

## **Effect Size Digital Mathematics Textbook in Blended Learning Assisted by Schoology Improves Mathematical Problem Solving Ability for Polytechnic Students**

**I Ketut Darma<sup>1✉</sup>, I Gede Made Karma<sup>2</sup>, I Made Anom Santiana<sup>3</sup>, and Ni Wayan Sadiyani<sup>4</sup>**

<sup>1,4</sup> Department of Mechanical Engineering, Politeknik Negeri Bali

<sup>2</sup> Department of Accounting, Politeknik Negeri Bali

<sup>3</sup> Department of Civil Engineering, Politeknik Negeri Bali

✉ Jalan Kampus Bukit Jimbaran, P.O. Box. 80364 Kuta Selatan, Tuban Badung Bali, Indonesia

✉ [ketutdarma@pnb.ac.id](mailto:ketutdarma@pnb.ac.id)

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### **ABSTRACT**

This study aims to determine the effect size of digital mathematics textbooks in blended learning assisted by Schoology to improve mathematical problem-solving abilities in polytechnic students. The research was conducted at the Bali State Polytechnic (PNB), using the Research & Development method with a 4-D model (define, design, develop, and disseminate). Currently, the dissemination stage is carried out through an effectiveness test using a quasi-experiment approach, with a one-group pretest-posttest design. The subjects are PNB engineering students in 2020/2021, and 10 classes are taken by purposive sampling. Data were collected using a mathematical problem-solving ability test and analyzed using a t-test, N-Gain scores, and effect size. The results of the analysis show that the effect size of digital mathematics textbooks to improve mathematical problem-solving skills in Schoology-assisted blended learning is very large. The implication is that increasing the ability to solve mathematical problems through blended learning assisted by Schoology for polytechnic students will be quite effective if it is facilitated by digital mathematics textbooks.

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## **INTRODUCTION**

Vocational education is a type of education that produces graduates who are ready to work with high job skills according to the needs of the business and work world. Vocational education focuses on the world of work and industry (Sudira, 2018). The expected output is knowledge and work skills obtained from the application of the learning-by-doing process.

Polytechnic is part of vocational higher education. In the 21st century, polytechnic graduates are required to be able to master the knowledge and skills needed by the industrial world, business, and the world of work and be able to work with proper and correct procedures. Learning at the

polytechnic must develop student work competency capabilities to be ready to solve various problems in the world of industry, business, and work. Learning needs to be packaged according to the focus of 21st-century learning.

21st-century learning is learning designed for the 21st-century generation, integrating literacy skills, knowledge, skills, and attitudes to be able to keep up with the latest technology and information developments. One of its characteristics is the blended learning approach. Blended learning combines the advantages of online learning, face-to-face activities in class, and contextual practice (Semler, 2005). This learning combines the advantages of face-to-face learning models directly in class and online learning that can be done anywhere and anytime.

Blended learning is a combination of synchronous and asynchronous learning (Smaldino et al., 2012). Synchronous directly as the 1st study room; a learning environment that occurs at the same time and place. Synchronous virtual is the 2nd learning space, a learning environment occurs at the same time in different places. Independent asynchronous as the 3rd learning space, a learning environment occurs independently, anytime, and anywhere according to the conditions and learning styles of each. Collaborative asynchronous is the 4th learning space, a learning environment that occurs anytime and anywhere through collaboration between two or more people.

The learning process that takes place can use the other three learning spaces optimally, namely: virtual synchronous, independent asynchronous, and collaborative synchronous. These three study rooms have become a habit for teachers, students, and parents. Its implementation, referring to the application of distance learning principles, prioritizes independent learning with asynchronous learning activities with the implementation pattern first in study rooms 3 and 4 and then in study rooms 2 (Chaeruman, 2020). Learning can be packaged using a problem-based learning approach (Dwiyogo, 2014).

In the implementation of blended learning, five keys must be implemented, one of which is performance support materials (Carman, 2002). Performance support materials are performance support tools and materials, one of which is textbooks. Textbooks are a set of teaching materials arranged systematically, displaying a form of competency that students will master in their learning process (Dick et al., 2005). Textbooks need to be adapted to the conditions of students and the learning strategies used by lecturers. Textbooks are formatted in digital form and must be accessible to students both offline and online so that study participants can study independently (Chaeruman, 2019).

Digital textbooks are independent teaching materials packaged electronically for students so they can study independently online or offline. The material for digital textbooks is presented using a special application so that it can be read with digital devices such as smartphones or cellphones, laptops, and the like. The use of digital textbooks can increase the effectiveness of learning because the content is equipped with various interesting simulations/animations as well as virtual experimental designs that can lead students to be involved in or experience the science process. Digital textbooks are considered more profitable than using printed teaching materials.

Blended learning requires an application, namely the Learning Management System (LMS). LMS is an application used to manage online learning, containing aspects of material, placement, management, and assessment (Mahnegar, 2012). Many types of LMS can be utilized in the learning process, one of which is Schoology. Schoology is an LMS in the form of a social web offering free classroom-like learning. Schoology has facilities that other LMS do not have, such as the equation facility for writing mathematical expressions. Another advantage is that attendance figures are available by selecting attendance, permission, being late, or not entering. Schoology is effectively used to implement blended learning (Sicat, 2015).

Mathematics is one of the basic sciences taught in polytechnics, playing an important role in the development of science and technology. Mathematical skills and knowledge are very important in everyday life and as a basis for the development of science and technology (Aziz, 2002). Mathematics as a supporting tool prepares polytechnic students to be able to solve problems (Nagasaki, 2015). Mathematics is a medium for developing the attitudes and skills of polytechnic students in the 21st century.

Problem-solving ability is an inseparable part of learning mathematics. Problem-solving abilities are an integral part of learning mathematics (Wahyudin, 2008), and are even used as a centre for teaching mathematics (Ruseffendi, 2006). The ability to solve mathematical problems is very important for students to have because this ability is one of the objectives of teaching mathematics, even as the heart of mathematics (Branca, 1980). To facilitate students in achieving these skills in blended learning assisted by Schoology, learning resources are needed that are following the 21st-century mathematics learning paradigm. One of them is mathematics textbooks in the form of digital textbooks.

Mathematics digital textbooks are developed based on instructional principles, so they can be good teaching materials. Some of the instructional principles that must be considered are the principles; relevance, consistency, and adequacy (Akbar, 2013). Good teaching materials are said to be good if they fulfil: 1) aspects of validity, (2) aspects of practicality, and 3) effectiveness (Trianto, 2007). Furthermore, teaching materials are said to be valid if they meet content validity and construct validity (Rochmad, 2012). Practicality refers to the level of user intervention considerations that can be used and preferred under normal conditions (Van Den Akker, 2005). While effectiveness refers to the achievement of goals (Mulyasa, 2007). The effectiveness of the level or degree of application of teaching materials (Rochmad, 2012).

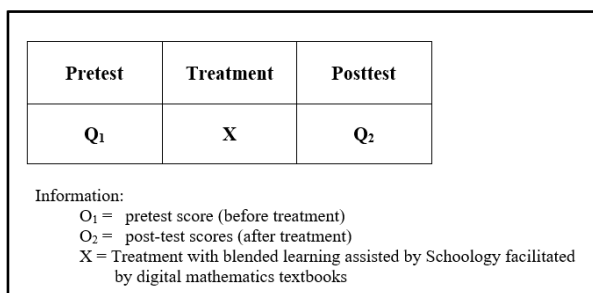
So far, teaching materials that are following the focus of 21st-century learning have not been available. On the other hand, teaching materials have a very important role in every education system, utilization of appropriate teaching materials in the learning process can increase student activity in learning (Prastowo, 2013). Digital teaching materials in the form of interactive e-modules based on Android are effectively used to improve student learning outcomes in the learning process (Sidiq & Najuah, 2020).

Textbooks and blended learning are essential in supporting the learning process so if the two are combined, it is believed that they will be able to help students complete their education in the digital era. This study aims to obtain effective textbooks in blended learning assisted by Schoology to improve mathematical problem-solving abilities. The research was carried out in

stages, and a valid and practical prototype of a digital textbook was obtained. The current stage in 2021 aims to determine the effect size level of the prototype developed.

## METHODS

This study used the Research & Development (R&D) method to obtain digital mathematics textbooks for blended learning. Implemented in stages in the field of Engineering BSP. Using a 4-D development model: 1) Define, 2) Design, 3) Develop, and 4) Disseminate (Trianto, 2011). Currently, the dissemination stage is being carried out by testing the effectiveness of the product. The dissemination stage is carried out to promote the product so that it can be accepted by users or the system. Dissemination also aims to test the effectiveness of digital textbooks in improving mathematical problem-solving skills in Schoology-assisted blended learning. The effectiveness of textbooks can be seen from changes in the results of the pretest and posttest of students' ability to solve math problems. The test was carried out through a quasi-experiment with a one-group pretest-posttest design (Sugiyono, 2017) as presented in Picture 1. The subjects are mathematics lecturers and students in Engineering at the BSP.



Picture 1: One Group Pretest-Posttest Design  
 Author [source]

The sample size of 10 classes with 130 subjects was taken by purposive sampling from 18 classes in 8 study programs. The sample class was taught using the Flipped Classroom version of the blended learning model assisted by the Schoology application and digital mathematics textbooks.

Pretest and posttest data were collected using a mathematical problem-solving ability test developed by the researcher himself. The validity level of the test ranges from 0.44 to 0.76 in the moderate to high category. Variations in the level of validity of the test ranged from moderate to high. The reliability of the test was 0.77 in the high category, and the consistency of the measurement results was in the high category. The difficulty level of the test ranges from 0.63 to 0.83. The variation in the difficulty level of the test questions ranges from medium to easy. While the test discriminating power index is between 0.32 to 0.55. Variations in the level of the ability of the questions in the test to distinguish between the high achievers and the low achievers among testers ranged from moderate to good. After testing the requirements analysis, the data were analyzed using the t-test, the N-Gain score, and the effect size. The effectiveness of textbooks is measured based on the achievement of the percentage of the N-Gain Score. The achievement category is determined based on the percentage of the N-Gain Score (%). The effectiveness level of textbooks uses the categories from Hake (1998) in Table 1.

Percentage	Interpretation
< 40	Ineffective
40 < g < 55	Less effective
56 < g < 75	Effective enough
> 76	Effective

Table 1: Categories of N-Gain Effectiveness Interpretation  
 Hake, 1998 [source]

Meanwhile, the effect of textbooks on increasing problem-solving abilities is seen from the results of the effect size test with the formula developed by Cohen d in (Dunst & Hamby, 2012) as follows.

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

Information:

- d = effect size
- M<sub>1</sub> = Average pretest score
- M<sub>2</sub> = Average posttest score
- SD<sub>1</sub> = pretest standard deviation
- SD<sub>2</sub> = posttest standard deviation

The results of the effect size calculation are interpreted according to the classification developed by Cohen's d in Table 2 below.

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

Table 2: Cohen's benchmarks for interpreting effect-size estimates  
 Cohen's in (Dunst & Hamby, 2012) [source]

## RESULTS AND DISCUSSION

The effectiveness test begins with measuring initial abilities through a pretest of mathematical problem-solving abilities. After the learning process ends, it is continued to measure the final ability through the post-test. The average pretest of mathematical problem-solving abilities is 43.9 in the low category, with a minimum of 42.8, a maximum of 46.8, and a standard deviation of 1.65. While the average post-test ability to solve mathematical problems is 79.98 which is in the high category, the minimum is 74.9, the maximum is 85.8, and the standard deviation is 2.3. The posttest average is much higher than the pretest. The results of testing the analysis requirements, pre-test and post-test data showed the value of the Kolmogorov-Smirnov statistic 0.059 with a significant probability of 0.200 > 0.05. pretest and posttest scores proved to be normally distributed, and parametric analysis using the t-test can be continued.

The results of the t-test between the initial ability (before) and final ability (after) of the learning process show that the value of t = -267.1 with a probability (two-tailed sig.) 0.00 is less than 0.05, (mean difference 37, 2). The ability before and after the learning process is significantly different.

Textbooks resulting from the development can significantly improve the ability to solve mathematical problems.

The percentage of n-gain pre-test scores with an average post-test achievement of 63.6% is categorized as quite effective, with a minimum of 46.1%, a maximum of 75.4%, and a standard deviation of 5.69. Digital mathematics textbooks are effective enough to be used as companion teaching materials in the implementation of the Schoology-assisted blended learning model to improve mathematical problem-solving abilities. The results of the analysis of the effect size ( $d$ ) of textbooks on improving mathematical problem-solving abilities show a  $d$  value of  $18.6 > 0.8$  which is in the very large category (Cohen's in (Dunst & Hamby, 2012)). Digital mathematics textbooks have a very large effect on increasing problem-solving abilities in math problems in Schoology-assisted blended learning.

Digital mathematics textbooks for blended learning, the material refers to the 2014 IQF curriculum, divided into two textbooks. The structure: Introduction page, Nas page (body of the book), and End page. The introduction page consists of a title page, table of contents, list of figures, list of tables, introduction, preface, and discourse. The NAS page (body) contains a detailed description of each chapter, and sub-chapters accompanied by examples, and practice questions. At the end of each chapter, a summary is given to make it easier for the reader to remember important things. The closing page consists of appendices, a bibliography, majors (index), and a glossary

Textbooks are packaged into textbooks of Applied Mathematics I and II. The material is compiled based on the following principles: relevance, consistency, and adequacy (Widodo & Jasmadi., 2008); (Noviarni, 2014). The depth refers to the aspects contained in the learning outcomes of the course, and the learning sub-achievements, while the structure of the material content is based on a hierarchical approach (Widodo & Jasmadi., 2008). Both are formatted using Flip PDF and integrated into the Schoology Resource menu. In some parts of the material, audio, and video tutorials are inserted. The delivery approach uses problem-based learning. Evaluation of learning uses a form of test that is packaged in a competency test at the end of each chapter.

Blended learning is implemented using the Schoology application, uploaded to the website page [www.schoology.com](http://www.schoology.com), and integrated into the resource menu. Both are inserted with audio, and video tutorials explaining a real problem, so that they can enrich the learning experience of students, and can be stored and read in electronic communication storage (smartphones). Students can access it through the site [www.schoology](http://www.schoology) so that it can be taken anywhere, read, and studied anywhere without the need for a special room.

The content of this digital mathematics textbook is also constructed based on predetermined material and is described by Competency Standards, Basic competencies, Indicators, and learning outcomes adapted to the problem-based learning model. The material is very interesting, easy to operate, helps understand concepts, and helps students learn independently. Make it easier for students to practice independently by following the available learning video steps.

Mathematics digital textbooks support the learning process, students can be actively involved, and learning becomes interesting and meaningful. Student motivation and interest tend to increase and be positive. Learning with digital textbooks can train students to become problem solvers. Because

the use of digital textbooks can direct student attention and encourage student interest in learning: understanding problems, planning solutions, solving problems according to plan, and re-examining the results obtained. So that it can provide opportunities to grow problem-solving skills, especially on indicators of understanding problems and solving problems. Its application does not always require an internet connection.

Digital mathematics textbooks are effective enough to be used as teaching materials in blended learning, but small revisions are still needed to optimize them so that the material students learn becomes more meaningful and systematic. Mathematics digital textbooks in blended learning assisted by Schoology are quite effective and have a huge effect in improving the ability to solve mathematical problems for polytechnic students. The implication is that improving mathematical problem-solving abilities in blended learning assisted by Schoology will be quite effective in increasing mathematical problem-solving abilities if assisted by digital mathematics textbook media.

## CONCLUSION

The effect size of digital mathematics textbooks is very large, increasing the ability to solve mathematical problems in blended learning. The effect is very large on increasing mathematical solving abilities in Schoology-assisted blended learning. The implication is that increasing the ability to solve mathematical problems through blended learning assisted by Schoology will be quite effective if facilitated by digital mathematics textbooks.

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