p-ISSN: 2086-4280
e-ISSN: 2527-8827

The Effect of Learning Mathematics with Digital Platforms

Koryna Aviory[1], Dwi Setianingsih[2*], Fajar Widiatmoko[3]

Mathematics Education Study Program, Yogyakarta PGRI University
Jalan PGRI I Sonosewu No. 117, Daerah Istimewa Yogyakarta, Indonesia
[1]koryna@upy.ac.id, [3]fjrwdatmko11@gmail.com

Special Education Study Program, Yogyakarta PGRI University
Jalan PGRI I Sonosewu No. 117, Daerah Istimewa Yogyakarta, Indonesia
[2*]dwisetianingsih@upy.ac.id

Article received: 13-11-2023, revised: 02-12-2023, published: 30-01-2024

Abstrak

Platform digital dapat digunakan sebagai strategi pembelajaran asinkron di kelas. Pembelajaran asinkron adalah pembelajaran dengan interaksi yang dilakukan secara fleksibel dan tidak harus dalam waktu yang bersamaan, misalnya menggunakan forum diskusi atau pembelajaran/tugas mandiri. Tujuan penelitian ini adalah untuk melihat apakah terdapat pengaruh pembelajaran matematika dengan platform digital terhadap hasil belajar matematika. Platform digital yang diamati terbatas pada Zoom dan WhatsApp Group. Jenis penelitian ini adalah eksperimen. Teknik pengambilan sampel adalah simple random sampling dengan jumlah 63 siswa. Analisis uji kesetimbangan menunjukkan bahwa kedua kelas memiliki kemampuan yang sama. Instrumen yang digunakan adalah tes. Hasil validitas menunjukkan bahwa instrumen tes dapat digunakan karena memiliki rentang indeks 0,667 – 1. Analisis data menggunakan statistik parametrik. Data mengikuti asumsi distribusi normal dan variansnya homogen. Simpulan penelitian menyatakan bahwa terdapat pengaruh yang berbeda antara kedua strategi pembelajaran. Dengan melihat rata-rata kedua kelas dapat dikatakan bahwa pembelajaran yang paling berpengaruh adalah pembelajaran dengan WhatsApp Group.
Kata Kunci: Hasil Belajar; Platform digital; Prestasi Akdemik; Strategi Belajar

Abstract

Digital platforms can be used as asynchronous learning strategies in the classroom. Asynchronous learning is learning with interaction that is carried out flexibly and does not have to be at the same time, for example using discussion forums or independent learning/assignment. The purpose of this research was to see whether there was an effect of learning mathematics with digital platforms on mathematics learning outcomes. The observed digital platforms are limited to Zoom and WhatsApp Group. This type of research is an experiment. The sampling technique was simple random sampling with a sample number of 63 students. The analysis of the equilibrium test shows that both classes have the same ability. The instrument used is a test. The results of the validity indicate that the test instrument can be used because it has an index range of 0.667 – 1. The data analysis uses parametric statistics. The data follows the assumption of a normal distribution and the variance is homogeneous. The conclusion of the study states that there are different effects between the two learning strategies. By looking at the average of the two classes it can be said that the most influential learning is learning with the WhatsApp Group.
Keywords: Academic Performance; Digital Platforms; Learning Outcomes; Learning Strategies

I. INTRODUCTION

The Industrial Revolution 5.0 and society 4.0 had an impact, especially on the education sector. The development of digital technology affects education. The use of technology depends on the learning strategy used (Tang et al., 2022). Technologies that can be used include smartphones, laptops, computers, tablets, and so on. The use of technology has made a paradigm shift throughout the education system (Haleem et al., 2022). Digital platforms can help students to interact in a virtual learning environment so that real-time communication can be carried out (Hu et al., 2023).

There are several digital platforms used in Indonesia, such as Zoom, WhatsApp, Google Classroom, Schoology, and Edmodo (Lestari & Gunawan, 2020; Mulyadi & Afriansyah, 2022). Students believe that learning through digital platforms has had a positive impact on increasing their achievement (Irzawati, 2021). In line with research that states that digital platforms are very comprehensive and understandable by teenagers (Sao et al., 2023). Two types of applications can be used in learning, namely face-to-face applications and non-face-to-face applications (Anita et al., 2021). Face-to-face applications that can be used in learning are Google Meet, Skype, and Zoom. Meanwhile, non-face-to-face applications that can be used in the learning process are Edmodo, Google Classroom, and WhatsApp. With the abundance of platforms that can be utilized in online learning, teachers must be careful in choosing which platform to use, especially for delivering mathematics subject matter. Digital platforms are proven to powerfully and relationally influence teaching (Decuypere et al., 2021). In addition, students' learning experiences will be formed through digital platforms (Abuhassna et al., 2020).

Based on the results of interviews with mathematics teachers, it was found that in carrying out the process of learning mathematics online, one of the most easily accessed and used digital platforms is WhatsApp. This platform is one of the free messaging apps that has more than 2 billion users worldwide in 2020 (Sousa et al., 2022). This is not surprising when referring to the advantages offered by the WhatsApp platform.

Apart from using WhatsApp, the digital platform that is often used is Zoom. This platform is used by teachers to interact directly in the learning process. Zoom can stabilize student aspirations when physical mobility stops and can mediate student mobility and immobility (Chen, 2023). Zoom is a platform that provides video conferencing services so that it can present an atmosphere of meetings in the network (Carmi, 2024). So, teachers and students can interact by meeting face to face. In addition, this platform has the advantage that teachers can display or present material with the share screen feature. This convenience will be very useful for teachers to explain material, especially material that requires calculations (mathematics). Students can record and listen directly to the teacher's explanation. Therefore, zoom is very suitable to be used as a learning medium (Pustikayasa, 2021). The use of Zoom in learning affects student learning outcomes (Alfina & Susanto, 2021).

p-ISSN: 2086-4280
e-ISSN: 2527-8827

Even though online learning has been facilitated by the many digital platforms and the advantages they offer, it still raises polemics, especially regarding students' mathematics learning outcomes. Learning outcomes are student achievements in following the learning process (Solihat et al., 2023). Student learning outcomes can be influenced by factors from within (internal) students and also factors (external) from outside students. Everything that supports students in carrying out the learning process is an external factor. One of the external factors is the use of learning strategies. Online learning is one of the learning strategies. Online learning makes students easily bored, coupled with the difficulty of students understanding teacher explanations, students tend to be passive, and learning outcomes often decrease (Kerfoot, 2009).

Several factors affect the implementation of online learning, such as the internet network, learning media, learning strategies, and the family environment (Aviory et al., 2022). Digital platforms are one of the learning media. Digital platforms can be used as asynchronous learning strategies in the classroom (Warsito et al., 2023). Asynchronous learning is learning with interaction that is carried out flexibly and does not have to be at the same time, for example using discussion forums or independent learning/assignment (Parsa, 2022). Therefore, it is desirable to further research the effectiveness of the use of digital platforms in online learning.

The polemic about mathematics learning outcomes arises because online learning is considered nothing more than face-to-face learning. Therefore, researchers are interested in conducting research with the title "The Effect of Learning Mathematics with Digital Platforms on Learning Outcomes". This study aims to see which digital platforms will affect student learning outcomes. The learning outcomes to be observed are limited to knowledge and skill competencies.

II. METHOD

This research was conducted at SMP Negeri 2 Sewon. This type of research is an experiment. The population used was students from class VIII A to VIII H. The sample was chosen randomly so that two classes were obtained, experimental class 1 and experimental class 2. Experimental class 1 was given the direct learning treatment with Zoom, while experimental class 2 was treated WhatsApp Group with the help of videos and power points. The implementation of learning is observed using several indicators, such as learning activities during the learning process and behaviors/actions during the implementation of learning. The instrument test used was a multiple-choice of 30 items. The test is measured based on knowledge and skill competencies. Content validation was carried out before the instrument was used for research. Validation was carried out by two expert judgments. Calculation of validity using the Aiken index. The instrument can be used if it has a minimum Aiken index of 0.4 (Retnawati, 2016).

Before the two classes were given treatment, an equilibrium test was carried out. This test is used to find out whether the

two classes to be given treatment are in a state of balance/equivalence. The test was carried out parametrically with a t-test. Normality and homogeneity of variance should be performed as prerequisites of the t-test. The normality test is carried out in two ways, namely by the Kolmogorov-Smirnov method and by using the sloping curve. While the homogeneity of variance is seen by using the Levene test. Data analysis was used to see which digital platforms were influential, using a two-tailed t-test with significance 5%, then compared the mean of the two classes.

III. RESULT AND DISCUSSION

A. Result

The initial step of the research is to validate the instrument. Content validity is determined by the agreement of two expert judgments. Content validity is used to see the suitability of the items with the indicators. The expert judgment assessment uses a Likert scale with a scale range of 1 – 4 (irrelevant, less relevant, quite relevant, and very relevant). The calculation results with the Aiken index are in the range of 0.667 – 1. There are eight items including moderate validity, because they have the Aiken index in the range of 0.4 – 0.8. The rest, twenty-two items, are said to be very valid because they have an index above 0.8. So it can be concluded that all items can be used for research.

1. Preliminary Data Analysis

The next step is to carry out a balance test between the two class groups selected as the sample. The data used is the value of learning outcomes in the material before the research. Before carrying out a parametric equilibrium test, it is necessary to fulfill the assumptions of normality and homogeneity. Table 1 is the result of the Kolmogorov-Smirnov analysis for the normality test. The results of the analysis show that the data from both classes (experiment 1 and experiment 2) follow the normal distribution assumption. This is evidenced by the p-value = 0.055 > 0.05.

Tabel 1.
Kolmogorov-Smirnov' Test

		Mark
N		63
Normal Parameters, b	Means	42.751
	std. Deviation	16.737
Most Extreme Differences	absolute	.169
	Positive	.169
	Negative	-.061
Kolmogorov-Smirnov Z		1.339
asymp. Sig. (2-tailed)		055

a. Test distribution is Normal.
b. Calculated from data.

Normality testing can be done in another way, namely by looking at the slope of the curve. The data is said to follow a normal distribution pattern if the slope of the curve is in the range of ± 2.0 (Hahs-Vaughn & Lomax, 2020). The results of the normality test with the curve can be seen in Table 2.

Tabel 2.
Skewness and Kurtosis values

	Skewness		Kurtosis	
	Statistics	std. Error	Statistics	std. Error
ClassEkp1	.802	.421	.977	.821
ClassExp2	.814	.414	.453	.809

Next, we will test the homogeneity of variance with the Levene' test. The data analysis can be seen in Table 3. The results of the analysis show that p-value = 0.613 > 0.05, then H0 is accepted, meaning that the research sample has a homogeneous/same variance.

Tabel 3.

p-ISSN: 2086-4280
e-ISSN: 2527-8827

Test of Homogeneity of Variances

Levene Statistics	df1	df2	Sig.
.258	1	61	.613

Prerequisites for testing the initial data are met, it will be followed by an equilibrium test. This test serves to see whether the two classes that will be used as research are equivalent/balanced. The test statistic used is the t-test. The results of the analysis can be seen in Table 4. The calculation shows that p-value = 0.084 > 0.05, so H0 is accepted. This means that there is no significant difference between the two classes that will be used as research samples so it can be said that the two classes are equivalent.

Tabel 4.
Independent Sample Test

E	t	df	Sig.	MD	STD
EVA	-1.765	61	082	-7.322	4.148
EVNA	-1.761	58.604	084	-7.322	4.159

Information:
E : Equilibrium
EVA : Equal variances assumed
EVNA : Equal variances not assumed
Sig. : Sig. (2-tailed)
MD : Mean Differences
STD : Std. Error Difference

2. Final Data Analysis

This study uses two classes as research samples. Experimental 1 was given learning with Zoom, while experimental 2 was given video-based learning with the WhatsApp Group. The results of measuring learning achievement can be seen in Table 5.

Tabel 5.
Statistical Description

	Experiment Class 1	Experiment Class 2
Valid	31	32
missing	0	0
Means	53.118	60.729
std. Deviation	13.051	16.059
Minimum	20	23.333
Maximum	80	90
std. Error Means	2.344	2.839

The average learning outcomes produced by each class are also different, namely 53.118 and 60.729. The maximum score obtained with Zoom m is 80. While the lowest score is 20. For the WhatsApp Group, the highest score is 90 and the lowest score is 23.33.

Before carrying out the parametric test, it is necessary to carry out the prerequisite test, namely the homogeneity of variance and normality. The results of the calculation of the normality test were carried out in two ways, namely by Kolmogorov-Smirnov and based Skewness and Kurtosis. The results of calculations using Kolmogorov-Smirnov can be seen in Table 6. The p- value = 0.423 > 0.05, so H0 is accepted, meaning that the research data follows the normal distribution assumption.

Tabel 6.
Kolmogorov-Smirnov Test

		Mark
N		63
Normal Parameters, b	Means	56.9841
	std. Deviation	15.03549
Most Extreme Differences	absolute	.111
	Positive	.103
	Negative	-.111
Kolmogorov-Smirnov Z		.879
asymp. Sig. (2-tailed)		.423

a. Test distribution is Normal.
b. Calculated from data.

While the normality test with Skewness and Kurtosis is shown in Table 7.

Tabel 7.
Skewness and Kurtosis values

	Skewness		Kurtosis	
	Statistics	std. Error	Statistics	std. Error

ClassExp1	-.376	.421	.334	.821
ClassExp2	-.140	.414	-.480	.809

The results of calculations, data in experimental class 1 and experimental class 2, show that the curve is in the range ± 2,0, meaning that the data follows a normal distribution pattern.

The homogeneity test can be seen in Table 8. The test results with the Levene test conclude that the data has a homogeneous/same variance. This can be seen from the p-value of 0.183 > 0.05 which makes H0 acceptable. Both prerequisite assumptions have been met, then the data can be continued for further testing with parametric.

Tabel 8.
Test of Homogeneity of Variances

Levene Statistics	df1	df2	Sig.
1,816	1	61	.183

Parametric statistics with the t-test are used to see whether the two learning strategies have different effects. The results of the analysis can be seen in Table 9, it can be seen that p-value = 0.043 <0.05, then H0 is rejected. This means that the two learning strategies produce different effects. To see which strategy has a better effect on learning outcomes, the average of two learning strategies can be compared. The calculation of the average learning outcomes can be seen in Table 5. The table shows that video-based learning strategies with WhatsApp Group are better than using Zoom.

Tabel 9.
Independent Sample Test

E	t	df	Sig.	MD	STD
EVA	-2,060	61	044	-7.611	3.694
EVNA	-2,067	59,231	043	-7.611	3.682

Information:
E : Equilibrium
EVA : Equal variances assumed
EVNA : Equal variances not assumed
Sig. : Sig. (2-tailed)
MD : Mean Differences
STD : Std. Error Difference

B. Discussion

Education governance in the digital era prioritizes development strategies that are significant to theory and practice (Yang et al., 2023). Connections and integration between education governance and big data need to be built effectively to interpret, operate methods, and intervene in developing education governance. The transformation of the education sector towards the informatization of education and improving the quality of education is a guide in the new era (Dong et al., 2022). Significant changes occur in systems, approaches, and management that have implications in human life. New experiences in the use of technology in education meet the current educational framework (Mukul & Büyüközkan, 2023).

The learning experience can be enriched by the use of technology. The digital platform will be synchronized with the learning strategies used by teachers. The development of digital platforms will improve teachers' well-being and mental health (Moldavan et al., 2022). The Industrial Revolution 4.0 reconstructed all learning designs. Learning and teaching further integrate the use of digital technology. Digital education using a didactic and student-centered approach will affect learning (Al-Hail et al., 2023). Other findings suggest that social media contributes to teachers' professional development. Searching for information and sharing information positively impacts

p-ISSN: 2086-4280
e-ISSN: 2527-8827

teaching enthusiasm (Richter et al., 2022). Digital platforms will build language usage and word choice skills, so knowledge and experience will be formed (Burhan-Horasanlı, 2022).

This research shows that the difference in average knowledge and skill competencies of the two digital platforms does not have a large reach. The learning outcomes with the WhatsApp Group digital platform have an average of almost 61 while the learning outcomes with the Zoom digital platform have an average of above 53. Researchers also conducted unstructured interviews with several children in each class sample. In classes that use Zoom, as many as 85% of students said that the use of Zoom's digital platform is less effective.

The interaction between teachers and students is carried out virtually. If there are students who are constrained by material, they must wait for the next meeting. Sometimes students are embarrassed to ask questions, either in person or by chat. In addition, if there are obstacles in the internet network, the delivery of material will be hampered. This is one of the obstacles in the implementation of learning (Hamid, 2020). The ineffectiveness of the Zoom platform is also seen when teachers are delivering material, almost 30% do not turn on the camera, even though they have been reprimanded. This platform encourages students to think harder and be more creative (Li & Che, 2022).

Meanwhile, in classes that use WhatsApp Groups, as many as 90% of students said that WhatsApp Groups are very effective. This is because WhatsApp Groups allow students to be able to ask questions, discuss, and share knowledge in this group. WhatsApp makes it possible to send text, images, videos, and voice messages, making multimedia communication faster, easier, and more inclusive (Kashy-Rosenbaum & Aizenkot, 2020). In addition, teachers can assign assignments and projects through WhatsApp and students can upload their work. Teachers can also provide feedback via direct message or in class groups. The most popular are class schedule reminders and assignment submission times as well as links to collect assignments that can be embedded in group descriptions, making it easier for students and teachers to control schedules and discussions.

Learning strategies that have online appeal will be more popular among students. Practical teaching strategies will make learning more effective (Lin et al., 2017). Choosing an effective digital platform can absorb actual teaching and learning practices (Nair & Kumar, 2021). The impact felt by choosing the right strategy will be associated with student learning satisfaction so it will trigger students to be involved continuously (Elizabeth et al., 2022). One of the learning strategies that has an online appeal is WhatsApp Groups based on learning videos. Videos shared through the WhatsApp Group digital platform can be played repeatedly so that it will be easier for students to repeat the subject matter. WhatsApp Groups have proven to be effective in facilitating discussions so that knowledge can be shared (Pimmer et al., 2021). This digital platform is very accessible to students anytime and anywhere. The use of WhatsApp can help students get

information related to learning and engage in discussions (Mulyono et al., 2021). In line with the results of the study that showed that WhatsApp Group produced a higher knowledge score because it had many key benefits (Christoph et al., 2021).

The advantages of WhatsApp include (1) It is not paid; (2) Can send messages directly (Munir et al., 2021); (3) It is possible to send voice messages or make voice calls and video calls; (4) Provide encryption features that ensure security in communication (Wijnberg & Le-Khac, 2021). Apart from that, in WhatsApp, it is possible to create groups or commonly called WhatsApp Groups. This feature is very beneficial for everyone because it makes it easier to communicate with several people. WhatsApp Group also makes it easier for teachers to communicate with students. In addition, it can also be used as a forum for discussion in one class. WhatsApp allows teachers to send learning materials in the form of documents, photos, videos or links. The use of WhatsApp as a learning medium is quite effective when viewed from the results of learning mathematics (Yensi, 2020).

IV. CONCLUSION

Based on the results and discussions, there are different influences in mathematics learning using digital platforms. The digital platforms used are limited to Zoom and WhatsApp Group. By comparing the average of the two classes, it can be said that the most influential learning is learning with WhatsApp Groups.

REFERENCES

Abuhassna, H., Al-Rahmi, W. M., Yahya, N., Zakaria, M. A. Z. M., Kosnin, A. B. M., & Darwish, M. (2020). Development of A New Model on Utilizing Online Learning Platforms to Improve Students' Academic Achievements and Satisfaction. *International Journal of Educational Technology in Higher Education*, *17*(1), 1–23. https://doi.org/10.1186/S41239-020-00216-Z/TABLES/3

Alfina, M. T., & Susanto, R. (2021). Pengaruh Penggunaan Media Zoom Meeting dalam Pembelajaran Online terhadap Hasil Belajar. *Jurnal Edutech Undiksha*, *9*(2), 298. https://doi.org/10.23887/jeu.v9i2.39967

Al-Hail, M., Zguir, M. F., & Koç, M. (2023). University Students' and Educators' Perceptions on The Use of Digital and Social Media Platforms: A Sentiment Analysis and A Multi-Country Review. *IScience*, *26*(8), 107322. https://doi.org/10.1016/J.ISCI.2023.107322

Anita, Y., Thahir, A., Anita, K., & Rahmawati, N. D. (2021). Buku saku digital berbasis STEM: Pengembangan media pembelajaran terhadap kemampuan pemecahan masalah. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(3), 401-412.

Aviory, K., Wahyumiani, N., & Suharni, S. (2022). Factors That Affect Learning Outcomes in Online Learning. *Research and Evaluation in Education*, *8*(1). https://doi.org/10.21831/reid.v8i1.44454

p-ISSN: 2086-4280
e-ISSN: 2527-8827

Ayu Suci Lestari & Gunawan. (2020). The Impact of Covid-19 Pandemic on Learning Implementation of Primary and Secondary School Levels. *Indonesian Journal of Elementary and Childhood Education*, *1*(2), 25–34.

Burhan-Horasanlı, E. (2022). Digital Social Reading: Exploring Multilingual Graduate Students' Academic Discourse Socialization in Online Platforms. *Linguistics and Education*, *71*, 101099. https://doi.org/10.1016/J.LINGED.2022.101099

Carmi, G. (2024). E-Learning Using Zoom: A Study of Students' Attitude and Learning Effectiveness in Higher Education. *Heliyon*, *10*(11), e30229. https://doi.org/10.1016/J.HELIYON.2024.E30229

Chen, L. H. (2023). Moving Forward: International Students' Perspectives of Online Learning Experience During the Pandemic. *International Journal of Educational Research Open*, *5*, 100276. https://doi.org/10.1016/J.IJEDRO.2023.100276

Christoph, P., Florian, B., Titilayo, D. O., Oluwafemi, D., Olusola, O., Janine, J., & Ademola, A. (2021). Whatsapp for Mobile Learning. Effects on Knowledge, Resilience and Isolation in The School-To-Work Transition. *The Internet and Higher Education*, *50*. https://doi.org/https://doi.org/10.1016/j.iheduc.2021.100809

Decuypere, M., Grimaldi, E., & Landri, P. (2021). Introduction: Critical Studies of Digital Education Platforms. *Critical Studies in Education*, *62*(1), 1–16. https://doi.org/10.1080/17508487.2020.1866050

Dong, Y., Shao, B., Lou, B., Ni, C., & Wu, X. (2022). Status And Development of Online Education Platforms in The Post-epidemic Era. *Procedia Computer Science*, *202*, 55–60. https://doi.org/10.1016/J.PROCS.2022.04.008

Elizabeth, A., Frank Badu, B., Emmanuel, G., & Fu-Chieh, H. (2022). Determining The Attributes That Influence Students' Online Learning Satisfaction During COVID-19 Pandemic. *Journal of Hospitality, Leisure, Sport & Tourism Education*. https://doi.org/10.1016/j.jhlste.2021.100364

Hahs-Vaughn, D., & Lomax, R. (2020). *An Introduction to Statistical Concepts* (Fourth Edi). Routledge.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding The Role of Digital Technologies in Education: A Review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/J.SUSOC.2022.05.004

Hamid, S. M. (2020). Online Digital Platforms During Covid-19 In EFL Classes: Visual Impairment Student' Perception. *Eternal: English, Teaching, Learning, and Research Journal*, *6*(2), 328–339. https://doi.org/10.24252/ETERNAL.V62.2020.A10

Hu, Y. H., Yu, H. Y., Tzeng, J. W., & Zhong, K. C. (2023). Using An Avatar-Based Digital Collaboration Platform to Foster Ethical Education for University Students.

Computers & Education, *196*, 104728. https://doi.org/10.1016/J.COMPEDU.2023.104728

Irzawati, I. (2021). The Utilization of Digital Platforms in Online Learning: EFL Students' Perspectives. IEFLJ: *Indonesian EFL Journal*, *7*(2), 131–138. https://www.journal.uniku.ac.id/index.php/IEFLJ/article/view/4566

Kashy-Rosenbaum, G., & Aizenkot, D. (2020). Exposure to Cyberbullying In Whatsapp Classmates' Groups and Classroom Climate as Predictors of Students' Sense of Belonging: A Multi-Level Analysis of Elementary, Middle and High Schools. *Children and Youth Services Review*, *108*, 104614. https://doi.org/10.1016/J.CHILDYOUTH.2019.104614

Kerfoot, B. P. (2009). Learning Benefits of On-Line Spaced Education Persist for 2 Years. *The Journal of Urology*, *181*(6), 2671–2673. https://doi.org/10.1016/J.JURO.2009.02.024

Li, J., & Che, W. (2022). Challenges and Coping Strategies of Online Learning for College Students in The Context of COVID-19: A Survey of Chinese Universities. *Sustainable Cities and Society*, *83*, 103958. https://doi.org/10.1016/J.SCS.2022.103958

Lin, M. H., Chen, H. C., & Liu, K. S. (2017). A Study of The Effects of Digital Learning on Learning Motivation and Learning Outcome. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(7), 3553–3564. https://doi.org/10.12973/eurasia.2017.00744a

Moldavan, A. M., Edwards-Leis, C., & Murray, J. (2022). Design and Pedagogical Implications of a Digital Learning Platform to Promote Well-Being in Teacher Education. *Teaching and Teacher Education*, *115*, 103732. https://doi.org/10.1016/J.TATE.2022.103732

Mukul, E., & Büyüközkan, G. (2023). Digital Transformation in Education: A Systematic Review of Education 4.0. *Technological Forecasting and Social Change*, *194*, 122664. https://doi.org/10.1016/J.TECHFORE.2023.122664

Mulyadi, R., & Afriansyah, E. A. (2022). Pengaruh literasi digital terhadap kemandirian belajar matematika siswa. *Math Didactic: Jurnal Pendidikan Matematika*, *8*(2), 183-191.

Mulyono, H., Suryoputro, G., & Jamil, S. R. (2021). The Application of Whatsapp to Support Online Learning During The COVID-19 Pandemic in Indonesia. *Heliyon*, *7*(8). https://doi.org/10.1016/J.HELIYON.2021.E07853

Munir, S., Erlinda, R., Putra, H. E., & Afrinursalim, H. (2021). Whatsapp as A Learning Tool During Covid -19 Pandemic: Advantages and Disadvantages. *International Journal of Educational Best Practices*, *5*(2), 168–182. https://doi.org/10.31258/IJEBP.V5N2.P168-182

Nair, K. V. R., & Kumar, S. (2021). Sustainable Teaching and Learning on Digital Platform in the Higher Education Sector. *Natural Volatiles & Essensial Oils*, *8*(4).

p-ISSN: 2086-4280
e-ISSN: 2527-8827

Nofriyandi, Abdurrahman, & Andrian, D. (2023). Digital Learning Media Integrated with Malay Culture to Improve Students' Numeration Ability and Motivation. *Mosharafa: Jurnal Pendidikan Matematika*, *12*(2), 301-314.

Parsa, I. K. (2022). Penerapan Pembelajaran Daring Metode Sinkron Asinkron Melalui Google Classroom. *Jurnal Ilmu Pendidikan*, *7*(2), 809–820.

Pimmer, C., Brühlmann, F., Odetola, T. D., Dipeolu, O., Oluwasola, O., Jäger, J., & Ajuwon, A. J. (2021). WhatsApp for Mobile Learning. Effects on Knowledge, Resilience and Isolation in The School-To-Work Transition. *The Internet and Higher Education*, *50*, 100809. https://doi.org/10.1016/J.IHEDUC.2021.100809

Pustikayasa, I. M. (2021). Optimasi Zoom Meeting Sebagai Media Pembelajaran Virtual Synchronous. *Tampung Penyang*, *19*(2), 140–149. https://doi.org/10.33363/tampung-penyang.v19i2.751

Retnawati, H. (2016). *Analisis Kuantitatif Instrumen Penelitian*. Yogyakarta: Parama Publishing.

Richter, E., Carpenter, J. P., Meyer, A., & Richter, D. (2022). Instagram as A Platform for Teacher Collaboration and Digital Social Support. *Computers & Education*, *190*, 104624. https://doi.org/10.1016/J.COMPEDU.2022.104624

Sao, S. S., Barre-Quick, M., Yu, R., Abboud, S., & Coleman, J. S. (2023). Advancing Access to Care through Digital Health: Perspectives from Youth on a Novel Platform to Increase Access to Sexual and Reproductive Health Care and Education for Adolescents and Young Adults. *Journal of Pediatric and Adolescent Gynecology, 36*(5), 449-454. https://doi.org/10.1016/J.JPAG.2023.04.002

Solihat, A. N., Gumilar, G., Srigustini, A., Kurniawan, & Suparman, A. (2023). Dampak Pembelajaran Daring Terhadap Stres Akademik Dan Learning Outcome. *Jurnal Ekonomi Pendidikan Dan Kewirausahaan*, *11*(1), 85–102.

Sousa, A. M., Almeida, J. M., & Figueiredo, F. (2022). Metrics of Social Curiosity: The Whatsapp Case. *Online Social Networks and Media*, *29*, 100200. https://doi.org/10.1016/J.OSNEM.2022.100200

Tang, C., Mao, S., Naumann, S. E., & Xing, Z. (2022). Improving Student Creativity Through Digital Technology Products: A Literature Review. *Thinking Skills and Creativity*, *44*, 101032. https://doi.org/10.1016/J.TSC.2022.101032

Warsito, Siregar, N. C., Gumilar, A., & Rosli, R. (2023). STEM for the 21st Century: Building a Stronger Workforce for the Digital Age. *Mosharafa: Jurnal Pendidikan Matematika*, *12*(4), 879-894.

Wijnberg, D., & Le-Khac, N. A. (2021). Identifying Interception Possibilities for Whatsapp Communication. *Forensic Science International: Digital Investigation*, *38*, 301132. https://doi.org/10.1016/J.FSIDI.2021.301132

AUTHOR'S BIOGRAPHY

Koryna Aviory, S.Si., M.Pd.

Born in Surakarta on December 6, 1986. Teaching staff at the Mathematics Education at PGRI University, Yogyakarta. Completed undergraduate studies in Mathematics at Sebelas Maret University (UNS), Surakarta, and graduated in 2009. Postgraduate study in Mathematics Education at Sebelas Maret University (UNS), Surakarta, graduated in 2011, and is currently carrying out doctoral studies in Education Research and Evaluation at Yogyakarta State University (UNY).

Dwi Setianingsih, M.Pd.

Born in Grobogan on August 4, 1990. Teaching staff at the Special Education at PGRI University, Yogyakarta. Completed undergraduate studies in Special Education at Sebelas Maret University (UNS), Surakarta, and graduated in 2012. Postgraduate study in Special Education at Indonesia University of Education (UPI), Bandung, graduated in 2015.

Fajar Widiatmoko, S.Pd.

Born in Sleman on September 04, 1998. Mathematics teacher at SMP Negeri 2 Sewon. Completed undergraduate studies in Mathematics Education at PGRI University, Yogyakarta, and graduated in 2022.