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Using Mobile Technology in Student Learning and Advanced Thinking Skills

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Active Engagement; Advanced-Thinking Skills; Learning Effort; Mobile Technology.

Abstract

To meet their learning demands in a university context, students' regular usage of digital technology has raised the need for personalization and diversity. Mobile devices are expanding into the mainstream and giving students more opportunities. Students are at ease utilizing digital technology and rapidly and easily pick up new technology. Students are engaged in their education outside of the typical classroom setting when mobile technology is used. Higher education institutions have recently supported students' usage of mobile technology to foster learning and growth. The educational options offered by mobile technology can help students succeed in higher education. The objective of this study is to examine the relationship between college students' academic use of mobile technology and their superior thinking skills through their active participation and learning efforts. The sample consisted of 656 students from a university in West Java, and the data were analyzed using a structured least squares equation model. The results show that the use of mobile technology in learning directly affects students' thinking skills, in addition to their learning effort and active participation in the classroom. These findings provide valuable information for higher education institutions seeking to introduce interactive and technology-integrated environments.

Kata kunci:
Keterlibatan Aktif; Keterampilan Berpikir Tingkat Lanjut; Upaya Pembelajaran; Teknologi Seluler

Abstrak

Kini, perangkat seluler menjadi alat universal dan menciptakan peluang bagi peserta didik. Pesderta didik merasa nyaman menggunakan teknologi digital dan mengadopsi teknologi baru dengan cepat dan mudah. Menggunakan teknologi seluler dalam pembelajaran melibatkan peserta didik di luar lingkungan kelas pada umumnya. Dalam beberapa tahun terakhir, institusi pendidikan tinggi telah mendorong pembelajaran dan pengembangan mahasiswa dengan mendukung penggunaan teknologi seluler. Teknologi seluler memberikan peluang pendidikan yang dapat meningkatkan pertumbuhan mahasiswa di pendidikan tinggi. Tujuan penelitian ini adalah untuk menguji hubungan antara penggunaan akademik teknologi seluler oleh mahasiswa dan keterampilan berpikir superior mereka melalui partisipasi aktif dan gaya belajar mereka. Sampel terdiri dari 656 mahasiswa dari sebuah perguruan tinggi di Jawa Barat dan data dianalisis menggunakan model persamaan structured least squares. Hasil penelitian menunjukkan bahwa penggunaan teknologi seluler dalam pembelajaran secara langsung memengaruhi keterampilan berpikir siswa, selain belajar dan partisipasi aktif mereka di kelas. Temuan ini memberikan informasi berharga bagi institusi pendidikan tinggi yang ingin memperkenalkan lingkungan yang interaktif dan terintegrasi teknologi.

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INTRODUCTION

The prevalence of digital technology in our daily lives means that the digital generation is growing up and entering schools and workplaces in a digitally rich environment. Technology is gradually becoming a common part of student life in today's online society.[1] The current generation of young people, who have access to educational activities anytime and anywhere, can develop learning methods thanks to the ubiquitous digital technologies at the heart of their daily activities at school, at home, and at work in the community.[2] This generation uses these technologies to interact with others, absorb information from multiple sources, participate in content creation, share information, and opinions, gain knowledge from sources of online education and expand access, and learn in a personalized learning environment using mobile devices.[3] The potential for using digital technology in higher education is based on a variety of learning experiences.[4]

In an ecosystem of digitally rich campus environments, student use of mobile technology in learning has increased exponentially over the past decade.[5] The entire educational community seems to have a firm grip on mobile devices, and these devices increasingly provide a personal platform that facilitates connection with the world. Empowering individuals with mobile technology improves students' preferences for the content and processes of traditional and student-centered learning methods.[6] The diverse interests and needs of learners can be supported by the ubiquitous and multifunctional features of mobile technology, allowing for personalized learning experiences and effective interactions with others.

Student use of mobile technology can contribute to positive experiences both in and out of the classroom. Mobile technology for the individual student has changed the meaning of learning in and out of the classroom, infusing the learning experience with

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[1] Valerie L. Mazzotti et al., 'Secondary Transition Predictors of Postschool Success: An Update to the Research Base', *Career Development and Transition for Exceptional Individuals* 44, no. 1 (2021): 47–64, https://doi.org/10.1177/2165143420959793; Xiao Fan Lin et al., 'Effects of a Contextualised Reflective Mechanism-Based Augmented Reality Learning Model on Students' Scientific Inquiry Learning Performances, Behavioural Patterns, and Higher Order Thinking', *Interactive Learning Environments*, 2022, 1–12, https://doi.org/10.1080/10494820.2022.2057546; Siew Foen Ng et al., 'A Quasi-Experiment on Using Guided Mobile Learning Interventions in ESL Classrooms: Time Use and Academic Performance', *Education and Information Technologies* 25, no. 6 (2020): 4699–4719, https://doi.org/10.1007/s10639-020-10191-7.

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more active and interactive tasks.[7] This includes seeking information, actively communicating with instructors in a large class, learning to use information more interactively, sharing opinions or working with others, creating content conceptualizing, and designing 'a more personalized framework'.

Although student use of technology has shown inconsistent results in academic achievement, mobile technology offers many educational opportunities that can enhance student development in higher education.[8] Student use of mobile technology for learning purposes can create significant opportunities in a variety of situations, such as student-centered learning, personalized learning, directed learning, and student-centered learning to differentiate and collaborate. Mobile technology can also facilitate active participation and interaction in the classroom, active discovery learning, knowledge translation, learning outcomes, as well as attitudes and personal performance.[9]

One of the educational goals of higher education institutions is to improve students' thinking skills through teaching and learning to prepare for tomorrow's society. Analytical, critical, and creative abilities are considered higher-level skills and are highly valued for preparing students for future careers and further academic work. Although the use of mobile technology tends to focus on improving students' academic performance in academic subjects, their higher-level thinking skills are rarely studied in depth. It is uncertain whether background identification improves research on the significant association between students' mobile technology use and advanced-thinking skills, rather than surface thinking skills (e.g., remembering, recalling, and understanding information), in the context of higher education. In this study, we explore the relationship between students' use of technology in learning and their superior thinking skills as learning outcomes, focusing on the role of active participation of students and student effort to learn in the context of higher education.

METHODS

An online survey plan was used to collect data. A model was recruited from a private university in a metropolitan area in West Java. Students were asked to click on a link in the email, which led to the online questionnaire. Respondents are allowed to withdraw their participation at any time during the completion of the online survey. Research data were collected as part of a larger study focused on the quality of higher education. The students voluntarily participated in the study.

In the end, we collected 656 valid answers. For the study, we used subjects with personal technology (e.g. smartphone or tablet). Of the subjects, 306 (67.1%) were male and 150 (32.9%) were female. In the sample, 30.9% (n = 11) were freshmen, 20.2% (n = 92) were sophomores, 18.9% (n = 86) were juniors, and 30.0% (n = 137) is a senior. The students participated in different disciplines: 16.2% studied humanities (n = 7); social

[7] Anne Yates et al., 'High School Students' Experience of Online Learning during Covid-19: The Influence of Technology and Pedagogy', *Technology, Pedagogy and Education* 30, no. 1 (2021): 59–73, https://doi.org/10.1080/1475939X.2020.1854337.

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sciences 20.2% (n = 92); natural science 1.5% (n = 66); 8.9% technical (n = 223); and another 0.2% (n = 1).

An online survey was developed to measure variables in larger studies. The survey has four subsections, including context, student engagement, school characteristics, and technology use. For this study, we adapted the literature from two sections on context and use of technology. We used the survey to gather demographic information, frequency of use of technology for lessons, increased levels of higher-level thinking skills, higher-level thinking skills, and effort learning power of students in the form of variables of interest.

Participants was asked to answer one question: "How often did you use mobile technology (e.g. smartphone, iPad, or Galaxy Tab) during the year recently?" These 8 related factors: (1) find information related to the course content; (2) create a memo after reading the document; (3) prepare a presentation; (4) use files in cloud storage; (5) taking notes for study; (6) communication with the facilitator (eg, answering questionnaires, submitting comments); (7) sharing information or documents; and (8) collaboration (e.g. google docs). Eight sections were developed through a review of the existing literature [67, 68]. Participants responded using a 4-point Likert-style scale, as follows: 1 = never, 2 = rarely, 3 = occasionally, and 4 = often.

A student's academic effort includes the effort a student puts into his or her schoolwork or academic performance. Hours (average) for courses, as an indicator of student effort, are a good predictor of student achievement [64]. To test the academic effort of college students, participants were asked to report the number of hours they studied each week for all of their classes. The two variables are the average number of hours studied per week before and after each week. The items that measure class hours are as follows: (a) "How many hours a week do you usually study before going to class?" And (b) "How many hours per week do you usually study after school?" Response options range from 0 (0 hours), 1 (1 to 5 hours), 2 (6 to 10 hours), and more up to 8 (more than 30 hours per week).

To measure active participation in lessons, we applied four items from the NSSE tool related to one of the standards, learning active and cooperative. This examines the level of student engagement in the classroom and the extent to which they collaborate with other students in and out of the classroom. Based on factor analysis, we accepted four items from the original seven-item scale from the original benchmarks. Items are dealt with in terms of frequency: (1) asking questions in class or contributing to class discussion, (2) introducing a class, (3) working with other students on projects in the classroom, and (4) outside the classroom.

Regarding advanced thinking skills, we adopted four items, namely analysis, synthesis, application, and judgment, from the National Association for Educational Research [69]. Sections focus on student engagement in deep learning. The main question asks the following: "To what extent has your in-depth learning (analyzing, synthesizing and organizing, applying and making judgments) increased by taking courses during the academic year?" The four characteristics of deep learning examined are (1) analysis of an idea, experience, or theory; (2) synthesizing and organizing ideas, information or experiences; (3) applying theories or concepts to real-life problems or new situations; and (4) make an assessment of the value or correctness of the information or argument.

RESULTS AND DISCUSSION

Results

In order to test model fit, we looked at the discriminant validity and reliability of the measurement model's construct validity. As shown in Table 1, the measuring model's factor loadings for each item, internal consistency reliability, convergent validity, and discriminant validity were all evaluated in the study. It was evaluated and found that internal consistency reliability should be greater than 0.70. We looked at discriminant validity and convergent validity (average variance extracted). All of the measurement model's items were significant for their items ($p < 0.05$) and exceeded the advised minimum criterion of 0.4. The criteria for composite reliability and Cronbach's alpha exceeding 0.70 were met by all multi-item constructs.

Table 2 looks at correlations between the various items. The AVE (>0.50) and more than the correlation of that item with other items were used to assess convergent validity. The AVE for all multi-item constructs was greater than 0.50, which suggests that at least 50% of the variance of the indicators was taken into consideration. This requirement was satisfied by all latent items. The correlations between items should be less than their own extracted variance explanations when measuring discriminant validity. Validity can be assessed using cross-loading and the average variance extracted (AVE). The correlation coefficients between a construct and any other construct in the model should be smaller than the square root of the AVE of that construct. Every diagonal value is greater than the correlation between items. Every diagonal value is greater than the correlation between items. The multi-item constructs of the models have adequate discriminant and convergent validities. The measuring model's validity and reliability are supported by all of the outcomes.

Table 1 shows the descriptive findings regarding the measurement model's convergent validity

Develop Item	Cronbach′ Alfa	AVE*	Composite Reliability
Using mobile technologies in academia	0.85	0.88	0.50
Active participation in classes	0.81	0.87	0.63
Learning endeavor	0.78	0.89	0.81
Higher-order reasoning abilities	0.81	0.87	0.64

* AVE=average variant extracted

Table 2 Measurement model discriminant validity

Develop Item	MA	PC	EL	RA
Using mobile technologies in academia (MA)	**0.714**			
Active participation in classes (PC)	0.424	**0.797**		
Learning endeavor (EL)	0.024	0.144	**0.906**	
Higher-order reasoning abilities (RA)	0.259	0.357	0.246	**0.805**

The square root of the AVE for each item is represented by the digits in the diagonal row that are bolded.

Table 3 Results of confirmatory factor analysis test

Develop Item	Loading Factor	Loading Factor Score
Using mobile technologies in academia	Information looking	0.68
	After reading information, making a note	0.74
	Getting a presentation ready	0.77
	Utilizing resources in cloud services	0.62
	Taking notes for academic purposes	0.69
	Having conversations with teachers	0.75
	Distributing information or documents	0.74
	Cooperating get together	0.63
Active participation in classes	Discussions or queries	0.76
	Presentation in class	0.83
	Worked in class among other classmates	0.83
	Spent time outside of class working with peers	0.73
Learning endeavor	Hours of studying for the class	0.91
	Hours of homework following class	0.88
Higher-order reasoning abilities	Improved analytical capabilities	0.75
	Enhanced synthesis	0.88
	Improved decision-making abilities	0.77
	Improved application	0.79

This study examined the structural model after validating the measurement model in order to confirm the links between the items before moving on to test the hypotheses. With 5000 samples, we utilized the bootstrap resampling method. Table 4 displays the findings of the data analysis.

Table 4 includes results, path coefficients, and hypotheses

Hypotheses	Path	Path Coefficient	T-Statistics	Sig.	Conclusions
H1	MA→PC	0.424	10.718	+++	Support
H2	MA→RA	0.140	2.667	++	Support
H3	MA→EL	-0.044	0.781	NS	Support
H4	PC→RA	0.267	5.419	+++	Not support
H5	PC→EL	0.163	2.891	++	Support
H6	EL→RA	0.204	2.667	+++	Support

MA = Using mobile technologies in academia, PC = Active participation in classes, RA = Higher-order reasoning abilities, EL = Learning endeavor; ++ $p < 0.01$, +++ $p < 0.00$, NS = Nonsignificant.

With path coefficients of 0.424 (H1, p <0.001) and 0.140 (H2, p <0.01), respectively, the results in Table 4 show the impact of MA = Using mobile technologies in academia (MA) on Active participation in classes (PC) and Higher-order reasoning abilities (RA). Even though we predict a poor correlation between the two variables, there is only a slight impact of Using mobile technologies in academia (MA) on learning endeavor (EL). H3 is therefore rejected. This suggests that students' academic use of personal technology did not result in more study time; in the absence of this, academic usage of personal technology could increase the effectiveness of learning. As predicted, Active participation in classes (PC) had a beneficial impact on learning endeavor (H5, = 0.163, p <0.01) and higher-order reasoning abilities (H4, = 0.267, p <0.001). Higher-order reasoning abilities (RA) were found to be positively impacted by academic endeavor (H6, = 0.205, p <0.001).

Discussion

This study focuses on the influence of undergraduate students' use of mobile technology on their higher thinking skills through their active participation and learning efforts. As students increasingly use mobile technology for learning purposes, it is important to understand the educational impact of this technology on the student learning experience. This study predicts that students' use of mobile technology in the classroom will benefit their interaction and perception of high-level thinking skills. The results of the PLS-SEM analysis support 5 out of 6 proposed hypotheses: H1, H2, H4, H5, and H6. Our results show that the use of mobile technology for academic work supports the recommendations of our research model regarding mediating students' active participation in learning activities and learning efforts. That is, students' use of mobile technology in learning positively affects their perception of their advanced thinking skills.[10]

Based on the experimental results, several main conclusions emerge. *First*, the positive effect of using mobile technology in learning on active participation in lessons can be understood as students using mobile technology to engage in learning. Actively learn and collaborate with students and teachers in the classroom, as well as retrieve the learning references needed to complete pre- and post-course tasks. This result is consistent with studies showing a positive impact of using mobile technology for active learning participation in academic activities.[11] However, the use of technology in a course does not always guarantee a positive impact on learning and performance.[12] Gunuc explains that the negative relationship between technology use and learning outcomes can be triggered by unreliable technology use or too frequent use of technology can lead to distraction and lack of time for study tasks.[13] The results of this study indicate that students who actively use mobile technology for their academic work are more likely to engage in class, as they are better prepared for classroom activities due to focus focus on using mobile technology.

Second, students' usage of mobile devices in the classroom was a good indicator of their capacity for higher-level thought. According to Qureshi et al., the association between technological engagement and academic achievement is moderated by students' active cooperative learning experiences.[14] The extent to which students perceive themselves to possess advanced thinking abilities reflects their cognitive growth and learning from their educational experiences. When students converse with others, consider their knowledge and information, and use knowledge to enhance their

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[10] Helsi Arista et al., 'Gaya Kepemimpinan Kepala Madrasah Dalam Pembentukan Karakter Religius Peserta Didik (Input, Proses Dan Output)', *Kharisma: Jurnal Administrasi Dan Manajemen Pendidikan* 2, no. 1 (15 April 2023): 38–52, https://doi.org/10.59373/kharisma.v2i1.13; Fitri Susanti et al., 'Pengaruh Kepemimpinan Dan Motivasi Kerja Pegawai Terhadap Kedisiplinan Guru Di Madrasah Aliyah Negeri', *Kharisma: Jurnal Administrasi Dan Manajemen Pendidikan* 2, no. 2 (26 August 2023): 91–102, https://doi.org/10.59373/kharisma.v2i2.14.

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learning experience, the development of their cognitive skills is promoted.[15] Higher-level thinking skills in particular are not successfully correlated with learning outcomes when academic mobility technology use is poorly conceived or shallow. From this vantage point, it makes sense for kids to actively participate in class activities with the assistance of the teacher and peers in a way that encourages involvement as a whole.[16]

Third, academic effort strongly predicts the development of advanced thinking abilities; however, the usage of mobile technology in learning did not predict learning effort in our model. The findings of H3 on the non-significant relationship between learning effort and mobile technology use account for students' evaluations of the usefulness of technology for learning when completing pre- and post-coursework assignments. This finding suggests that students could not understand how using technology for studying is a learning behavior. Therefore, it might be vital to take into account the factors that influence how students use mobile technology for learning, such as how much time they spend studying or trying to enhance their learning results. However, utilizing technology in the classroom can boost students' interest in their academic work and their motivation to learn. Although the association between the use of mobile technology in learning and advanced thinking skills was not entirely influenced by academic effort, we discovered that student learning effort did have an impact on their cognitive abilities. They spend more time learning as a result of this. However, some contend that technology should be used in the classroom with caution because it can be distracting or disruptive, which puts students and faculty members at risk.[17]

The study's findings can benefit academics in higher education. In order to fully engage in the course, students must show that they have advanced learning outcomes. Mobile technology has the potential to be a useful and efficient tool for engagement. Encouraging students to use technology is insufficient. Since many studies have shown that mobile technology may offer richer experiences, which inevitably result in educational success, educators need to rethink their strategy and boost their utilization of mobile technology in the classroom.[18]

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The efficient use of mobile technology for students depends on carefully thought-out learning activities that can encourage active engagement of students in speaking and working with their instructors and peers. The facilitator of the integration of mobile technology, content, and learning objectives is the instructor.[19] To accomplish learning objectives like encouraging students to reflect, think critically, engage in active discussion, and synthesize ideas and information, instructors must effectively integrate technology into their classes. They must understand how to properly use gadgets and how to operationalize the incorporation of mobile technology into their classes. They also need to aid kids in utilizing the technologies.

CONCLUSION

In conclusion, students' usage of mobile technology in the classroom can, either directly or indirectly, predict their use of higher-level thinking skills. They enroll in classes and start studying. The model revealed that structural aspects were significant, suggesting that meditation variables should be included in mobile technologies integrated into lessons to improve the learning experience. This finding could assist educators in creating lessons that make use of mobile devices to enhance the attainment of learning objectives.

Additionally, there are some flaws in this study, particularly in its approach. In terms of the application of the survey method and respondent selection, respectively, this study has limitations in sample selection and sample representativeness. Although we made an effort to gather a sample that reflected the demographics of students at West Java University, we only included volunteers because responses were attracted via school email. Therefore, the probability of coverage and sampling error still exists. Second, data is gathered by self-evaluation. As a result, the results can be very poor at gauging intellect or performance. Therefore, cognitive tests taken from participants in future studies should be evaluated. Additionally, rather than overgeneralizing, care should be taken when interpreting data based on the point of view of discussion and discovery. Further study that takes into account the characteristics of the student sample can overcome this constraint.

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