LOGIC
Journal of Engineering Design and Technology
Vol.22 No.1 March 2022; p. 43 - 50

p-ISSN : 1412-114X
e-ISSN : 2580-5649
http://ojs2.pnb.ac.id/index.php/LOGIC

EFFECT SIZE OF MATHEMATICS BLENDED LEARNING DESIGN ON INCREASING MATHEMATICAL PROBLEM-SOLVING ABILITY OF POLYTECHNIC STUDENTS IN THE COVID-19 PANDEMIC PERIOD

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Abstract. **T**he purpose of this study was to determine the magnitude of the effect of blended learning design on increasing Mathematics Problem Solving which is the ability of polytechnic education students during the covid 19 pandemic. The study was carried out at the Bali State Polytechnic, using a mastery-experimental approach, using a pre-test post-test design. non-equivalent controls. design group. The subjects of this research are students of mechanical engineering in the year 2020/2021. Sampling was carried out purposively as many as 10 classes and divided into two groups, namely experimental and control. The data were obtained by using a mathematical ability test developed by the researcher himself. Data were analyzed using inferential statistics, namely t-test and N-Gain scores. Problem solving ability data was measured using a validated test, then analyzed using the average difference test and normalized gain. The results of the analysis show that there is a significant difference in effectiveness between the blended learning and full e-learning models. The blended learning model can be stated to be more effective in improving mathematical problem solving abilities compared to full e-learning or online models. The magnitude of the effect is very large on increasing mathematical solving abilities in learning using blended learning. The implication of this research is that the application of an optimal blended learning design in polytechnic education during the covid 19 pandemic makes the learning process more effective and succeeds in improving students' mathematical problem solving abilities.

Keywords : effect size, blended learning, mathematical problem-solving ability, polytechnics, covid 19.

1. INTRODUCTION

Vocational education is education that prepares students to be able to work using a competency-based approach [1]. In general, the aim is to prepare and produce graduates who have the skills to be able to enter the world of industry, business, and work as well as to continue higher education levels. However, it is preferable to be ready to work, equipped with various knowledge and skills. Vocational education has a very strategic role in handling the workforce and educating them to become skilled, professional, and highly competitive personnel in accordance with 21st-century skills. Vocational education must prepare and implement 21st-century learning by forming 4C skills, namely: Critical thinking, Communication, Collaboration, and Creativity.

Polytechnic is part of higher vocational education that produces graduates who are competent and able to carry out tasks in the industry well and professionally. Graduates must be able to master the necessary knowledge and skills. For example, a technician or analyst for Maintenance-Repair of Automotive and Industrial Machinery.

In addition, polytechnic graduates are required to be able to work with accuracy, that is, on time, in the right size, and with the right rules. Learning at polytechnics must be able to develop students' competence skills so that they are ready to solve various problems in society and at work, so they are ready to enter the world of work in the 21st century. Learning in polytechnic vocational education needs to be packaged in accordance with the development of the learning paradigm in the 21st century and beyond so that it can guarantee job readiness, ability, and career development in accordance with the demands of stakeholders.

Corona Virus Disease 2019 (COVID-19) suddenly appeared in early 2020, causing changes in various aspects of life including education in polytechnics [2], [3]. The polytechnic education system uses a package system with a learning process designed so that graduates are ready to work. The learning process in the field of hard skills is achieved through the application of the concept of learning by doing with the proportion of theoretical material 40% and practice 60%. The learning process should not be stopped and must be sustainable both in theory and practice. The learning has to be held online through e-learning [4]. Lecturers are required to be able to make various innovations in their learning patterns so that the 4C skill development process can continue without being hampered by the COVID-19 pandemic.

At the beginning of 2020, the Covid-19 pandemic suddenly appeared and had an impact on various aspects of life, including vocational education [2], [3]. The learning process at polytechnics should be able to take place continuously without being limited by space and time, namely by learning through e-learning [3]. Lecturers are required to be able to innovate in preparing learning tools and change the face-to-face learning pattern in the classroom into a fully online learning pattern through e-learning.

E-learning is an educational system that utilizes information technology in the teaching and learning process. Through e-learning, learning can be more flexible with respect to time, place and speed of the process, so that individual students have the opportunity to control their own learning. E-learning, has a minimum level of effectiveness equivalent to face-to-face learning [5]. On the other hand, full online learning is considered less able to accommodate all learning needs [6], One of them is the difference in the learning styles of each student. Besides that, the interaction between lecturers and students is still limited even between students [7]. This lack of interaction can slow down the formation of values in the learning and teaching process. The communication process between lecturers and students occurs in one direction. On the other hand, learning requires a two-way communication process. or there is feedback between the two parties. Joyce stated that e learning only increases insight and knowledge, if you want to get an increase in skills and attitudes, real face-to-face activities are needed [8]. Bates and Sangra emphasize that the e-learning model really needs direct face-to-face learning to provide feedback from students to instructors/lecturers and vice versa [9]. The combination of online and offline learning or between e-learning and face-to-face can produce effective and efficient learning. Furthermore, Hameed, Badii, & Cullen stated that the e-learning or online model would be more efficient if it was combined with face-to-face or offline learning [10]. To support and complement each other between e-learning and face-to-face learning, a blended learning model can be used.

Blended learning is learning that combines the advantages of face-to-face learning and online learning. This learning model combines the advantages of face-to-face learning in classroom learning and online learning that can be done anywhere and anytime without distance or time limits. Direct face-to-face learning between lecturers and students was a common lesson in our education before the covid 19 pandemic. Students could discuss, exchange opinions or ideas about certain materials, but time constraints resulted in the face-to-face learning process being not optimal. Through e-learning that can be done anywhere and anytime, the previous learning done face-to-face can be resumed in online learning. The learning process can be more optimal.

Blended learning is very in line with the learning style of the millennial generation, and provides opportunities for students to use ICT to search for information based on big data [11]. The application of blended learning for students will encourage an increase in digital literacy and technological literacy. Blended learning is very relevant to 21st century learning [12], can be a solution in overcoming the weaknesses or shortcomings of e-learning [13], [14]. Combining the advantages of the face-to-face learning model (offline) and the e-learning model (online) will have a good influence and are more suitable for the learning process. [15], [16]. Blended learning has proven to be effective in improving the quality of student learning outcomes and has a positive impact on student academic achievement, including improving students' problem solving abilities [17], have a positive impact on student learning outcomes, skills, and everyday attitudes [18], and can improve students' understanding and thinking skills [19].

Problem solving ability is one of the highest skills and is called higher order thinking, because the results of the solution contain thinking skills, collaboration, communication, and others [20] . This ability is a skill in students, so they are able to use mathematical activities to solve problems in mathematics, problems in other

sciences and problems in everyday life [21]. Problem solving ability has received great attention from researchers in the field of education and is even referred to as a skill that must be mastered in the 21st century [22].

Mathematics is one of the basic science courses that need to be taught at the Polytechnic and is one of the keys in the development of science and technology. Mathematical knowledge and skills are very important in daily life activities and as the basis for the development of science and technology in the world [23]. Mathematics as one of the supporting tools prepares polytechnic students to be able to solve problems in the world of work or everyday life [24]. Mathematics is one of the media in developing student attitudes and skills in polytechnics in the 21st century and beyond.

The problem solving ability faced is an inseparable part of learning mathematics. Skills and abilities in problem solving become an integral part of learning mathematics courses [25], even this method is central in the teaching of mathematics [26]. It should be emphasized that the importance of having mathematical problem solving abilities and skills in students is that they are the goal of teaching mathematics and as the heart of mathematics. [27]. A learning model that is in accordance with the 21st century mathematics learning paradigm is needed, to make it easier for students to achieve these skills. One of the models is schoology-based blended learning.

The implementation of e-learning requires an application, namely a learning management system (LMS). LMS is an application or software used to manage online learning, covering several aspects, namely material, placement, management, and assessment [28]. One of the conditions, educators and students must be connected to an adequate internet network. The features of the LMS to support the online learning process are: discussion forums, learning resource curriculum, quizzes, assignments, types of academic information, and student data management. LMS that can be used in the learning process, including: Schoology, Learnboos, Edmodo, Moodle and others. Schoology in the form of a social web can be used easily by students and lecturers, as well as other social media such as Facebook, Twitter and others. Schoology is an interesting and fun e-learning platform that can be used as a medium for social interaction as well as learning. The advantages of Schoology compared to other LMS include using terms that we usually use on social networks such as Facebook, Moodle, and Edmodo such as recent activity, message, course, resource, groups, assignment, and attendance [29]. Schoology has facilities that Edmodo and Moodle don't have. Another advantage is that attendance figures are available by choosing to be present, permitted, late, or not entering. Every student activity will also be monitored through analytical facilities on course features, assessments, discussions and other activities provided for students. Schoology is also equipped with symbols, equations, and latex. all types of questions that contain pictures, symbols, and equations can be written easily in schoology. Sicat shows that Schoology is effectively used to implement blended learning [30]. Furthermore, Sitinjak, shows that students who are taught using the help of schoology have high learning outcomes compared to conventional learning. Students with visual learning styles who are taught using the help of schoology have the highest learning results compared to other learning styles [31].

Blended learning can be applied in the learning process where the use of online learning resources without leaving teaching and learning activities in the classroom. Online-based technology-supported learning with the help of digital technology. This digital technology assistance will make learning more effective. Through blended learning blended learning students can be trained to master technology and use technology wisely and problem solving skills can be improved. This study aims to determine the effectiveness of the schooloogy-based blended learning model in improving mathematical problem solving abilities in polytechnic students.

2. METHODS

This research is a quantitative research, aiming to determine the effect of blended learning model on mathematical problem solving ability. The study used a quasi-experimental approach, with a pre-test–post-test nonequivalent control group design [32].

Table 1.
Pre-test–post-test Nonequivalent Control Group Design

Class	Pretest	Treatment	Postest
Experiment	O_1	A_1	O_2
Control	O_1	A_2	O_2

Explanation:
O_1 = Pre-test for experimental and control groups
O_2 = Posttest for the experimental and control groups
A_1 = Learning treatment with blended learning model
A_2 = Learning treatment with full e-learning model

The research was carried out in the field of Engineering at a BSP. The population is Engineering students who received applied mathematics courses in 2020/2021 as many as 18 classes spread over 6 majors and 15 study programs. Samples were taken purposively as many as 10 classes and divided into experimental and control groups. The number of members of each group is 130 people. The experimental group was taught to use the Flipped Classroom version of the blended learning model with the LMS Schoology application, while the control group was taught to use the full e-learning model with the LMS Schoology application.

The problem-solving ability test has been developed by the researcher himself. The data obtained from this test have been tested for the level of validity and reliability. The level of validity is at 0.31-0.89. The reliability of the instrument is 0.97 and can be said to be reliable. The difficulty level is at 0.41 with a discriminating power index of 0.25-0.75. Prior to further testing, the normality of the data was tested using the Kolmogorov Smirnov test.

The research sample was tested for pretest and posttest. From the results of the sample test, the instrument validity level is 0.44-0.76, the reliability level is 0.77 (quite reliable), while the difficulty level is 0.63-0.83 and the discriminatory index is 0.23-0.55. Prior to further testing, the normality of the data was tested using the Kolmogorof Smirnov test.

Learning effectiveness is predicted based on a review of the percentage of N-Gain Score. The three results of the analysis show the effectiveness of blended learning as an alternative learning model in improving students' mathematical problem solving abilities and skills. The value category obtained from the N-Gain Score can be determined based on the N-Gain Score value or from the N-Gain Score value in the form of percent (%). In this study the value of N-Gain Score in the form of percent (%). The level of effectiveness of learning using categories from [33] is shown in Table 2.

Table 2.
Category Interpretation Effectiveness of N-Gain Score

Percent (%)	Interpretation
< 40	Ineffective
40< g < 55	Less effective
56 < g < 75	Effective enough
>76	Effective

Source: [33]

Meanwhile, the effect size of design blended learning increasing problem-solving abilities is seen from the results of the effect size test with the formula developed by Cohen 's d in [34] as follows.

$$d = \frac{M_2 - M_1}{\sqrt{\frac{SD_1^2 + SD_2^2}{2}}} \quad (1)$$

Information:
d = effect size
M_1 = Average pretest score
M_2 = Average posttest score
SD_1 = pretest standard deviation
SD_2 = posttest standard deviation

The results of the effect size calculation are interpreted according to the classification developed by Cohen's d in Table 3 below.

Table 3.
Cohen ' s benchmarks for interpreting effect-size estimates

Mean difference effect sizes (d)	Benchmarks
0.00 – 0.19	Insignificant
0.20 – 0.49	Small
0.50 – 0.79	Medium
> 0.8	Large

Source: Cohen ' s in [34]

3. RESULTS AND DISCUSSION

Descriptive analysis showed that the average pretest of the mathematical problem solving ability of the two groups was 43.9 and 43.5, both categorized as low. Both groups had the same initial ability. The post-average mathematical problem solving ability in the group taught using the blended learning model was 79.8, while in the group taught using the e-learning model it was 74.6 both categorized as high. The average student achievement in the blended learning group was higher than the e-learning group.

The results of the normality test of the experimental group's pretest and posttest data showed that the Kolmogorov-Smirnov statistical value showed 0.059 and 0.051 both with sig probability. 0, 200 > 0.05. Similarly, the control group showed 0.052 and 0.043 both with sig probability. 0, 200 > 0.05 The pretest and posttest score data in each group were normally distributed, the normality of the data had been met, the parametric analysis using the t-test could be continued.

The results of the paired t test showed that the correlation between the initial ability (before) and the final ability (after) the learning process in the blended learning group was 0.73 which was categorized as positive, very strong and significant. This means that the correlation between the abilities before and after the learning process is positive and very strong and is actually related significantly (significantly). While in the group that was taught using full e-learning the correlation between initial ability and final ability was 0.43 categorized as positive, strong and significant.

The results of the t-test in the experimental group found that the value of t = -267.1 with a probability (sig. two sides) of 0.00 is less than 0.05, (mean difference 37.2). it means that the ability before and after the learning process is significantly different (mean difference 37.2. The test results for the control value t = -176.9 with a probability (sig. two sides) of 0.00 is less than 0.05. This means the ability before and after the learning process was significantly different with a mean difference of 31.0.

Blended learning can significantly improve mathematical problem solving ability. Furthermore, in the experimental group the percentage of n-gain score pretest with posttest minimum 46.1% and maximum 75.4%. The average percentage of n-gain score between pretest and posttest was 63.6%, categorized as quite effective. Meanwhile, in the control group the percentage of n-gain score pretest with a minimum posttest of 41.5%, a maximum of 68.3%, and an average of 54.89% was categorized as less effective. Schoology-based blended learning model is quite effective in improving mathematical problem solving skills. The results of the different test of the average NGain Score (%) with the t-test show the t value = 13.67 with probability (sig.2-talled) = 0.000, meaning that the t value is significant. The average achievement of the N-Gain score in the control group (54.89%) was lower than the achievement in the experimental class (63.6%). There is a significant (significant) effectiveness difference between the use of the blended learning model and the full e-learning model in improving mathematical problem solving abilities of polytechnic students. The learning process using the full e-learning model can significantly improve mathematical problem solving abilities, but its effectiveness is lower than the blended learning model, as evidenced by the pretest and posset that are categorized as positive and significant but the correlation is weak. The blended learning model is more effective in improving mathematical problem solving abilities than the full e learning model. The blended learning model is more effective in improving mathematical problem solving abilities than the full e learning model. The results of the effect size analysis (d) of blended learning design on increasing mathematical problem solving abilities show the d value of 1.7 > 0.8 which is categorized as very large [12]. The implementation of blended learning design in learning has a very large effect on increasing mathematical problem solving abilities.

The findings of this study support the results of previous studies: 1) research by [35], blended learning is effective in increasing the value of attitudes and responses to media variations, 2) recommendations for the results of ⁽Namyssova's research, increasing the effectiveness of college lectures can be improved. start by applying a blended learning model [36], 3) Adi and Fathono, blended learning is effective and efficient for use in sports schools [37] , 4) Deivam, and Devaki, blended learning is more effective than conventional teaching methods [38], and 4) Paudel, e-learning can be an alternative means of face-to-face learning during Covid-19, but the application of the blended learning approach to the learning process will be more effective and successful [39].

The findings of this study also support the theory expressed by Stein, and Graham that blended learning as a solution to solving the learning gap is currently more focused on face-to-face learning or only online learning [40]. Blended learning can stimulate skills, provide creative attitudes to be able to carry out learning activities independently, activities are not dependent on instructors or lecturers, provide convenience and build independent attitudes for students to be creative and innovative in carrying out learning activities. Blended learning is very appropriate to be applied in the conditions of the covid-19 pandemic, especially in polytechnic education.

Blended learning is a student-centered learning process (SCL). Groups of students who are taught using Blended learning are very likely to be actively involved in learning. Students not only get a learning experience when accompanied by lecturers in class and outside the classroom, but also get a wider learning experience

independently. When studying in class, they get learning materials and learning experiences in the form of orientation, exercises and feedback, examples, and direct motivation from the lecturer. Furthermore, when studying online they will be able to control their own learning time, can study anywhere, anytime and are not tied to the lecturer. They can also study independently or interact easily with lecturers and fellow students and have access to various online learning resources that can be obtained using their gadgets and applications. The variety of learning objects is more complete, which can be in the form of electronic books or electronic articles, simulations, animations, augmented reality), virtual reality, learning videos or other multimedia that can be accessed online [11]. Students become increasingly motivated to learn, and seek information from various online and print sources. Increased motivation to learn and students become very active in looking for supporting materials from various sources, in turn their learning outcomes also increase.

The learning process is the interaction of students, lecturers and learning resources. The process is not only limited to providing information from lecturers to students, but through reciprocal communication between the two parties. In the process of reciprocal communication, students have the opportunity to be actively involved in learning both mentally, intellectually, emotionally, and physically to be able to seek and find knowledge, attitudes, and skills. In the group of students who are taught to use the full e-learning model, there are limited interactions between lecturers and students, even between students [7]. This lack of interaction can slow down the formation of values in the learning process. The communication process between lecturers and students occurs in one direction. Learning requires a two-way communication process or there is feedback between the two parties. The learning process tends towards training rather than education. Students who do not have high learning motivation and willingness to learn independently tend to fail. The success of e-learning is highly dependent on the willingness of students to learn independently [41]. The further impact on those who are taught full e-learning is that there is an impression of loneliness which encourages boredom and boredom in the learning process, learning motivation tends to decrease [13]. In the end it affects the achievement of learning outcomes. Those who are taught using full e-learning get lower learning outcomes compared to those who are taught using blended learning.

Blended learning is learning that combines the best aspects of face-to-face learning with the advantages of online learning. The learning process integrates ICT, combining various methods of delivery, teaching models, learning styles, and various variations of technology-based media. The implementation begins with a learning orientation to prepare face-to-face and online scheduling through clear instructions such as learning materials and assignments that must be done every week, and is also equipped with online and face-to-face learning directions. Online using the schoology model LMS application. The task content in learning includes the making of a structured and systematic project, namely the order of the topics is hierarchically related to the topic of the previous project, there is an increase in the scope of material that must be understood by students, to encourage students to think at a higher level. There is enrichment in each project task that combines online and face-to-face learning, online and face-to-face group discussions with critical thinking elements such as making assumptions and drawing conclusions. Group discussions can be held virtually via video conference using the Zoom cloud meeting application or discussion forum on the groups menu at schoopogy. Group discussion activities can encourage increased ability to collaborate, work in teams, communicate in the classroom and outside the classroom. In doing project assignments, students can innovate and be creative and use technology to produce a quality product. Learning resources or teaching materials are accessed online through learning links such as YouTube and other sites. While working on problem-solving-oriented project assignments, students are encouraged in addition to building higher order thinking skills, collaborating, innovating and being creative, but also being encouraged to improve communication skills, problem solving, technological literacy and data literacy. The application of the blended learning model in polytechnic education can help students achieve 21st century skills. In line with Sahim the blended learning model can improve the performance of vocational education students and produce more effective learning [42].

The application of blended learning with the schoology application makes it possible for learning interactions to occur anywhere and anytime (time and place flexibility). Learning resources have been packaged electronically and are available to be accessed by students via the internet, so they can interact with these learning resources anytime and from anywhere. The tasks of learning activities that have been completed can be submitted to the instructor/lecturer via submission or re-submission assignment on the assignment menu. Students are not tightly bound by the time and place of learning activities as is the case with face-to-face learning. The implementation of blended learning using schoology can provide security and comfort for students, as well as lecturers in carrying out learning activities during the covid 19 pandemic. Blended learning, can reduce mass gathering activities as one of the health protocols to avoid contracting covid-19. However, blended learning remains oriented towards achieving learning outcomes, namely increasing knowledge, skills and attitudes. Online learning can increase insight and knowledge, and face-to-face learning can improve skills, especially in specific

materials where skills are not automatically obtained from increasing knowledge. The implication is that the application of the schoology-based blended learning model in polytechnic education during the Covid-19 pandemic is quite effective in improving students' mathematical problem solving abilities. The implication is that the schoology-based blended learning model can be used as an innovative learning strategy in mathematics learning for vocational education, especially polytechnics.

4. CONCLUSION

There is a significant difference between the average mathematical problem solving ability of students taught using the blended learning model and being taught using the full e-learning model. The blended learning model is more effective in improving mathematical problem solving abilities than the full e learning model. The effect size is very large on increasing mathematical solving abilities in learning using blended learning based on schoology. The implication is that the optimal application of the blended learning model in polytechnic education during the covid 19 pandemic, the learning process becomes more effective and succeeds in improving students' mathematical problem solving abilities.

5. ACKNOWLEDGEMENT

We would like to thank the Directorate of Research and Social Services, Ministry of Research, Technology and Higher Education for their financial support so that this research can be carried out properly. The 2021 Research Contracts are numbered: 32/PL8/PG/2021 and 180/E4.1/AK.04.PT/2021. We also thank all validators, practitioners, mathematics lecturers, all BSP engineering students, and the entire editorial team.

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