

ONLINE Learning Satisfaction and Digital Literacy Competence as Predictors of Mathematics Engagement of STUDENTS

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ABSTRACT

This research aimed to determine the influence of online learning satisfaction and digital literacy competence on Mathematics engagement among Grade 12 students who were drawn out from the total population using purposive sampling from private schools in Davao City, Philippines. This study utilized a descriptive-correlational design. In order to collect the relevant data, three adapted survey questionnaires were administered to the respondents to measure the level of online learning satisfaction, digital literacy competence and mathematics engagement. The major findings of the study indicated that the level of online learning satisfaction of Grade 12 students and digital literacy competence were rated very high. However, the students' level of Mathematics engagement was found to be high. The results further revealed a positive relationship between online learning satisfaction and Mathematics engagement. Furthermore, between the two independent variables, digital literacy competence was considered the better predictor of the mathematics engagement of Grade 12 students.

KEYWORDS: *Education, mathematics, online learning satisfaction, digital literacy competence, mathematics engagement, descriptive-correlational, Philippines*

INTRODUCTION

Student engagement has become a significant aspect of curriculum implementation. The decline on students' engagement in mathematics learning has been the focus of numerous studies (Cooper, 2014). In America, a low level of engagement in Mathematics was shown crucial where students refuse to learn and deviate themselves from the discussion (Sato & Hodge, 2015).

On a global scale, Martin et al. (2012) stated that a challenged existed in

Australian middle school students regarding their engagement in Mathematics ranging from 40 percent to 60 percent. Similarly, Lee et al. (2023) emphasized that several educators in United States in public schools have recognized the lack of positive mathematics engagement from the students. The lack of mathematics engagement among students was highly attributed to school and student-related factors such as economic disadvantage status of school, gender, home language, and immigration. In China, students in elementary schools report less cognitive and emotional engagement in Mathematics (Bear et al., 2018). Moreover, report of low engagement in mathematics was accounted by Purdasseea (2022) where Mauritius teachers reported that students displayed low levels of engagement in Mathematics and a loss in perceiving information.

In the Philippine setting, Ramos et al., (2022) states that a decreasing shift of learner's engagement towards Mathematics is remarkably attention getting. A notion of short attention span towards the subject tends to be a reason of the unpredicted shift. Less learner-instructor support seems tricky in uplifting social engagement of the learners towards Mathematics. It was also verified with the findings of Nicolaidou and Philippou (2003) that students showed negative engagement in mathematics as they proceed to higher grade levels. Student's frustration and complexity of mathematics concepts lead to the development of low mathematics engagement among older students.

Locally, schools in Davao City, showed less engaged in Mathematics despite the efforts of teachers in implementing cognitive strategies (Gaylo, 2017). Accordingly, many students less engaged in Mathematics because it was too tough for them to grasp. Based from the findings, majority of children were not engaged in Mathematics (Simamora et al. 2017). Same study of Shernoff, et al. (2003) found a very low level of engagement in Mathematics class, where they reported that students were less engaged than any other subject. They were less comfortable doing mathematics that even if they worked hard, they still find learning new things in Mathematics difficult (Gaylo, 2017).

On the other hand, studies show concern about Mathematics' student engagement in online learning continues to increase when compared to the conventional face to face class (Parsons et al. 2008). It is revealed that students were less satisfied on their engagement in Mathematics in online classes (Elshami, 2021). The findings support previous studies which reported that students have low engagement in Mathematics in online learning (Baloran, 2021). Also, Istenic (2016) revealed that students who use digital tools performed less in solving mathematical problems in the instance that they were

not quite well oriented in dealing with a multitude of data, and cannot manage to perceive the problem and to select the data that would help them find the solution. Studies further showed that poor engagement in Mathematics with the use of digital technologies relates to poor digital literacy competence of the students (Vacca, 2020).

The inability to answer mathematical problems is a critical issue that must be addressed (Etang & Regidor, 2022). Consequently, many schools have embraced online learning as supplementary medium of instruction yet seemed indecisive to rely on (Inan et al. 2021). Consequently, student engagement in Mathematics should be elaborated as it substantiates the ways how students perceived the daily instruction.

In line with this, the researcher aimed to have a better understanding of online learning satisfaction, digital literacy competence, and student engagement. The researcher felt the need of conducting quantitative research of the above variables as they come across but never in the study of Gray & DiLoreto (2016) which is the effects of student engagement, student satisfaction, and perceived learning in online learning with the application of cross-sectional design using survey methodology, student engagement in Mathematics (Kong et al., 2013); Student's Mathematical belief and attitudes as predictors of students' Mathematical ability (Ethang and Regidor, 2022), student digital literacy, student online learning satisfaction and academic performance (Cote & Milliner, 2017); implementation of digital literacy toward pandemic situation (Hariati, 2021); but limited in the studies joined the three variables in one elaboration of interpretations. Therefore, a continuous investigation regarding the problems of student Mathematics engagement using online learning and students online learning satisfaction with their level of competence in digital manipulations towards their engagement in Mathematics is urgent in order to provide a well-designed result. This may give guide in crafting teacher's training and capability enhancement as well as school support and policy to enhance the instruction essential to the student's learning engagement.

The findings of this study will be shared with the public, making it a valuable resource for educational leaders, mathematics teachers, researchers, and policymakers in innovating enhancement programs for mathematics learners. Additionally, the results will be shared with the Division of Davao City to contribute insights into current mathematics pedagogy. Furthermore, the research aims to disseminate its findings through national and international

research conferences and publish it in a high-impact journal to reach a broader readership.

Theoretical Framework

This study was rooted through Broaden-build-up Theory by Fredrickson (2013) and e-Learning theory Model by Mayer et al. (2015). These two theories provided the structure to define how to approach the study. Broaden- Build- up theory highlighted the interaction between students' positive engagement and online learning satisfaction. This relationship has impactful implication on how students interact with their online environment in different aspect including emotional, social, and mental perspective. Further, the theory emphasized that when students feel engaged and satisfied in their learning experience, they encounter less challenges in learning since they feel engaged and satisfied. Another theory connected to the study was the e-Learning Theory by Mayer et al. (2015). E-learning theory emphasizes how technologies can be used and designed to create new learning opportunities and to promote effective learning. This theory is about designing educational technology use to promote effective learning by reducing extraneous cognitive load and managing germane and intrinsic loads at students' appropriate levels. The framework mentioned above should be understood to accurately investigate the gaps this study wants to fill. this framework of the study will provide evidence on the impact of online learning satisfaction and digital literacy competence towards mathematics engagement.

METHODS

Research Design

This study utilized a quantitative research approach specifically a descriptive-correlational design with the aid of adapted questionnaires in gathering the needed data from the respondents. Quantitative research is a systematic investigation of phenomena by gathering quantifiable data and performing statistical, mathematical, or computational techniques (Clark & Creswell, 2015). Further, it is a structured way of collecting and analyzing data from various sources Yilmaz, K. (2013) to quantify the problem and understand its extent, seeking results that someone can project to a larger population (Watson, 2015). On one hand, correlational research was useful when the objective is to study the relationships between two or more random variables within the same population or between the same variables in two different populations (Curtis et. al, 2016). This design was appropriate to employ and

determine the significance of the relationship between online learning satisfaction and mathematics engagement as well as digital literacy competence and mathematics engagement. On the other hand, descriptive correlation designed aimed to provide static picture of situation as well it established the relationship between different variables (Seeram, 2019). Given this definition, to determine the levels of students' online learning satisfaction, digital literacy competence, and mathematics engagement, the use of such design was necessary.

Place of the Study

This study was conducted in Davao City, Davao del Sur Philippines specifically across the three private secondary schools, which are referred to as School A, School B, and School C that is located at the center of the city with numerous Grade 12 students enrolled. These schools were chosen since these schools adhere the K-12 curriculum and utilize online teaching and learning. These schools are selected accordingly based on the ability of the number of respondents whom essentially can benefit the result of the for proper guidance using their online class.

Respondents

The respondents of this study were the 150 Grade 12 learners from the three private secondary schools of Davao City, Davao del Sur, Philippines. These respondents were appropriate for the objective from the study since these students experienced a fully implemented online classes in their respective institutions.

The respondents were chosen purposively based on a criterion. Purposive sampling refers to the intentional selection of respondents based on their ability to explain a specific theme, concept, or phenomenon (Lavrakas, 2019). Specifically, the inclusion criteria of the respondents were the Grade 12 learners in private school that utilizes online learning as means of teaching and learning process only. The Grade 12 public school learners that did not use online learning were excluded to this study.

RESULTS

Level of Online Learning Satisfaction

Table 1 presents the level of online learning satisfaction of Grade 12 students. Three indicators of online learning satisfaction are presented on the table with corresponding mean and standard deviation; these indicators including online learning environment, school support during pandemic, and online

learning methods and platforms. Result show that the overall mean is 4.37 which is described as very high, interpreted as always observed. This indicates that the students’ online learning satisfaction is very high implying that the students had great satisfaction with their experience in the online learning’s environment, support, and methods. Further, the overall standard deviation of 0.66 signifies that the responses of the students varied marginally.

Table 1
Level of Online Learning Satisfaction

Indicators	Mean	SD	Description
Online Learning Environment	4.30	0.57	Very High
School Support During Pandemic	4.27	1.25	Very High
Online Learning Methods and Platforms	3.91	0.54	High
Overall Mean	4.37	0.66	Very High

The indicator with the highest mean is online learning environment. The means of this indicator online learning environment ranged from 4.18 to 4.55. The category mean is 4.30 described as very high interpreted as always observed. This means that that student had great satisfaction with their experience in the online learning environment. Such findings support to the results of Nambiar (2020) who found out that many students manifested higher level of participation in all learning environments, hence increasing their online learning satisfaction. The results also implies that students are always satisfied with the level of the engagement on their online learning environment experience and found the flexibility and adaptability of online environment fulfilling as it guides them and helps them to complete their course. Meanwhile, the indicator with a lowest mean is online learning methods and platforms. The means of this indicator online learning methods and platforms ranged from 3.65 to 4.17. The category mean is 3.91 describe as high, interpreted as oftentimes observed. This means students that online class holds great potential as an effective mode of instruction as students preferred its utilization however, some of the students experience very minimal problems when using LMS showing its good quality as user-friendly environment, hence, effective implementation of such systems must be continued and improved. The present finding agreed with result from the study conducted by Rahmat et al. (2022) who revealed that students initially exhibited favorable dispositions towards online learning, which were correlated with the utilization of proficient coping mechanisms. Aside from

the above results, numerous studies such as Almusharraf and Khahro (2020) and Mukhtar (2020) revealed there have other platforms used in the implementation of different online modalities such as Google Hangouts, Teams, Meet, Moodle, and Edmodo.

Level of Digital Literacy Competence

Table 2
Level of Digital Literacy

Indicators	Mean	SD	Description
Information and Communication Literacy	4.25	0.54	Very High
Media Literacy	4.34	0.52	Very High
Information Literacy	4.37	0.51	Very High
Overall Mean	4.32	0.35	Very High

Table 2 presents the level of digital literacy competence of the Grade 12 students. Three indicators of digital literacy competence are depicted on the table with corresponding mean and standard deviation; these indicators include information and communication literacy, media literacy and information literacy. Results show that the overall mean is 4.32 which is describe as very high and interpreted as always observed. The results signifies that the students’ digital literacy competence in learning in online environment is very high implying that the students are capable of understanding written texts from different sources online, expressing and delivering their ideas through different forms of media and can solve problems and develop critical thinking skills with the aid of the principles of computer application. This finding concurs with Yoleri and Anadolu (2022) indicated that students have high level of digital literacy competence and possess advanced digital literacy skills. Further, the standard deviation of 0.35 signifies that the student responses varied slightly.

The indicator with a highest mean is information literacy. The means of this indicator information literacy ranged from 4.21- 4.49. The category mean is 4.37 described as very high and interpreted as always observed. This means that the students evaluate and assess online information and sources all the time in which they can distinguish false and valid information, check whether cites and websites are reliable, and properly cite references. This is similar to the findings of Taheri et al. (2020) who discovered that students exhibited a level of information literacy and Setyoko et al. (2023) who reported that students exhibited proficient information literacy abilities in locating and choosing information, verifying the accuracy of information, summarizing information in

written form, and conveying information through presentations. Meanwhile, the indicator with a lowest mean is information and communication literacy. The means of this indicator ranged from 3.83 to 4.53. The category mean is 4.25 which is described as very and interpreted as always observed. This means that the students are also highly aware of their responsibilities as they navigate to many online sites and sources and can present confidently their ideas through video contents without having difficulty in producing one build their confidence in showing the information that they have gathered online. The finding aligns with the results Handayani et al. (2022) discovered that the students had high level in accessing and managing digital inputs with the use of technologies and (Adeoye & Adeoye, 2017) showed that in online learning, student displays high level of adapting technology with pertains to compiling and processing learning output internet.

Level of Mathematics Engagement

Table 3 presents the level of Mathematics Engagement of Grade 12 learners. Results show that the overall percentage mean is 4.18 described as high and interpreted as oftentimes observed. The results indicates that Grade 12 students’ engagement in Mathematics is high implying that students are highly engaged when it comes to attending their own responsibilities in learning Mathematics in cognitive, emotional and social engagement. The findings aligns the study of Joshi et al. (2022), research showed that when learning mathematics online, students exhibit high levels of cognitive, emotional, social engagement. Further, the standard deviation ranges from 0.57 signifies that the responses of the students varied marginally.

Table 3
Level of Mathematics Engagement

Indicators	Mean	SD	Description
Cognitive Engagement	4.33	0.60	Very High
Emotional Engagement	4.03	0.78	High
Social Engagement	4.18	0.70	High
Overall Mean	4.18	0.57	High

The indicator with the highest mean is cognitive engagement. The means of this indicator cognitive engagement ranged from 4.16 to 4.47. The category mean is 4.33 described as very high and interpreted as always observed. This means that students are involving themselves in the process of learning mathematics and

always ensure that they can keep up with the online class by working hard, concentrating, and learning as much as they can. The finding compliment to the results of Zhang et al. (2023) high level of cognitive engagement in Mathematics among students that was attributed to both intrinsic and extrinsic motivation. Meanwhile, the indicator with the lowest mean is emotional engagement. The mean of this indicator emotional engagement ranged from 3.81 to 4.10. The category mean is mean rating is 4.03 described as high and interpreted as oftentimes observed. This mean that in many cases, the Grade 12 students find thinking about mathematics enjoyable and finds learning mathematics as an interesting subject with challenges of absorbing mathematical concepts and principles. The findings of the study support to the study of Ulfah et al. (2021) highlighted high emotional engagement among students which is highly attributed positivity and added that added that students revealed have a strong sense of joy answering Mathematics questions online, and enjoying games.

Significance of the Relationship of Student’s Online Learning Satisfaction and Digital Literacy Competence to Mathematic Engagement

Table 4
Significance of the Relationship of Student’s Online Learning Satisfaction and Digital Literacy Competence to Mathematics Engagement

Independent Variables	Mathematics Engagement		
	R	p-value	Remarks
Student's Online Learning Satisfaction	0.527	.000	Significant
Digital Literacy Competence	0.463	.000	Significant

*Significant at $p<0.05$

Table 4 presents the results in testing the significance of the relationship between online learning satisfaction and mathematics engagement as well as digital literacy and Mathematics engagement of the Grade 12 students. The findings shows that there is a significant relationship between online learning satisfaction and mathematics engagement as well as digital literacy and mathematics engagement. Significance was tested at $\alpha = 0.05$ level. As shown in the table, the analysis reveals that when correlated with mathematics engagement, online learning satisfaction has an r-value of 0.527 with a corresponding p-value of 0.000 while digital literacy has an r-value of 0.463

with a corresponding p-value of 0.000. Significance was tested at $\alpha = 0.05$ level. Therefore, online learning satisfaction and digital literacy are related to the mathematics engagement of the Grade 12 students.

The results signify a moderate direct relationship between online learning satisfaction and mathematics engagement which means that high levels of student's online learning satisfaction are correlated with the high level of student mathematics engagement. Similarly, there is a moderate direct relationship between digital literacy and mathematics engagement entailing that high level of student's digital literacy competence is correlated with high level of students' mathematics engagement. The overall satisfaction towards online learning can be determined by the platform environment, support from school, and methods employed during online learning. The finding of this study confirms the Broden-Build Up Theory of Fredrickson (2013) who posited the interaction between students' positive engagement and satisfaction in learning that when individuals are satisfied and enjoyed what they are learning, it broadens perspectives and helps in building intended outcomes resulting in an increase in engagement.

Furthermore, since students' digital literacy competence is very high, their engagement in learning is high. These findings also concur with the results of Hobbs (2017) who found a significant relationship between digital literacy and engagement. Low level of competence in digital literacy relates to low level of engagement in mathematics learning. Conversely, high level of digital literacy relates to high level of engagement. These results can be elucidated by going back to the theoretical framework of this study. The premise e-Learning Theory by Mayer et al. (2015) accentuated on how technologies can be used and designed to create new learning opportunities and to promote effective learning. Students need to be autonomous and independent learners so that they can acquire current information to build a valid and accurate knowledge base through technologies.

Significance of the Influence of Student's Online Learning Satisfaction and Digital Literacy Competence to Mathematics Engagement

Table 5 presents the regression analysis to determine the significance on the combined influence of online learning satisfaction and digital literacy competence on Mathematics engagement of grade 12 students. As shown in the table, the data reveal that the two independent variables, online learning satisfaction and digital literacy competence, could significantly influence the mathematics engagement of the Grade 12 students ($p < 0.05$). This means that both online learning satisfaction ($\beta = 0.391$) and digital literacy competence ($\beta =$

0.419) have a causal relationship with the students’ engagement in learning mathematics.

Table 5
Significance of the Influence of Student’s Online Learning Satisfaction and Digital Literacy Competence to Mathematics Engagement

Mathematics Engagement				
Variables	β	T	p-value	Remarks
Student's online learning satisfaction	.391	4.989	.000	Significant
Digital literacy competence	.419	3.339	.001	Significant
<i>Holistic model</i>				
R ²	.328			
F-value	35.917			
P-value	.000			
Remarks	Significant			

Significant at p<0.05

Given this positive causal relationship along with the descriptive results, which show a very high level of online learning satisfaction and a high level of mathematics engagement, the data implies that the increased change in the level of students’ online learning satisfaction is directly causing an increased change of about 39.10% in the level of mathematics engagement of the Grade12 students. Additionally, the positive causal relationship along with the descriptive results between digital literacy competence and mathematics engagement, shows a very high level of digital literacy competence and a high level of mathematics engagement. This indicates that the increased change in the level of digital literacy competence is directly causing an increased change of 41.90% in the level of mathematics engagement of the Grade 12 students. Moreover, the data suggest that between the two independent variables, digital literacy competence is considered a better predictor of the mathematics engagement of Grade 12 students based on beta standardized coefficient value.

More evidently, the overall p-value (< 0.05) with an F value of 35.917, as shown in the holistic model, implies that the mathematics engagement of the Grade 12 students is significantly predicted by the combined independent variables (online learning satisfaction and digital literacy competence).

However, the R^2 value of 0.328 signifies that only 32.80% of the variance of the mathematics engagement of the Grade 12 students is influenced by the combined independent variables (online learning satisfaction and digital literacy competence). Thus, it infers that other combined factors equivalent to 67.20% could significantly influence the mathematics engagement of Grade 12 students which is not covered in this study.

Both online learning satisfaction and digital literacy competence significantly influence students' mathematics engagement. Put simply, while these were intended to characterize different construct in learning, it is highly indicated that they can be integral parts in addressing students' engagement in learning mathematics through online means. Therefore, teachers can stimulate interactions and engagement in online learning by lowering barriers on students' mastery of the use of new technological platform and environment (Hollister, 2022). In an online learning environment, engagement is a key factor in enhancing students' desirable learning outcomes, positively associated with student online learning satisfaction (Kim & Kim, 2021).

Nonetheless, the biggest influencer to students' mathematics engagement is digital literacy competence. Siregar (2022) found out that digital literacy has a positive and significant impact in influencing student engagement in online learning environment. Therefore, schools, administrators, and teachers should pay more attention to the digital literacy of the students. He further emphasized that online learning should not be a reason for any possible decline in students' engagement and achievement; arguing that when students digital literacy competence is below tolerable, online learning must be temporarily ceased and schools and institutions should implement programs improving students' digital literacy.

CONCLUSION

Based on the findings of this study, the following conclusions were drawn: The level of online learning satisfaction of the Grade 12 learners in terms of online learning environment, school support during pandemic, and online learning methods and platforms was very high. It implies that the online learning satisfaction of students was always observed. Hence, it can be concluded that the students find online learning enjoyable and satisfying. The level of digital literacy competence in terms of information and communication literacy, media literacy, and information literacy was very high. This means that digital literacy competence of Grade 12 students was always observed. Hence, during mathematics online classes, students were able to make use of technologies at one's disposal and understand the social practices that surround

the use of new media. The level of Mathematics engagement in terms of their cognitive engagement, emotional engagement and social engagement was high. It implies that the Mathematics engagement of Grade 12 students was oftentimes observed. The students can work satisfactorily in mathematics classes through self-regulation and collaboration with others however, they need to develop emotional engagement as it was the indicator to have the lowest mean score. Online learning satisfaction had a positive significant relationship with the mathematics engagement of the Grade 12 students. Similarly, digital literacy competence had a significant positive relationship with the mathematics engagement of the Grade 12 students. It implies that when students' level of online learning satisfaction was very high, their mathematics engagement was high. Additionally, when students' level of digital literacy competence was very high, their mathematics engagement was high. The mathematics engagement of Grade 12 students was significantly predicted by the combined independent variables, online learning satisfaction and digital literacy competence. Moreover, between the two independent variables, digital literacy competence was considered the better predictor of the mathematics engagement of Grade 12 students based on beta standardized coefficient value.

REFERENCES

- Adeoye, A. A., & Adeoye, B. J. (2017). Digital literacy competence of undergraduate students in Nigeria universities. *Library Philosophy and Practice*, 1665.
- Almusharraf, N., & Khahro, S. H. (2020). Students satisfaction with online learning experiences during the COVID-19 pandemic. *International Journal of Emerging Technologies in Learning (iJET)*, 15(21), 246. <https://doi.org/10.3991/ijet.v15i21.15647>
- Baloran, E. T., Hernan, J. T., & Taoy, J. S. (2021). Course satisfaction and student engagement in online learning amid COVID-19 pandemic: A structural equation model. *Turkish Online Journal of Distance Education*, 1–12. <https://doi.org/10.17718/tojde.1002721>
- Bear, G. G., Yang, C., Chen, D., He, X., Xie, J. S., & Huang, X. (2018). Differences in school climate and student engagement in China and the United States. *School Psychology Quarterly*, 33(2), 323–335. <https://doi.org/10.1037/spq0000247>
- Clark, & Creswell. (2015). *Understanding research: A consumer's guide* (2nd ed.). Pearson Education, Inc.

- Cooper, K. (2014). Eliciting engagement in the high school classroom: A mixed-methods examination of teaching practices. *American Educational Research Journal*, 51(2), 363–402.
- Cote, T. J., & Milliner, B. (2017). Preparing Japanese students' digital literacy for study abroad: Is more training needed? *JALT CALL Journal*, 13(3), 187–197.
- Curtis, E. A., Comiskey, C., & Dempsey, O. (2016). Importance and use of correlational research. *Nurse Researcher*, 23(6).
- Elshami, W., Taha, M. H., Abuzaid, M., Saravanan, C., Al Kawas, S., & Abdalla, M. E. (2021). Satisfaction with online learning in the new normal: Perspective of students and faculty at medical and health sciences colleges. *Medical Education Online*, 26(1), 1920090. <https://doi.org/10.1080/10872981.2021.1920090>
- Etang, M. A., & Regidor, R. (2022). Students' mathematical beliefs and attitudes as predictors to students' mathematical ability. *International Journal of Education and Social Science Research*, 5(3), 23–60.
- Fredrickson, B. L. (2013). Positive emotions broaden and build. In *Advances in experimental social psychology* (Vol. 47, pp. 1–53). Academic Press.
- Gaylo, D. N., & Dales, Z. I. (2017). Metacognitive strategies: Their effects on students' academic achievement and engagement in mathematics. *World Review of Business Research*, 7(2), 35–55.
- Gray, J. A., & DiLoreto, M. (2016). The effects of student engagement, student satisfaction, and perceived learning in online learning environments. *International Journal of Educational Leadership Preparation*, 11(1), n1.
- Handayani, N. A., Rosana, D., Wilujeng, I., Sari, M. I. P., Nofianti, E., Az-Zahro, S. F., & Ramadhanti, D. (2022). ICT literacy analysis of junior high school students through environmental learning on green consumerism using Padlet. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1049–1054. <https://doi.org/10.29303/jppipa.v8i3.1254>
- Hariati, P. (2021). Implementation of digital literacy competence toward pandemic situation. In *International Virtual Conference on Democracy and Education* (pp. 2920–2926).
- Hobbs, R. (2017). Measuring the digital and media literacy competencies

- of children and teens. In *Cognitive development in digital contexts* (pp. 253–274). Elsevier.
- Hollister, B., Nair, P., Hill-Lindsay, S., & Chukoskie, L. (2022, May). Engagement in online learning: Student attitudes and behavior during COVID-19. In *Frontiers in Education* (Vol. 7, p. 851019). Frontiers Media SA.
- Inan Karagul, B., Seker, M., & Aykut, C. (2021). Investigating students' digital literacy competence levels during online education due to COVID-19 pandemic. *Sustainability*, 13(21), 11878.
- Istenic Starčič, A., Cotic, M., Solomonides, I., & Volk, M. (2016). Engaging preservice primary and preprimary school teachers in digital storytelling for the teaching and learning of mathematics. *British Journal of Educational Technology*, 47(1), 29–50.
- Joshi, D. R., Adhikari, K. P., Khanal, B., Khadka, J., & Belbase, S. (2022). Behavioral, cognitive, emotional and social engagement in mathematics learning during COVID-19 pandemic. *PLOS ONE*, 17(11), e0278052.
- Kim, S., & Kim, D.-J. (2021). Structural relationship of key factors for student satisfaction and achievement in asynchronous online learning. *Sustainability*, 13, 6734. <https://doi.org/10.3390/su13126734>
- Kong, Q. P., Wong, N. Y., & Lam, C. C. (2003). Student engagement in mathematics: Development of instrument and validation of construct. *Mathematics Education Research Journal*, 15(1), 4–21.
- Lavrakas, P. J., Traugott, M. W., Kennedy, C., Holbrook, A. L., de Leeuw, E. D., & West, B. T. (Eds.). (2019). *Experimental methods in survey research: Techniques that combine random sampling with random assignment*. John Wiley & Sons.
- Lee, Y., Davis, R. O., & Wan, L. (2023). International students' satisfaction with online learning during the COVID-19 at a South Korean university. *International Journal of Learning, Teaching and Educational Research*, 22(3), 19–32. <https://doi.org/10.26803/ijlter.22.3.2>
- Martin, A. J., Anderson, J., Bobis, J., Way, J., & Vellar, R. (2012). Switching on and switching off in mathematics: An ecological study of future intent and disengagement amongst middle school

- students. *Journal of Educational Psychology*, 104, 1–18.
- Mayer, R. E., Moreno, R., & Sweller, J. (2015). E-learning theory. <https://www.learning-theories.com/e-learning-theory-mayer-sweller-moreno.html>
- Mukhtar, K., Javed, K., Arooj, M., & Sethi, A. (2020). Advantages, limitations and recommendations for online learning during COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, 36(COVID19-S4), S27.
- Nambiar, D. (2020). The impact of online learning during COVID-19: Students' and teachers' perspective. *The International Journal of Indian Psychology*, 8(2), 783–793.
- Nicolaidou, M., & Philippou, G. (2003). Attitudes towards mathematics, self-efficacy and achievement in problem solving. *European Research in Mathematics Education III*, 1–11.
- Parsons-Pollard, N., Diehl Lacks, R., & Hylton Grant, P. (2008). A comparative assessment of student learning outcomes in large online and traditional campus-based introduction to criminal justice courses. *Criminal Justice Studies*, 21(3), 239–251.
- Purdasseea, S. (2022). *Student engagement in mathematics lessons and tasks during transition from primary to secondary school* [Doctoral thesis, University of Brighton].
- Rahmat, H., Aris, A., Miskam, H. M., Rajendran, K., & Mashudi, R. (2022). Students' attitudes and coping strategies relating to online learning during the COVID-19 pandemic: A cross-sectional study. *F1000Research*, 11, 320. <https://doi.org/10.12688/f1000research.73610.1>
- Ramos, R. A., Carandang, E. S. P., & Pante, T. O. (2022). Learner engagement and satisfaction in the online mathematics course: The experience of a private Philippine university. *World Journal of Education*, 12(2), 28–35.
- Sato, T., & Hodge, S. (2015). Japanese exchange students' academic and social struggles at an American university. *Journal of International Students*, 5(3), 208–227.
- Shernoff, D., Csikszentmihalyi, M., Schneider, B., & Shernoff, E. (2003). Student engagement in high school classrooms from the perspective of flow theory. *School Psychology Quarterly*, 18(2),

- 158–176. <https://doi.org/10.1521/scpq.18.2.158.21860>
- Simamora, R. E., Sidabutar, D. R., & Surya, E. (2017). Improving learning activity and students' problem solving skill through problem based learning (PBL) in junior high school. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 33(2), 321–331.
- Siregar, T. R. S. (2022). The effect of digital literacy in the establishment of student engagement. *Proceedings of the 2nd International Conference of Strategic Issues on Economics, Business and, Education (ICoSIEBE 2021)*. <https://doi.org/10.2991/aebmr.k.220104.038>
- Seeram, E. (2019). An overview of correlational research. *Radiologic Technology*, 91(2), 176–179.
- Setyoko, S., Sarjani, T. M., Mahyuni, S. R., & Suryanti, S. (2023). Implementation of android-based blended learning for improving learning outcome and information literacy skill of students. *Jurnal Penelitian Pendidikan IPA*, 9(1), 74–79. <https://doi.org/10.29303/jppipa.v9i1.2248>
- Taheri, A., Langarizadeh, M., Dehkordi, J. G., & Yousefianzadeh, O. (2020). Development of health literacy among postgraduate students: From information literacy perspective. *Journal of Education and Health Promotion*, 9(1), 338. https://doi.org/10.4103/jehp.jehp_340_20
- Ulfah, N., Chandra, N. E., & Hidayat, F. (2021). Students' perceptions on online learning: A study on EFL university students in pandemic era. *Advances in Social Science, Education and Humanities Research*. <https://doi.org/10.2991/assehr.k.211021.020>
- Watson, R. (2015). Quantitative research. *Nursing Standard*, 29(31).
- , K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. *European Journal of Education*, 48(2), 311–325.
- Yolero, S., & Anadolu, Z. N. (2022). Examination of digital literacy skills of undergraduate students according to various variables. *Advanced Education*, 121–134. <https://doi.org/10.20535/2410-8286.262190>
- Vacca, S. (2020). *Digital literaciesx and competencies: Examining*

teacher candidates' achievement, engagement, attitudes, and personalized learning in technology enhanced environments [Doctoral dissertation, The University of Western Ontario (Canada)].

Zhang, Y., Yang, X., Sun, X., & Kaiser, G. (2023). The reciprocal relationship among Chinese senior secondary students' intrinsic and extrinsic motivation and cognitive engagement in learning mathematics: A three-wave longitudinal study. *ZDM – Mathematics Education*, 55(2), 399–412. <https://doi.org/10.1007/s11858-022-01465-0>