



# Indigenous Cultural Knowledge: A Motivated Virtual Learning Experience of Pajjaga Andi Dance Variations in Improving Mathematical Creative Thinking

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**Abstract.** The Pajjaga Andi dance is a typical Bugis local wisdom that has a unique variety and is synonymous with mathematics. This can be integrated into the learning process through metaverse-based virtual media to overcome mathematical creative thinking abilities which are still very low. The aim of this research is to see the effect of motivated virtual learning of the Pajjaga Andi dance variety in improving students' mathematical creative thinking abilities. The type of research used is non-equivalent control group design quasi-experimental research. Mathematical creative thinking ability is measured using a test instrument in the form of an essay with five questions. Based on the results of data analysis, it can be concluded that virtual learning motivated by the Pajjaga Andi dance variety can improve students' mathematical creative thinking abilities with an increase of 38.92 or 80%. This indicates that virtual learning motivated by the Pajjaga Andi dance variety is effective in improving creative mathematical thinking skills, as well as having an impact on cultural preservation as a form of indigenous cultural knowledge.

**Keywords:** indigenous cultural knowledge, virtual learning experience, mathematical creative thinking

## 1 Introduction

Local wisdom is a view of life and knowledge with different strategies in the form of local community activities to meet broad and comprehensive life needs so that the study is difficult to be limited by space [1][2]. One of the local pearls of wisdom that is very famous in the Bugis area of South Sulawesi is the Pajjaga Andi dance. Pajjaga Andi dance is a dance that has existed since the days of the Bone Kingdom. In the beginning, this dance was used to teach ethics and manners to noble children in the palace, especially during royal inaugurations or other royal events. Although this dance served as a means of education for the descendants of royalty, as time went on and the government system changed, the Pajjaga Andi dance was no longer confined to the palace [3].

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After the government system of the king of Bone was abolished, the *Pajjaga Andi* dance was introduced outside the palace. Now, this dance is often performed on special occasions or included in art competitions, without regard for social status or royalty. Even so, it must be acknowledged that the origins of this dance hold significant educational value for children. In order to maintain the philosophical values and meanings contained in the *Pajjaga Andi* dance, and to ensure they become part of cultural resilience, efforts must be made to explore and understand more deeply the philosophy and significance of the *Pajjaga Andi* dance. Recognizing the hidden meaning in the *Pajjaga Andi* dance is a way of respecting cultural heritage and passing it on to future generations as an important part of cultural identity or knowledge preservation. Preservation knowledge is an understanding of the principles, practices, and methods used to maintain, protect, and maintain something so that it exists, is maintained, or remains in good condition [4][5]. This theory involves knowledge of techniques preservation, risk management, maintenance, and actions needed to maintain the integrity and sustainability of something [6], in this case is the indigenous cultural knowledge of the *Pajjaga Andi* dance.

The *Pajjaga Andi* dance is known for its graceful and gentle movements, consisting of eight variations [7], namely the *muttama'* (entering movement), *makkasiwiyang* (respect), *mangngade* (adab), *mappatabe* (asking for permission), *massampeang* (refusing reinforcements), *mali siparappe rebba sipatokkong*, *sere*, and *massimang* (please excuse me). Of these eight variations, if managed properly in the learning process it can make it easier for students to think creatively mathematically. Mathematical creative thinking is one of the four important skills that need to be developed in facing the world of work [8], which is known as 4C Skills (Critical thinking, Communication, Collaboration, and Creativity). The ability to think creatively mathematically is the ability to think that aims to create or find new ideas that are different, unusual, and original with definite and precise results [9][10] The ability to think creatively mathematically requires systematic and consistent thinking to create unique creativity according to needs [11].

The ability to think creatively mathematically is still very weak in high school students. Based on the results of the 2019 National Examination, the average student math score was only 39.33, including in Bone Regency the lowest score was [12]. Low math scores were also found in SMA Negeri 6 Bone students with an average Minimum Competency Assessment (MCA) result of 65 below the standard criterion of 70 (scale 0 – 100). This is also supported by the results of observations and interviews with the deputy head of curriculum as well as a mathematics teacher which shows low results of students' Final School Examinations (FSE) in mathematics from 2018 – 2021.

One of the factors causing students' low math scores is the lack of ability to think creatively. The process of learning mathematics so far is still rote and based on the formulation of textbooks [13], so that when students encounter various questions it will be difficult to solve them. In fact, students at the senior high school level are required to be able to master the cognitive realm in higher order thinking (high order thinking skills) including mathematical creative thinking. However, this has not been able to be realized properly in schools due to various factors, such as the use of inappropriate learning strategies, as well as the availability of inadequate facilities and infrastructure.

To overcome the problem of low ability to think creatively mathematically, a learning process is needed that involves students' experiences with real or contextual conditions. This learning can be realized through the exploration of local wisdom in the form of indigenous cultural knowledge. The majority of research so far has only been limited to describing local wisdom as a culture that must be preserved [14][15][16][17]. In addition, there are also studies related to local wisdom which are explored as media or methods in the learning process [18][19][20][21][22]. So far no one has studied the local wisdom of the *Pajjaga Andi* dance in terms of variety as a strategy in the learning process to improve students' mathematical creative thinking abilities. In fact, the variety of *Pajjaga Andi* dance is rich in philosophical values that can create joyful learning and meaningful learning. To facilitate the process of exploring the various forms of the *Pajjaga Andi* dance, this research will be supported by increasingly sophisticated technological developments, namely metaverse-based (virtual learning spaces) to provide virtual learning experiences for students.

The metaverse concept in this research provides a virtual learning simulation, in which teachers and students interact in exploring the philosophical values of the *Pajjaga Andi* variety of dances which are carried out virtually. The integrated learning strategy of the *Pajjaga Andi* dance based on the metaverse is expected to improve students' mathematical creative thinking skills because of its unique stages in stimulating students' thought processes to solve various problems. Therefore, the priority of this research is to study indigenous cultural knowledge as a virtual learning experience motivated by the *Pajjaga Andi* dance variety to improve students' mathematical creative thinking abilities.

## 2 Methodology

The method used in this study is an experimental method with a quantitative approach. The experimental method is a way to implement plans that have been prepared in the form of real and practical activities in achieving learning objectives[23]. Through a quantitative approach, researchers study the natural sciences with the aim of obtaining clear and accurate information from the experimental testing process. The type of research used includes quasi-experimental research, namely using designnon-equivalent control group design. Through this design, both classes of research are givenpretest andposttest which is used as a benchmark for improvement students' mathematical creative thinking abilities. Use of research designnon-equivalent control group design can be seen in table 1.

**Table 1.** Research Design

Class	Pretest	Treatment	Posttest
Control	$O_1$		$O_2$
Experiment	$O_3$	X	4

Information:

$O_1$  : Mathematical creative thinking ability in the control class before learning

- $O_2$  : Mathematical creative thinking ability in the control class after learning
- $O_3$  : Mathematical creative thinking ability of the experimental class before treatment
- $O_4$  : Mathematical creative thinking ability of the experimental class after treatment
- $X$  : The application of virtual learning is motivated by the Pajjaga Andi dance variety

This research was conducted at SMA Negeri 6 Bone for four months. The research population included all 180 students of class XI MIPA. Sampling technique using purposive sampling where students are selected with certain considerations. Through this sampling, two classes were selected to be used in the study, namely class XI MIPA 4 as a control class of 30 students, and XI MIPA 5 as an experimental class of 29 students. The data collection technique in this study used a mathematical creative thinking ability test in the form of an essay of five questions, which were studied on the instrument pretest and posttest. To measure the effectiveness of motivated virtual learning, the Pajjaga Andi dance variety is applied, implemented pretest and posttest in the control and experimental classes. The effectiveness of virtual learning motivated by the Pajjaga Andi dance variety can be seen from the total increase pretest and posttest in both classes. As for indicators pretest and posttest refers to the four main indicators of mathematical creative thinking ability tests [24], namely the ability of fluency (generates many answers), flexibility (generates a variety of questions), originality (asks a variety of questions), and elaboration abilities (develops and improves ideas).

Data analysis techniques include analysis of prerequisite tests and hypothesis testing. The prerequisite test is a test that must be carried out in choosing the right testing technique in proving the research hypothesis, including the data normality test and the variance homogeneity test. The data used to test the hypothesis is obtained by calculating the N-Gain Score using the formula:

$$N - Gain : \frac{X_{post} - X_{pre}}{X_{max} - X_{pre}}$$

Information:

- $X_{post}$  : Posttest value
- $X_{pre}$  : Pretest value
- $X_{Max}$  : Maximum value

The category or interpretation of the N-Gain Score value can use the N-Gain value directly or in the form of a percentage, with the following categories of effectiveness.

**Table 2.** Distribution of N-Gain Score

N-Gain Value Category	
$g > 0.7$	Tall
$0.3 \geq g \geq 0.7$	Currently
$g < 0.3$	Low

This research was conducted to find out how the effectiveness of implementing virtual learning motivated by the *Pajjaga Andi* dance variety in improving students' math-

**Table 3.** N-Gain Effectiveness Category

Percentage (%)	Category
> 76	Effective
56 - 75	Effective enough
40 - 55	Less effective
< 40	Ineffective

ematical creative thinking abilities. This application was carried out in an experimental class that had been selected through a technique purposive sampling. Meanwhile, in the control class the learning model was applied Project Based Learning which are often used by teachers during the learning process. This shows an equal comparison, where the control class is given learning that is familiar or has been applied by the teacher so far. Meanwhile, the experimental class was given special treatment to prove whether virtual learning motivated by the *Pajjaga Andi* dance variety was effective in improving student learning outcomes, especially the ability to think creatively mathematically. The results of the pretest and posttest analysis in both classes (control and experimental classes) serve as a role model in measuring the extent to which the effectiveness of learning in improving students' mathematical creative thinking abilities.

### 3 Result and Discussion

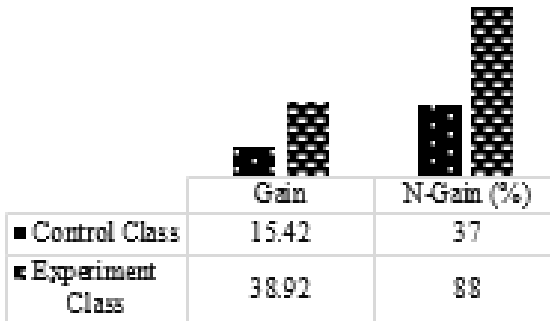
The results of the preference test in the two test classes showed that the data were not normally distributed ( $p$ -value pretest and posttest on the results of Shapiro Wilk's test of normality  $< 0.05$ ). Meanwhile, the homogeneity test results show homogeneous data for the pretest and not homogeneous for the posttest. This shows that for testing the hypothesis can use a non-parametric test (Mann Whitney). In general, the average value of students' mathematical creative thinking abilities in the control class during the pretest obtained a score of 58.17, and experienced an increase during the posttest to 73.58. This indicates that the application of the Project Based Learning learning model has a positive effect on students' mathematical creative thinking abilities, with learning outcomes already above the KKM score of 70. Meanwhile, the application of virtual learning motivated by the *Pajjaga Andi* dance variety in the experimental class also shows good results. maximum. The pretest results of students in the experimental class obtained a score of 55.67% and there was an increase in the posttest results of 94.58 which was above the KKM. The results of the pretest and posttest analysis in the two study classes both showed a significant increase, but the results of the increase indicated that the score in the experimental class was greater than that in the control class. The following is a description of test results data in the control and experimental classes on students' mathematical creative thinking abilities.

From the results of table 4 above, it can be seen that the average score of students' mathematical creative thinking abilities has increased from the pretest to the posttest results, both in the control class and the experimental class. The increase that occurred in the control class showed that the application of the Project Based Learning learning model was effective in increasing students' mathematical creative thinking abilities.

**Table 4.** Description of Test Data for Control Class and Experiment Class

Description of Statistics	Control Class		Experiment Class	
	Pretest	Posttest	Pretest	Posttest
Mean	58.17	73.58	55.67	94.58
Minimum	30.00	35.00	42.50	87.50
Maximum	72.50	100.00	75.00	100.00
Standard Deviation	12.15	16.43	9.58	3.41

Meanwhile, in the experimental class which was the main test class, virtual learning was applied motivated by the *Pajjaga Andi* dance variety to improve students’ mathematical creative thinking abilities. Even though the pretest results showed the lowest scores in the experimental class compared to the control class, after the application of learning in the experimental class was able to experience a significant increase, even greater than the posttest results in the control class. This indicates that the application of virtual learning motivated by the *Pajjaga Andi* dance variety is more effective in improving students’ mathematical creative thinking skills than the Project Based Learning learning model. The increase that occurred in the two research classes can be seen from the results of the calculation of the N-Gain Score, which can be seen visually as follows.



**Fig. 1.** Comparison of N-Gain Scores for the Control Class and the Experiment Class

Figure 1 above shows a comparison of the N-Gain Score in the control and experimental classes. The increase (gain score) in the control class from the results of the pretest and posttest obtained a score of 15.42 which was in the low category or increased by 37% (not effective). Meanwhile, the increase (gain score) in the experimental class obtained a score of 37 (moderate) or 88% in the effective category. This supports the indication that learning virtual motivated variety of *Pajjaga Andi* dance in the experimental class is more effective in improving students’ mathematical creative thinking skills compared to the Project Based Learning learning model in the control class.

### 3.1 Motivated Virtual Learning Variety of Pajjaga Andi Dance

The learning strategy used in the experimental class to improve students' mathematical creative thinking skills was adapted from the Bugis Pajjaga Andi dance variety. The Pajjaga Andi dance is known for its graceful and gentle movements, consisting of eight variations [7], namely the *muttama'* (entering movement), *makkasiwiyang* (respect), *mangngade* (adab), *mappatabe* (asking for permission), *massampeang* (refusing reinforcements), *mali siparappe rebba sipatokkong*, *sere*, and *massimang* (please excuse me). Based on the eight variations of Pajjaga Andi dance, this learning strategy consists of four core stages, namely the *muttama'* *makkasiwiyang* stage (review), the *mangngade* *mappatabe* stage (extending), the *massampeang* stage (problem solving), and the *sere* *massimang* stage (recap). The following are the stages of the learning strategy adapted from the Pajjaga Andi dance variety.

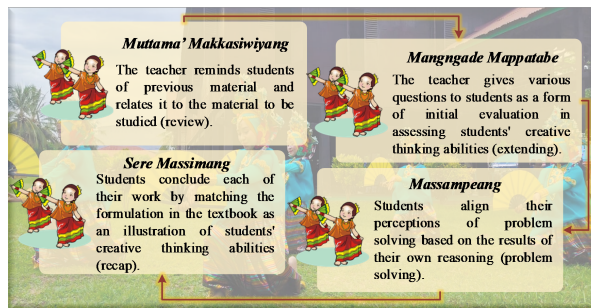


Fig. 2. Stages of Motivated Learning Strategy Variety Pajjaga Andi Dance

To make it easier for students to explore the philosophical values contained in the Pajjaga Andi dance variety, this research was conducted by providing a metaverse-based virtual learning experience. Metaverse is a digital technology capable of creating 3D virtual worlds by utilizing Augmented Reality (AR) and Virtual Reality (VR) technology, where users can appear to be interacting in real terms in a virtual world [25][26]. The application of virtual learning motivated by the Pajjaga Andi dance variety, namely guiding between the use of metaverse-based virtual learning and learning strategies motivated by the Pajjaga Andi dance variety. This provides new experiences for students in the learning process, so that it has an impact on student motivation and interest in learning. One of the main factors that causes low student learning outcomes in mathematics is the lack of motivation and interest in carrying out the teaching and learning process [27][28].

Student motivation and interest in learning can be increased by presenting an interesting and fun learning process. During this time, students feel pressured when listening to the word mathematics, thus indirectly affecting their motivation and interest in learning. Through the application of virtual learning can invite students to be directly involved in the learning process (student centered). This is something that has just been implemented at school (SMA Negeri 6 Bone) which can attract the attention of many

students. Increasing student interest in learning can be seen from the enthusiasm of students during the learning process. Even though they have been divided into groups to gradually explore learning, students are still fighting over it because they are curious about the media used. This learning is even more interesting when it is explored directly together with one of the local wisdoms that is familiar to students, namely the Bugis Pajjaga Andi dance.

The application of virtual learning is motivated by the variety of Pajjaga Andi dance, namely students exploring every variety of Pajjaga Andi dance using the metaverse. Students can see directly the animation demonstrating the Pajjaga Andi dance from each stage. In addition, another thing that is of interest to students is the provision of various questions at each stage of the dance. When the animation has demonstrated a variety of Pajjaga Andi dance, a dor prize box will appear containing numbers. Each number will contain 5 questions as a form of quizzes for students to choose from to work on. Through giving these various questions can improve students' ability to think creatively mathematically. The application of virtual learning motivated by the Pajjaga Andi dance variety in the experimental class can improve students' mathematical creative thinking skills because of its unique stages in stimulating students' thought processes to solve various problems.

In addition to improving students' mathematical creative thinking abilities, the application of learning that is integrated with the local wisdom of the Pajjaga Andi dance is also part of cultural resiliences. This form of integration is very important in introducing culture to the next generation, both in terms of the philosophical values contained therein, as well as its impact on education. Recognizing the hidden meaning in the Pajjaga Andi dance is a form of respecting cultural heritage and introducing it to future generations as an important part of cultural identity or knowledge preservation. Preservation knowledge involves knowledge of preservation techniques, risk management, care and actions needed to maintain the integrity and sustainability of something in the form of indigenous cultural knowledge. Indigenous cultural knowledge refers to the knowledge, traditions, beliefs and practices that are owned and inherited by indigenous peoples or indigenous tribes who have inhabited certain areas since ancient times [29][30]. This is the same as the Pajjaga Andi dance culture typical of the Bugis which has been carried out by the community so far. However, along with the development of modernization, the philosophical values of this dance began to erode and it was only danced as a graceful and unique form of dance. Therefore, the integration of Pajjaga Andi dance in the learning process with involving virtual learning is an alternative in maintaining cultural identity to support the cultural resilience of the Bugis community, as well as a medium used to improve student learning outcomes to support the fourth point of the Sustainable Development Goals, namely quality education.

### **3.2 Improvement of Mathematical Creative Thinking Ability**

Mathematical creative thinking is the ability to use new ideas or ideas that are logical and original as alternative solutions to solving problems [31][32]. The ability to think creatively mathematically requires systematic and consistent thinking to create unique creativity according to needs [11]. Students who have the ability to think creatively

mathematically can easily solve every mathematical problem at various levels according to their understanding and reasoning [33]. The ability to think creatively mathematically can be improved by having learning that contains content contextually to attract students' attention in rational thinking [34][35].

One of the efforts that can be made to improve students' mathematical creative thinking skills is to involve the students' own experiences in the learning process. This has been proven to be able to improve student learning outcomes, including their ability to think creatively. Student experiences can be found in everyday life, so that they can stimulate the ability to solve problems or reason [36]. One area that is rich in culture with philosophical values that can be integrated into the learning process is Bone Regency, South Sulawesi. Some of the local wisdom that can be integrated into learning mathematics includes the typical Bugis food (beppa), traditional house roofs (coppo bola soba), traditional dances (pajjoge), Bugis handicraft arts (erang-erang, songko' recca, lipa sabbe), and traditional games (massallo kawali, lojo-lojo pindip) which have very identical forms with mathematical concepts [37][38][39]. This local wisdom has been found in many students' daily lives, so that when given a variety of questions that involve their experiences, students can more easily determine the information available to choose the right solution.

The increase in students' mathematical creative thinking abilities in this study could occur due to the application of virtual learning motivated by the Bugis *Pajjaga Andi* dance variety. Through a series of stages of this learning strategy, students are slowly able to hone their mathematical creative thinking skills, which include fluency ability (producing many answers), flexibility (generating a variety of questions), originality (asking various questions), and elaboration ability (developing and improving ideas). The ability of students to produce many answers (fluency), a variety of questions (flexibility), and ask a variety of questions (originality) is formed when the teacher gives various questions through the medium of the metaverse-based *Pajjaga Andi* dance variety, which in this strategy is referred to as the stage *manngade mappatabe* (extending). By giving a variety of questions, students can more easily understand a series of questions, especially in this study using material on a system of two-variable linear equations. Even though in each question two different types of variables are given (variables  $x$  and  $y$ ), students find it easier to distinguish and determine them because they are used to solving similar problems. Meanwhile, the ability of students to develop and improve ideas (elaboration) is formed when students do equalization of perceptions at the *mas-sampeang* stage (problem solving).

Seeing the stages of the virtual learning strategy motivated by this unique *Pajjaga Andi* dance variety, students can solve various problems that have been troubling in mathematics because they already have the ability to think creatively mathematically. This is evident from the increase in pretest and posttest results of students in the experimental class which previously showed very low results below the KKM average. The results of the pretest of students in the experimental class obtained an average score of 55.67 with the lowest score of 42.50 and the highest score of 75. Only 2 students obtained scores above the KKM (minimum 70), while 27 other students were below the average. flat. However, after implementing virtual learning motivated by the *Pajjaga Andi* dance variety, student learning outcomes experienced a significant increase,

namely obtaining a posttest average score of 94.58 with the lowest score of 87.5 and the highest score of 100. This indicates that the implementation of motivated learning strategies the variety of Pajjaga Andi dance combined with metaverse-based virtual learning media is effective in improving students' mathematical creative thinking abilities with an increase of 88% in the effective category.

## 4 Conclusion

Virtual learning is motivated by the variety of Pajjaga Andi dance, which is a learning strategy that is integrated with the variety of Pajjaga Andi dance with the help of metaverse-based virtual learning media. This learning strategy consists of four main stages, namely the *muttama' makkasiwiyang* stage (review), the *manggade mappatabe* stage (extending), the *massampeang* stage (problem solving), and the *sere massimang* stage (recap). The metaverse concept in this strategy provides a virtual learning simulation, in which teachers and students can interact in exploring the philosophical values of the Pajjaga Andi variety of dances which are carried out virtually. The application of virtual learning strategies motivated by the Pajjaga Andi dance variety is proven to be able to improve students' mathematical creative thinking abilities, namely abilities fluency (generates many answers), flexibility (generates a variety of questions), originality (asks a variety of questions), and elaboration skills (develops and improves ideas). This can be seen from the results of the N-Gain Score analysis in the experimental class which showed an increase of 38.92 or 88% in the effective category. The application of virtual learning motivated by the Pajjaga Andi dance variety is even more effective than the Project Based Learning learning model applied to the control class, only increasing by 15.42 or 37%. This indicates that the learning strategy virtual motivated Pajjaga Andi dance variety is able to significantly improve mathematical creative thinking skills. The integration of the Pajjaga Andi dance into the learning process is also a form of cultural preservation which has begun to be eroded by modernization to become indigenous cultural knowledge.

## References

1. S. Uge, A. Neolaka, M. Yasin, *Int. J. Instr* **12**, 375–388, (2019)
2. A. Tohri, A. Rasyad, M. Sururuddin, L. Istiqlal, *Int. J. Eval. Res. Educ* **11**, 333–344, (2022)
3. J. Ardi, H. Paserangi, *J. Jur. Fak. Syariah dan Huk* **9**, 19–35, (2022)
4. J. Wells, *Int. J. Herit. Stud* **27**, 449–469, (2021)
5. T. Sun, *Int. J. Human-Computer Interact* **1**, 1–22, (2023)
6. T. Segatsho, J. Moloi, *Mousaion* **37**, 1–11, (2019)
7. S. Sulfiana, *Tari pajjaga andi makkunrai versi lembaga seni budaya arung palakka di Kecamatan Tanete Riattang Kabupaten Bone* (Universitas Negeri Makassar, 2013)
8. M. Vistara, R. Rochmad, K. Wijayanti, *Math. Educ. J* **6**, 140–156, (2022)
9. A. Johansen, E. Mogstad, B. Gajic, B. Bungum, *Stud. Sci. Educ* **18**, 98–111, (2022)
10. T. Dadakhon, A. Sabohat, *Eur. Multidiscip. J. Mod. Sci* **6**, 71–76, (2022)
11. W. Xu, F. Geng, L. Wang, *Think, Creat* **44**, 101041 (2022)
12. Puspendik, *Hasil UN matematika SMA tahun 2019* (Puspendik, 2019)

13. N. Zahwa, N. Hilda, T. Astuti, W. Weryani, Y. Prasetyawati, Z. Zulkardi, B.J. Ilm, *Kegur. dan Ilmu Pendidik* **8**, 110–119, (2022)
14. A. Amin, D. Kurniawan, D. Chen, R. Wirayuda, *Int. J. Instr* **15**, 931–948, (2022)
15. A. Asfar, A. Trisnowali, J. Dahlan, S. Prabawanto, A. Nurannisa, *J. Penelit. dan Pengemb. Pendidik* **6**, 492–499, (2022)
16. A. Asfar, A. Asfar, A. Nurannisa, *Proc* **2577**, 1–12, (2022)
17. A. Syaifullah, A. Asfar, A. Asfar, A. Srimularahmah, V. Ekawati, *Justek J. Sains dan Teknol* **5**, 108–116, (2022)
18. A. Sumiati, A. Asfar, *Proc* **2577**, 1–11, (2022)
19. N. Nurlia, A. Asfar, A. Asfar, M. Masri, T. Sari, *AIP Conf. Proc* **2577**, 1–11, (2022)
20. A. Nurannisa, A. Asfar, A. Asfar, A. Syaifullah, Nurlinda, *AIP Conf. Proc* **2577**, 1–11, (2022)
21. A. Asfar, A. Sumiati, A. Nurannisa, A. Nurannisa, A. Asfar, A. Asfar, A. Syaifullah, *J. Didakt. Mat* **9**, 170–185, (2022)
22. A. Nurannisa, A. Asfar, A. Asfar, A. Syaifullah, *Al-Jabar J. Pendidik. Mat* **12**, 283–294, (2021)
23. Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R&D* (CV Alfabeta, Bandung, 2018)
24. R. Dewi, R. Rochmad, D. Dwijanto, *J. Math. Educ. Res* **11**, 17–25, (2022)
25. P. Rospigliosi, *Interact. Learn. Environ* **30**, 1573–1576, (2022)
26. A. Danylec, K. Shahabadkar, H. Dia, A. Kulkarni, *Machines* **10**, 926–932, (2022)
27. D. Fadda, M. Pellegrini, G. Vivanet, C. Callegher, *J. Comput. Assist. Learn* **38**, 304–325, (2022)
28. S. Akinoso, *J. Educ. Res. Technol* **3**, 79–90, (2023)
29. J. Petzold, N. Andrews, J. Ford, C. Hedemann, J. Postigo, *Res. Lett* **15**, 113007, (2020)
30. R. Zidny, J. Sjöström, I. Eilks, *Sci. Educ* **29**, 145–185, (2020)
31. S. Waluya, Y. Sukestiyarno, A. Cahyono, *Int. J. Interact. Mob. Technol* **16**, 1–11, (2022)
32. R. Maskur, Y. Rahmawati, K. Pradana, M. Syazali, A. Septian, E. Palupi, *Eur. J. Educ. Res* **9**, 375–383, (2020)
33. J. Sitorus, *IJER Indonesian J. Educ. Res* **5**, 7–17, (2020)
34. S. Suherman, T. Vidákovich, *Math. Teach. Res. J* **14**, 56–79, (2022)
35. L. Choeriyah, A. Qohar, S. Subanji, *EDUTECH J. Educ. Technol* **4**, 585–597, (2021)
36. A. Asfar, M. Ahmad, H. Gani, A. Asfar, A. Nurannisa, *Asian J. Appl. Sci* **9**, 1–10, (2021)
37. A. Rahayu, A. Asfar, A. Nursyam, A. Asfar, *AIP Conf. Proc* **2577**, 1–11, (2022)
38. M. Magfirah, A. Asfar, A. Asfar, S. Nurwijaya, A. Fauziah, *AIP Conf. Proc* **2577**, 1–11, (2022)
39. W. Damayanti, A. Asfar, A. Asfar, A. Nurannisa, Yulita, S. Ayunita, *Paedagoria* **2**, 259–266, (2022)

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