power of Feedback. Review of educational research, 2007, 77(1): 81-112.
- [12] Mada R. Anharudin A. How Online Learning Evaluation (Kahoot) Affecting Students' Achievement and Motivation (Case Study on it Students). International Journal for Educational and Vocational Studies, 2019, 1.
- [13] Wiley D.A. The instructional use of learning objects. Agency for instructional technology Bloomington, 2002, Vol. 1.
- [14] Vygotsky L.S. et al. Mind in Society: Development of Higher Psychological Processes. Cumberland: Harvard University Press, 1978.
- [15] Brown J.S. Collins A. Duguid P. Situated Cognition and the Culture of Learning. Educational researcher, 1989, 18(1): 32-42.
- [16] Furtak E.M. et al. Experimental and Quasi-Experimental Studies of Inquiry-Based Science Teaching: A Meta-Analysis. Review of Educational Research, 2012, 82(3): 300-329.
- [17] Bell R.L. Smetana L. Binns I. SIMPLIFYING Inquiry INSTRUCTION: Assessing the inquiry level of classroom activities. The Science teacher (National Science Teachers Association), 2005, 72(7): 30-33.
- [18] Duran M. The Effect Of The Inquiry-Based Learning Approach On Student's Critical Thinking Skills. EURASIA Journal of Mathematics, Science and Technology Education, 2016, 12: 2887-2908.
- [19] Pilten P. Mentiş Taş A. Divrik R. Effect of Inquiry-Based Learning Method Supported by Metacognitive Strategies on Fourth-Grade Students Problem-Solving and Problem-Posing Skills: A Mixed Methods Research. International electronic journal of elementary education, 2021, 13(2): 287-308.
- [20] Scott D. et al. Examining the Efficacy of Inquiry-based Approaches to Education. Alberta Journal of Educational Research, 2018, 64.
- [21] Hsu T.-H. An Investigation into University Students' English Reading Motivation. Journal of Far East University General Education, 2012, 6(2): 98.
- [22] Trimmel M. Bachmann J. Cognitive, social, motivational and health aspects of students in laptop classrooms. Journal of Computer Assisted Learning, 2004, 20(2): 151-158.
- [23] Fonseca D. et al. Relationship between student profile, tool use, participation, and academic performance with the use of Augmented Reality technology for visualized architecture models. Computers in Human Behavior, 2014, 31: 434-445.
- [24] Gulek J.C. Demirtas H. Learning With Technology: The Impact of Laptop Use on Student Achievement. The Journal of Technology, Learning and Assessment, 2005, 3(2).
- [25] Goh C. et al. Students' Experiences, Learning Outcomes and Satisfaction in e-Learning. Journal of e-Learning and Knowledge Society, 2017, 13(2).
- [26] Herianto Wilujeng I. Increasing the attention, relevance, confidence and satisfaction (ARCS) of students through interactive science learning multimedia. Research in Learning Technology, 2021, 29.