



Analyzing Students' Mathematical Spatial Literacy Using a Project-Based Blended Learning Model

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History Article

Received: February, 2022

Accepted: April, 2022

Published: June, 2022

Abstract

The application of project based blended learning in analyzing mathematical spatial literacy is described in this article. The research method used is descriptive quantitative. Participants in the study consisted of 33 students of class XI at one public high school in Bandung Regency. The type of research used is pre-experimental with a one-shot case study design, the subject is taken by simple random sampling using purposive sampling technique. Data analysis in this study is quantitative data analysis in the form of descriptive statistical tests and differential statistical tests. Based on the results of calculations using descriptive statistical tests that students in the high category were 10 students (3%), the medium category was 21 students (64%) and the low category was 2 students (6%). The results of the differential analysis for the normality test of the data are not normally distributed and from the results of the calculation of the median test obtained $0,0148782 \geq 0,025$, this means that the results of this test conclude that at a 95% confidence interval, the median mathematical spatial literacy ability of students after the Project based blended learning model is applied can reach KKM.

Keywords: *Blended Learning, Method, Spatial Literacy Mathematics*

Abstrak

Penerapan project based blended learning dalam menganalisis literasi spasial matematis dideskripsikan dalam artikel ini. Metode penelitian yang digunakan adalah deskriptif kuantitatif. Partisipan dalam penelitian terdiri dari 33 siswa kelas XI pada satu SMA Negeri Kabupaten Bandung. Jenis penelitian yang digunakan pre-experimental dengan desain one shot case study, subjek diambil secara simple random sampling dengan menggunakan teknik purposive sampling. Analisis data dalam penelitian ini adalah analisis data kuantitatif berupa uji statistik deskriptif dan uji statistik inferensial. Berdasarkan hasil perhitungan menggunakan uji statistik deskriptif bahwa siswa yang memiliki kategori tinggi 10 siswa (3%), kategori sedang 21 siswa (64%) dan kategori rendah 2 siswa (6%). Hasil analisis inferensial untuk uji normalitas data tidak berdistribusi normal dan dari hasil perhitungan uji median diperoleh $0,0148782 \geq 0,025$, ini berarti Hasil pengujian ini memberikan kesimpulan bahwa pada selang kepercayaan 95%, median kemampuan literasi spasial matematis siswa setelah diterapkan model Project based blended learning dapat mencapai KKM.

Kata kunci: *Blended Learning, Metode, Literasi Spasial Matematis*

INTRODUCTION

The impact of the 2019 coronavirus disease pandemic has greatly affected various aspects in this country, especially in the field of education. By the end of 2021, Limited Face-to-Face Learning (PTMT) is dynamic, and it is still reacting to the implementation of Micro Community Activity Restrictions (PPKM) in each region, which is just getting started. This is in accordance with the direction of the Director General of PAUD Dikdasmen Kemendikbud Ristek Jumeri, who conveyed virtually on Thursday (24/06/2021) that the implementation of PTMT based on the Decree of the Four Ministers and the instruction of the Minister of Home Affairs Number 14 of 2021 can be carried out in a district/city that has been declared a zone. Under some conditions, it is risk-free. With the implementation of this policy, every school has begun to regulate the arrival of students to school to prevent a backlog. Student arrivals are restricted in terms of both the number of days they can stay and the number of students they can enroll in each session. Each class can only be half-filled for the health protocol to be implemented. When confronted with such circumstances, teachers, as educators have begun to investigate alternate modes of learning that are both suitable and effective for use in classroom and learning activities. The adoption of a mixed model, often known as blended learning, is an option that can be explored. According to Sari & Priatna (2020), "*blended learning means learning patterns that contain mixing elements or merging between one pattern with another*". Depending on the current situation, the blended learning model can be used with a variety of methods and strategies (Carman, 2005). In accordance with this, Charman as cited in Arifin & Abduh (2021), explained that the learning approach that is

suitable for the current situation is to combine conventional learning (face-to-face) and distance learning with online learning resources that include a variety of media choices such as text, images, diagrams, voice, and video that can be accessed by teachers and students from the internet, also known as blended learning. Blended learning originated in the training industry, as is the case in educational institutions where the trainer/facilitator is the primary source of information (Bersin, 2004).

Blended learning is a collaboration between educators and students to improve the learning experience through experimentation with different learning strategies, evaluation, and continuous improvement using technology that can enrich students' learning experiences and make learning meaningful. According to Sutopo as cited in Aslamiyah et al (2019), blended learning can improve the quality and quantity of human connection in the learning environment since it is equipped with a combination of technology and good interaction, resulting in social support, constructive and learning experiences. According to So, H.-J., & Bonk, C. J. (2010), blended learning is a learning method that combines face-to-face learning with technology-assisted learning (technology mediated instruction). The blended learning model can be used efficiently and successfully if an educator and students work together to attain learning objectives (Carman, 2005).

Blended learning can assist in resolving the problem of learning settings that are unable to accommodate a variety of student characteristics (Hendrik et al., 2021). Students that participate in blended learning have greater flexibility in their learning schedules. Students are being directed to be more self-controlled and to increase their learning abilities. Husaman as cited in Abroto et al (2021),

stated that the characteristics of blended learning, which include the following: (1) Learning that involves several steps for delivering teaching materials, learning models, learning strategies, and technology-based learning resources; (2) learning that is a combination of direct or face-to-face teaching, independent learning, and online learning; (3) effective learning when viewed from the delivery method and learning style; and (4) teaching in which the role of parents as a support system for students and the role of the teacher as a facilitator is no less important.

By implementing blended learning, there will be changes in the learning process, where students will no longer simply listen to material descriptions from the teacher but will also be able to access *e-learning* resources at any time and from any location. When compared to other methods, especially in direct learning, this method can demonstrate greater differences in terms of motivation, interest, and student learning outcomes (Usman, 2019). As a result, this method becomes an appropriate and effective alternative method that can be used in the teaching and learning process. As stated by Stein & Graham (2014); Bath and Bourke (2007), blended learning is a combination of face-to-face learning and online learning that produces effective, efficient, and flexible learning. Blended learning necessitates the use of strategies and a systematic approach when combining technology. in face-to-face events as well as online education. A blended approach to learning is one that is aligned with the requirements of the 2013 curriculum. To be effective, blended learning, according to Carman (2005); Pares (2016), requires an instructional method that integrates several types of learning strategies that must address five important learning elements: *live events; online content; collaboration;*

assessment; and reference resources.

The concept of blended learning, which is applied in this study, is integrated with project-based learning, resulting in a learning environment known as Project-Based Blended Learning (PjBBL). Project-based learning will be delivered in both face-to-face and online formats. PjBBL is a learning approach in which students combine online learning with face-to-face instruction by collaborating to design, perform, and finish project-based or product-specific learning activities. The utilization of online resources to assist project-based learning is the most distinguishing element of PjBBL.

The implementation of a project-based learning model can facilitate the integration of blended learning into mathematics education (Khalifah, 2019 & Wahyudi et al, 2018). The project-based learning model is a learning model in which all activities are centered on students. Students carry out activities in solving problems through the process of investigating, designing, solving problems, making decisions, and creating a product, while the teacher's role in project-based learning is to supervise and guide the activities of students (Erdogan & Bozeman, 2015).

The blended learning model used in this study is intended to improve students' mathematical spatial literacy. As is well known, mathematical literacy plays a significant role in mathematics. According to Stecey & Turner (2015); Ojose, B (2011), literacy in the context of mathematics is knowledge that can be used to know and use the fundamentals of mathematics successfully in dealing with everyday issues. With sensitivity to mathematical concepts that are relevant to the phenomena they are confronted with, someone who is mathematically literate must be able to employ knowledge and under-

standing effectively. Mathematical literacy is the ability to understand and apply basic mathematical concepts in everyday life (de Lange, 2006). Mathematical literacy is concerned with 'real' (de Lange) difficulties. Mathematical literacy is linked to real-world problems, which means that the questions presented are not true math problems involving numbers and variables, but rather real-world problems that can be solved mathematically.

Mathematical literacy in this study is focused on the spatial dimension or known as spatial literacy. Spatial literacy is an ability that supports everyone's understanding of the three-dimensional world in which we live and move which refers to everyone's awareness of space which requires an understanding of the nature of objects, relative positions and other things related to space (De Lange, 2003; de Lange, 2006).

According to Piaget & Inhelder as cited in Priatna (2017), spatial ability is an abstract concept that includes the following elements: 1) spatial relationships, the ability to observe the relationship between object positions in space; 2) frame of reference, a sign that is used to determine the position of objects in space; 3) projective relationship, the ability to see objects from various points of view; 4) distance conservation, the ability to estimate the distance between two points; 5) spatial representation, the ability to represent spatial relationships by manipulating cognitively, and 6) mental rotation, the ability to imagine the rotation of objects in space. The spatial literacy indicators employed in this study are: the first indicator, which is orientation; the third indicator, which is visualization, and the fifth indicator, which is relations.

Therefore, to achieve good spatial literacy, it is necessary to understand the basic mathematical spatial abilities and the learning process that supports this

process. Thus, based on the above explanation, this study aims to find out how far the students' mathematical spatial literacy skills are after the project based blended learning model is applied and whether with the implementation of project based blended learning students' mathematical spatial literacy values can meet the KKM.

METHOD

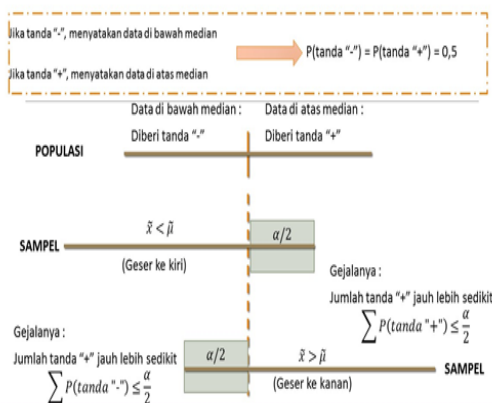
This study used a quantitative research method with descriptive data analysis. The data was conducted through the post-testing procedure which was processed using Quantitative Descriptive Analysis (QDA). The post-test questions are in the form of material on the application of matrices to geometric transformations, and they are to be answered in the form of material.

The type of research was pre-experimental with a one-shot case study research design. The one-shot case study research design is a quasi-experimental study that is conducted without the use of a comparison group and without the use of a pre-test (Wijayanti, 2019). In this study, the project-based blended learning paradigm serves as an independent variable, with mathematical spatial literacy serving as the dependent variable.

There are five questions in the form of descriptions in this study's test. Simple random sample and purposive sampling techniques were used to select 33 students from class XI at a public high school in Bandung Regency, Indonesia. Students' mathematical spatial literacy was observed as part of a project-based blended learning methodology for gathering data for this study. According to Maier's (1998) theory of spatial ability, there are two types of spatial ability: dynamic mental and static mental. These two types of abil-

ity were broken down into various sub-indicators: Dynamic mentality refers to one's ability to anticipate the next waking moment. There are three distinct components of 3D, each of which is related to a certain movement in the wake: spatial perception, visualization, and mental rotation. Third-dimensional shapes can be predicted using mental processes that do not necessitate movement, such as predicting the shape of the wake. There is a shift in the subject-object relationship, but the physical distances between them remain constant. There are two main types of mental static: spatial relations and spatial orientation. The Quasar General Rubric was used to develop the score rules for mathematical spatial literacy (appendix A).

The quantitative data analysis used in this study is in the form of descriptive statistical tests and differential statistical tests. Following calculations correspond to acceptable descriptive statistics (percentage, mean, standard deviation, or correlation); presenting data (boxplot diagram); and interpreting data (in this case, correlation) (Soendari, 2012). In the calculation, differential statistical tests are performed by checking for normality, and hypothesis testing is performed by employing the median test (sign test) on a single sample of the population.



RESULT AND DISCUSSION

Result

The results of the students' mathematical spatial literacy tests were analyzed using IBM SPSS.25. A summary of the descriptive statistics for the test data is shown in the Table 1.

Table 1. Analytical Statistics Students' Test of Mathematical Spatial Literacy

Statistics	
Mean	61.36
Median	60.00
Mode	55
Std. Deviation	20.321
Range	90
Minimum	0
Maximum	90

The graphic representation of the descriptive statistics in the table above is shown as follows (See Figure 2).

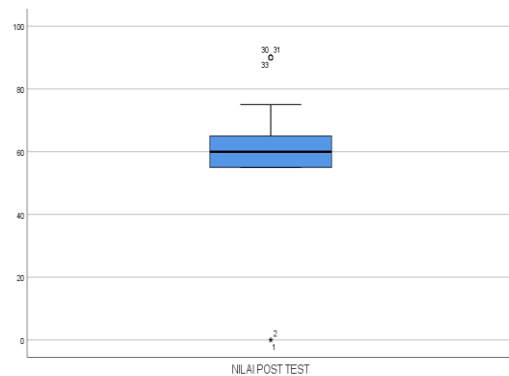


Figure 2. Boxplot Diagram Student's Mathematical Spatial Literacy Test

According to the boxplot diagram, it can be determined that there are three data points that are the top outlier (major outlier) and one data point that is the bottom outlier (minor outlier). This demonstrates that there are three students who have greater scores than the rest of their classmates (exceeding the upper quartile deviation limit). However, there is a student whose score is significantly lower than the average of the other students (over the lower quartile deviation limit).

Furthermore, utilizing the following criteria, students' relational understanding abilities will be evaluated according to their level (high, medium, and low categories).

Table 2. Students' Mathematical Spatial Literacy Criteria

Criteria	Interval	F	%	Categories
$x < \bar{x} - s$	$x < 41$	2	6	Low
$\bar{x} - s \leq x \leq \bar{x} + s$	$41 \leq x \leq 82$	21	64	Medium
$x > \bar{x} + s$	$x > 82$	10	30	High

Description: x indicates the student's score on the mathematical spatial literacy tests' Mathematical Spatial Literacy Criteria.

The category of student abilities based on the criteria above, is represented through the following pie chart (see Figure 3).

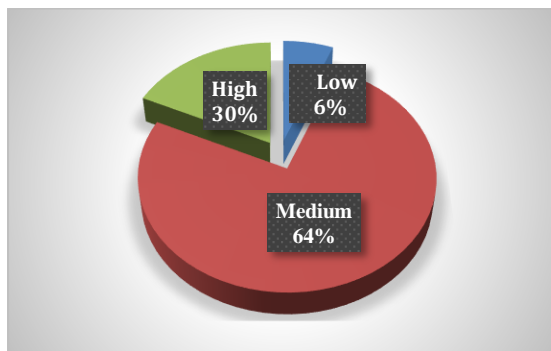


Figure 3. Pie Chart of Mathematical Spatial Literacy Percentage by Ability Category

According to the data in the tables and figures above, most students have mathematical spatial literacy in the medium category, with a percentage gain of 64%. Meanwhile, only a small fraction of students in the high and low categories received percentages of 18% and 6%.

A hypothesis test is conducted for one sample to determine whether mathematical spatial literacy can be achieved after the implementation of the project-based blended learning model to meet the minimum completeness condition (KKM = 75). Previously, the normalcy assumption test had been performed first,

resulting in the results shown in Table 3.

Table 3. Analysis of Post Test Results Normality Test

One-Sample Kolmogorov-Smirnov Test		
POST TEST RESULT		
N		33
Normal Parameters a,b	Mean	77.56
	Std. Deviation	20.321
Most Extreme Differences	Absolute	.316
	Positive	.193
	Negative	-.316
Test Statistic		.316
Asymp. Sig. (2-tailed)		.000

Table 3 shows the results of the Kolmogorov-Smirnov test, which compares the values of probability numbers or Asymptotes. Sig (2-tailed) with a significance level of 0.05 or 5 percent. The Asymp value is determined using the Kolmogorov-Smirnov test. Because the result is less than the level of significance of 0.05 and the sig (2-tailed) is 0.000, it may be concluded that the data is not regularly distributed. As a result, hypothesis testing for one sample is carried out by evaluating the median of one sample, with the hypothesis formulation as follows.

H_0 : $Me = 75$, the median of mathematical spatial literacy that, after using the project-based blended learning model, **can reach the KKM.**

H_a : $Me \neq 75$, the median of mathematical spatial literacy that, after using the project-based blended learning model, **cannot reach the KKM.**

In summary, the results of the sign test (which tested the median of one sample) based on the hypothesis may be shown through the following calculations:

It is found that the least sign is "+" so $x = 11$ and $n = 24$.

$$P(\text{Sign } +) = \sum b(x, n, 0,5)$$

$$\Leftrightarrow P(\text{Sign } +) = \sum b(11, 24, 0,5)$$

According to the binomial table, the result is $P(\text{Sign } X) = 0.0148782$.

In Figure 2, if $P(\text{sign}) \leq \frac{\alpha}{2}$ is $P(\text{sign}) \leq 0,025$, then H_a is rejected and H_0 is accepted. From the results of the calculations obtained $0,0148782 \geq 0,025$, this indicated that H_a is rejected and H_0 is accepted. Therefore, this test concludes that the median student's relational understanding capacity after the project-based blended learning model is implemented can approach or exceed the KKM with a 95 percent confidence interval.

Discussion

In the classroom, the teacher gives information step by step to aid students in understanding the content and explains project assignments that students must complete. Students must provide a project design plan as well as a final report on the project assigned by the teacher that is related to the material being given. In this section, you will find an overview of project-based blended learning activities (attachment B). Following the completion of the learning exercises, students are given a final test in the form of spatial literacy questions. In this section, you can find spatial literacy questions and student responses (attachment c).

According to the descriptive analysis of students' spatial literacy skills on the implementation of the project-based blended learning model, 10 students (30%) were in the high category, 21 students (64%) were in the medium category, and 2 students (6%) were in the low category. Using the average of all sample class pupils, the final score is 77.56, which is higher than the KKM, which stands at 75. Following the results of hypothesis testing, it is possible for students to achieve KKM in their median mathematical spatial literacy once the project-based blended learning model is implemented.

That the project-based blended learning model is being used optimally during the learning process is demonstrated, however much more work needs to be done to improve it, particularly in the present COVID-19 pandemic situation, in which face-to-face learning is limited.

The findings of the implementation of PjBL learning activities are consistent with the findings of Ambarawati et al (2015), Ismayani et al (2016), and I Wayan (2017), who describe several advantages of the project-based learning model, including: a) the discovery of mathematical concepts becomes easier because students are side by side with the media, b) mathematics becomes more real so that it is easily understood by students, c) students' motivation increases as a result of the project-based learning model. This is also in accordance with Setiasih's (2019) perspective, which claims that project-based learning learning activities are more effective than conventional learning models that appear boring in learning since they are able to assist students in constructing their own knowledge.

Although the study discovered several advantages, it also revealed numerous challenges to implementing a project-based blended learning approach, particularly during the online distance learning phase, specifically the lower level of student participation when learning online. For some reason, there has been a low implementation of the face-to-face phase. Teachers and students must maintain a safe distance from one another since they must continue to follow health precautions at the same time as doing face-to-face learning. Project-based blended learning is less effective at improving students' mathematical spatial literacy understanding abilities because of these limits. Suparini, et al. (2021) & Mustakim (2020) found that there are several factors that contribute to less than optimal online

learning, including a lack of learning resources, quota constraints and unstable internet networks that limit communication with teachers; a lack of parental support; and students who feel unable to learn on their own.

According to statistics from the spatial literacy test on geometric transformation material indicate that students with high spatial abilities can solve problems at both the iconic and symbolic stages, while students with medium spatial abilities are primarily capable of solving problems at the symbolic stage. Students completed the iconic stage, but only a tiny percentage completed the symbolic stage, and students with low spatial ability, on average, were unable to finish either the iconic or symbolic stage. While analyzing the spatial literacy test results in terms of the indicators employed, it was discovered that the spatial literacy score on the first indicator (orientation) is significantly higher than the scores on the second indicator (visualization) and the third indicator (relationships).

The average spatial literacy on the second (visual) indication is lower than the average of the first and second indicators, which are the orientation indicator and the relationship indicator, respectively. According to the most recent information available, the average spatial literacy on the third indicator (relationship) is lower than the average spatial literacy on the first indicator (orientation) and higher than the average spatial literacy on the second indicator (visualization).

The results obtained above are consistent with the findings of research conducted by Syahputra (2013) & Azustiani (2017), which found that students with good and medium mathematical spatial abilities can improve their spatial abilities through realistic learning, and that stu-

dents with high and medium spatial abilities are able to complete ability tests. When it comes to spatial ability, the results of the research show that most students have difficulty fulfilling some of the indicators tested, whereas the spatial ability of students who have low abilities, the results show that most students have difficulty fulfilling some of the indicators tested.

CONCLUSION

Based on the findings of the research, it can be concluded that students in class XI at one of the Bandung Regency Senior High Schools who are learning mathematics through a project-based blended learning model are unable to optimize their mathematical spatial literacy abilities. This is in accordance with the results of hypothesis testing, which indicate that the median mathematical spatial literacy capacity of students after the project-based blended learning model is implemented can reach KKM = 75 at a 95% confidence interval.

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