**Journal of Instructional and Development Researches**
Homepage: https://www.journal.iel-education.org/index.php/JIDeR
e-ISSN: 2807-5471; p-ISSN: 2807-548X

JIDeR, Vol. 4, No. 1, February 2024

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# Development of Mobile Learning Teaching Materials on Opportunities to Improve Students' Mathematical Communication Skills in Vocational High Schools

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DOI: https://doi.org/10.53621/jider.v4i1.272

**Informasi Artikel**

**Article History:**
Received: January 31, 2024
Revised: February 05, 2024
Accepted: February 10, 2024
Published: February 29, 2024

**Keywords:**
Development of Mobile Learning; Teaching;
Mathematical Communication Skills.

**ABSTRAK**

Another fact that was discovered was the low average daily mathematics test scores in one of the State Vocational Schools. This fact influences mathematics learning and the greatest difficulty is carrying out mathematical communication and problem solving on the questions given. The following is the average value of daily tests on Opportunity material for the last three years at SMKN. To respond to the problem of students' low mathematical communication skills, the enormous demand for progress in science and technology, it is very necessary to make changes to the learning process, especially the selection of appropriate mathematics teaching materials. One example is developing an Android-based teaching material or mobile learning. The use of smartphones in learning allows students to carry out learning activities by accessing learning materials, directions and information anywhere and at any time without limited space and time. Mobile Learning also overcomes time constraints and is able to train students to learn independently from various sources. Students whose learning received procedural scaffolding with the help of smartphones were better than students who received conventional learning. This mobile learning teaching material is said to be effective based on student response questionnaire data and mathematical communication test results data obtained. The results of the student response questionnaire obtained a percentage of 95% with the criteria of being very effective for use in learning. Meanwhile, the percentage of learning completion results was 98% with a very high learning completion interval. The use of mobile learning teaching materials has an influence on students' mathematical communication skills. The average score of the experimental class students' mathematical communication ability test results in each school was higher than the control class. The average score for the experimental class at SMKN 1 Rejotangan was 85.00 while the average score for the control class was 76.15. The average score for the experimental class at SMKN 1 Boyolangu was 85.64, while the average score for the control class was 78.62. The average score for the experimental class at SMKN 2 Tulungagung was 82.79 while the average score for the control class was 75.99. After comparison and analysis, it was concluded that there was a difference in the test results of students' mathematical communication skills between the classes given the action and the control class.

## INTRODUCTION

The development of science and technology in this era of globalization is very rapid, in the learning process there is a lot of technology that can be used as a learning aid both in school and outside school (Rahmania Abida and Anggun Badu Kusuma, 2019 ) This requires the world of education to participate in innovation in using it as a learning medium, with the hope of being able to produce a quality generation. In accordance with the formulation in the preamble to the 1945 Constitution and supported by Law Number 20 of 2003 concerning the National Education System as stated in Article 3, education in Indonesia has a goal that supports the creation of qualified human resources. Therefore, good education is able to produce good

human resources in line with expectations (C. Cecep, Anwar Mutaqin and Aan Subhan Pamungkas, 2019).

Good education must be supported by adequate infrastructure and make it easy for students to access learning resources quickly. The existence of online learning which was carried out some time ago has provided a lot of experience, especially in the world of education, to create flexibility in resources and teaching materials. Online learning that has been carried out really demands the ability to face situations that are likely to shift completely to online form (Charles Hodges, 2020) We know that online learning can hinder communication between students and their learning environment at school. Educators and students can face many technical difficulties that hinder the implementation of the learning process (Thomas Favale, 2020).

Technology used in the learning process is able to influence curriculum development in three ways, namely: the use of new technology becomes a social goal of the curriculum, technology provides resources for curriculum development because it can enable educators to find and collect teaching materials and also guide students in learning , technology can provide tools to assess various areas of practice, such as simulation, which is creating models or visualization tools in certain areas of science (Isma Ramadhani, 2015).

Teaching materials in the learning process need to be implemented, in order to create effective and efficient learning (Lukman and Ishartiwi, 2014) The packaging of *mobile learning* teaching materials contains a summary of the material starting from concept maps, contextual problems In everyday life, simulations, *worksheets* and quizzes will really help students to understand a concept of teaching material. The use of *mobile learning* really needs to be implemented to create fun learning (Muhammad Ashim, 2015) The advantage of *mobile learning* teaching materials is that they enable students to learn independently, dare to try and are not afraid of making mistakes because they are used to using *smartphones*.

According to NCTM, there are five competencies in mathematics learning, namely mathematical problem solving, mathematical communication, mathematical *reasoning*, *mathematical connections* and mathematical *representation* (*National Council of Teachers of Mathematics, 2020)* Competence in mathematics consists of the basic skills and knowledge needed to be able to carry out mathematical calculations and the ability to think in mathematics. There are many difficulties in communicating mathematical language, so it is very important to develop mathematical communication skills (Abdul Rosyid, 2020).

Communication skills relate to the ability to explain, express opinions, listen and report thoughts. In line with this opinion, mathematical communication skills are the ability to express mathematical ideas verbally or in writing in the form of images, graphs and other visuals. (Romah, 2018) The average mathematical communication ability of vocational school students is relatively low. This is based on students' assumptions that mathematics is difficult to understand and difficult to communicate. Sometimes they are able to find the final result of a problem, but find it difficult to write down the process and steps. Students' ability to communicate ideas is still lacking due to difficulties in expressing them (Afria Alfitri Rizqi et al, 2016).

Another fact that was discovered was the low average daily mathematics test scores at one of the State Vocational Schools in Tulungagung. This fact influences mathematics learning and the greatest difficulty is carrying out mathematical communication and problem solving on the questions given. The following is the average value of daily tests on Opportunity material for the last three years at SMKN 2 Tulungagung. In the 2019/2020 school year, the average student test result score was 69.75 with the school KKM that had to be achieved at 77. In the 2020/2021 school year the average student test result score was 70.25 with the school KKM that had to be achieved at 77. For the 2021/2022 academic year, the average student test score is 70.75 with the school's KKM that must be achieved at 77.

To respond to the problem of students' low mathematical communication skills , the enormous demand for progress in science and technology, it is very necessary to make changes to the learning process, especially the selection of appropriate mathematics teaching materials. One example is developing an *Android*- based teaching material or *mobile learning* . The use of *smartphones* in learning allows students to carry out learning activities by accessing learning materials, directions and information anywhere and at any time without limited space and time (Purnama, Sesunan, and Ertikanto, 2017) *Mobile Learning* also overcomes time constraints and is able *to* train students to learn independently from various sources . Students whose learning received procedural *scaffolding* with the help of *smartphones* were better than students who received conventional learning (Huang, Wu, and Chen, 2012).

The material chosen in this research and development is opportunity. Opportunity or also called probability shows how likely it is that an event or incident will occur. Many students sometimes complain about the process of solving probability questions , they think it is quite difficult to understand contextual questions. This is supported by the test results given by researchers during observations in SMKN Tulungagung. Of the 3 6 students the average student score was 5.6. Some of the problems include students not being able to understand the core problem of the problem given so they write the mathematical model incorrectly, students are able to determine the solution to the final result but do not use mathematical symbols or notation correctly, and there are also students who are less able to carry out mathematical operations correctly. thus writing a wrong conclusion.

The subjects chosen for this research and development were State Vocational School students throughout Tulungagung Regency. Based on observations in the field, vocational school students have lower interest in learning mathematics than high school students, especially in normative subjects. This is possible because vocational school graduates are better prepared to be able to work. So their main focus in general is to study productive lessons rather than other subjects. Low interest in learning will also affect mathematical abilities. With interesting and interactive teaching materials, it is hoped that it will be able to increase vocational school students' interest in learning and improve their mathematical communication skills.

## RESEARCH METHODS

This research is a development research or *Research and Development (R&D)* procedural model, namely a descriptive model, showing the steps that must be followed to produce a product. *Research and Development (R&D)* is a research method used to produce certain products and test the effectiveness of these products (Sugiyono , 2017).

This research uses the research method for developing *Mobile Learning* teaching materials using the Borg and Gall development model. The Borg & Gall development model contains a systematic guide to the steps taken by researchers so that the product they design has appropriateness standards. The steps of this development model have ten work steps including; 1) initial information gathering stage, (2) planning stage, (3) initial product development stage, (4) initial field trial stage, (5) revision stage of initial field trial results, (6) field trial stage, ( 7) product revision stage, (8) field implementation test stage, (9) final product revision stage, (10) dissemination and implementation stage (Sugiyono , 2017).

The following is a flow chart of the Borg and Gall development model.

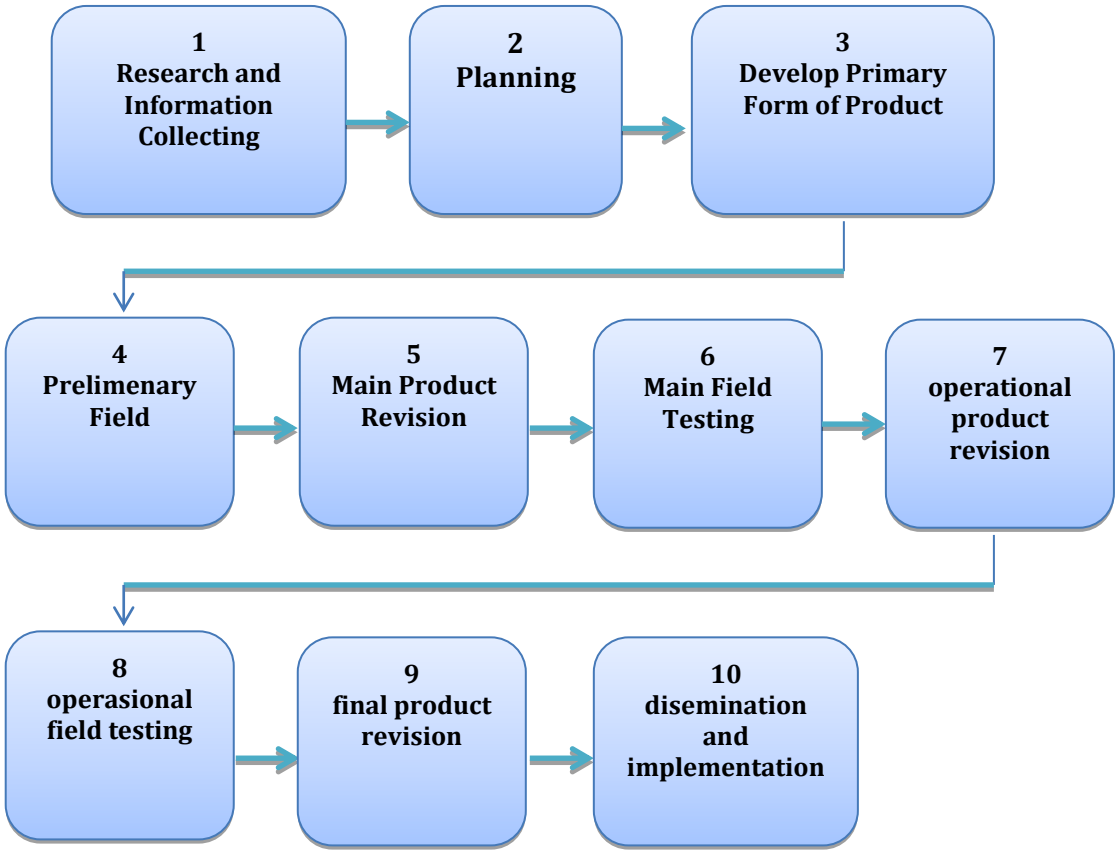


**Figure 1.** Steps for Using Research Methods and Development according to Borg and Gall (Borg, WR & Gall, MD Gall, 1983)

## RESULTS AND DISCUSSION

Based on the explanation of the problem formulation, points have been obtained which are the objectives of developing *mobile learning teaching materials*, namely as follows:

1. *Mobile Learning* Teaching Materials

This research is a development research or Research and Development (R&D) procedural model, namely a descriptive model, showing the steps that must be followed to produce a product. Research and Development (R&D) is a research method used to produce certain products and test the effectiveness of these products (Sugiyono, 2017) This research uses development research methods with the Borg and Gall development model. The steps of this development model have ten work steps including; 1) initial information gathering stage, (2) planning stage, (3) initial product development stage, (4) initial field trial stage, (5) revision stage of initial field trial results, (6) field trial stage, (7) product revision stage, (8) field implementation test stage, (9) final product revision stage, (10) dissemination and implementation stage (Sugiyono, 2017).

Research begins with collecting information as a basis for developing teaching materials. Based on the problems at the needs analysis stage, it is known that the student learning process has not been supported by flexible learning resources that can make it easier for students to learn. Many of them feel bored with monotonous learning using the same teaching materials. So students' interest in learning and mathematical communication skills are low. For this reason, researchers have developed products in the form of *mobile learning* teaching materials that are more interesting and flexible to use anytime, anywhere.

From the results of the initial information collection carried out through interviews, the

next step for the researcher is to plan the teaching materials that will be developed . The planning stage begins with reviewing the implemented curriculum, the expected competency achievements, then continues with developing learning objectives and the flow of learning objectives. After that, prepare teaching materials and tests to measure students' mathematical communication skills.

The initial development stage of teaching materials is carried out according to the content framework resulting from curriculum and material analysis, so that the author can form an initial product or product design. In the initial design of this teaching material product, the material presented was in accordance with the material contained in the Opportunity Teaching Module. After developing teaching materials, an expert validity test is carried out. By being validated by several experts, it is hoped that the product will be suitable for use in learning.

The next stage, namely initial field trials, is needed to assess the product developed for students. This product trial was carried out on limited trial subjects. During the limited trial, researchers conducted observations, interviews and questionnaires which were then analyzed. The results of limited group trials will show what the shortcomings of the product that has been developed are so that it can be used as material for product revision.

The next trial is by conducting a field test that covers a wider range of subjects than the limited trial. At this stage it is also to find out student responses and provide an assessment of the quality of the product being developed. After that, product revisions will be carried out according to student responses. The final trial stage was a field implementation test carried out in three schools.

After the field implementation test, of course there was still a shortage of teaching materials. At this stage the researcher makes final improvements to produce the final product. The final stage is dissemination and implementation by conveying the results of the development to users, namely teachers and students, especially at State Vocational Schools in Tulungagung, generally in all Vocational Schools.

2. *Mobile Learning* Teaching Materials

The feasibility of teaching materials is obtained from the results of test data on the validity and practicality of teaching materials. Based on the formula for the validity and practicality of teaching materials presented in chapter III, the following results were obtained:

a. The results of the validity of teaching materials by media experts obtained a percentage of 84% in the valid category.
b. The results of the validity of teaching materials by material experts obtained a percentage of 89% with a valid category.
c. The results of the practicality of teaching materials were obtained from the analysis of user activity observations, the percentage of students asking questions was 19% with the criteria that they could be used without revision. Meanwhile, the results of the teacher response questionnaire obtained a percentage of 96% with very practical criteria for use in learning. It can be concluded that *Mobile Learning teaching materials* are practical teaching materials.

Based on the results of the validity and practicality test analysis of these teaching materials, these teaching materials were declared suitable for use and dissemination.

3. *Mobile Learning* Teaching Materials

*Mobile learning* teaching material is said to be effective based on student response questionnaire data and mathematical communication test results data obtained. The results of the student response questionnaire obtained a percentage of 95% with the criteria being very effective for use in learning. Meanwhile, the percentage of learning completion results was 98% with a very high learning completion interval.

The results of research data analysis concluded that the average score of the *mathematical* communication ability test results for experimental class students in each school obtained higher results than those in the control class. The average score for the experimental class at SMKN 1 Rejotangan was 85.00 while the average score for the control class was 76.15. The average score for the experimental class at SMKN 1 Boyolangu was 85.64, while the average score for the control class was 78.62. The average score for the experimental class at SMKN 2 Tulungagung was 82.79 while the average score for the control class was 75.99. After comparison and analysis, it was concluded that there was a difference in the test results of students' mathematical communication skills between the classes given the action and the control class.

It is known that in each school that was used as a research site, the use of *mobile learning teaching materials* equally had an influence on the results of students' mathematical communication *skills* with a medium effect. At SMKN 1 Rejotangan, the influence of using *mobile learning* on students' mathematical communication skills was 0.77 with a medium effect. At SMKN 1 Boyolangu, the effect of using *mobile learning* on students' mathematical communication skills was 0.66 with a medium effect. Meanwhile, at SMKN 2 Tulungagung, the effect of using *mobile learning* on students' mathematical communication skills was 0.54 with a medium effect.

The factor that causes the research results to have the same influence in each school is because the researcher chose a research location designated as a Vocational School Center of Excellence with a particular concentration of expertise. Meanwhile, the classes chosen as research classes are classes with a concentration of superior expertise in each school (Achi Rinaldi, 2018).

Based on the analysis of research results, students' mathematical communication skills on opportunity material are better after using *mobile learning teaching materials*. Two important reasons why mathematical communication in mathematics learning needs to be developed are that mathematics is not just a tool to help find patterns, solve problems, or draw conclusions, but mathematics as a social activity in mathematics learning, mathematics as a vehicle for interaction between students and also between teachers and students (Duishenova, 2018).

Communication is an essential part of learning mathematics, because learning mathematics is not only learning to solve mathematical problems, but also learning to communicate mathematical ideas (MK Abadi, 2017). Through communication in mathematics, students can develop the ability to understand mathematical material, learn to make arguments about mathematical problems, and represent mathematical ideas orally, mathematical images, graphs, and mathematical symbols (E. Kosasih, 2020).

Obstacles encountered during mathematics learning using *mobile learning teaching materials* include: (1) The condition of students at the beginning of the meeting who had a little difficulty adapting to *mobile learning teaching materials* , considering that so far they had studied without using mobile devices, (2) Some students had difficulty installing application, due to insufficient cellphone memory, (3) Students' mathematical communication skills on set problems are still low, even though this ability is a prerequisite for students' success in solving problems on probability material. This is quite hampering the learning process during the research (Siti Nurhidayati, 2013).

Based on the interview results, it shows that learning using *mobile learning teaching materials* is positive, fun, not boring, does not make you sleepy, and students are interested in studying the questions given. The use of smartphones is quite helpful for students to be able to study in class or when students study at home.

According to students, by having material and practice questions on smartphones, students have the opportunity to ask for help from other people to learn to understand

material or questions that they find difficult. Sometimes students have difficulty explaining what becomes a problem in understanding the material because they are unable to understand the teacher's explanation. However, with a smartphone, this can be handled well.

**Table 1.** Recapitulation of Results of Mathematical Communication Skills of Class Students at SMKN Per Indicator

| No. | Indicator | Maximum Score Percentage | Criteria |
|---|---|---|---|
| 1. | Explain ideas, situations and mathematical relationships orally or in writing with real objects, pictures, graphs or algebra | 87% | Very good |
| 2. | Connect real objects, pictures, or diagrams to mathematical ideas | 57% | Very good |
| 3. | Read with understanding a written mathematical presentation | 50% | Very good |
| 4. | Expressing everyday events in language or mathematical symbols | 52% | Very good |
| 5. | Explain or ask questions about the mathematics you have learned | 57% | Good |
| 6. | Develop arguments, formulate definitions and generalizations | 65% | Good |

**Table 2.** Results of Mathematical Communication Ability Criteria for SMKN

| No. | Criteria | The number of students | Percentage |
|---|---|---|---|
| 1. | A (Very Good) | 28 | 74% |
| 2. | B (Good) | 9 | 24% |
| 3. | C (Fair) | 1 | 2% |
| 4. | D (Less) | 0 | 0% |

**Table 3.** SPSS output for the t-Test at SMKN

**Group Statistics**

| | CLASS | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| The value of mathematical communication | Experiment class | 40 | 84.9997 | 11.81473 | 1.86807 |
| | Control class | 40 | 76.1455 | 11.47810 | 1.81485 |

**Table 4.** Independent Samples Test

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 95% Confidence Interval of the Difference | |
| | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| The value of mathematical communication | Equal variances assumed | ,015 | ,902 | 3,400 | 78 | ,001 | 8.85425 | 2.60449 | 3.66911 | 14.03939 |
| | Equal variances not assumed | | | 3,400 | 77,935 | ,001 | 8.85425 | 2.60449 | 3.66904 | 14.03946 |

*Output* results show a significance level of 0.001 < 0.05, which means there is a significant influence between the use of *mobile learning* teaching materials on students' mathematical communication ability test results.

**Table 5.** Recapitulation of Mathematical Communication Ability Test Results for Students in Each School

| **School** / **Results** | **Rejotangan 1 Vocational School** | **SMKN 1 Boyolangu** | **SMKN 2 Tulungagung** |
|---|---|---|---|
| Experimental Class Average Score | 85.00 | 85.64 | 82.79 |
| Control Class Average Value | 76.15 | 78.62 | 75.99 |
| Classical Mathematical Communication Skills | Very good | Very good | Very good |
| T test | There is Influence | There is Influence | There is Influence |
| *Effect Size* Category | **0.77 Currently** | **0.66 Currently** | **0.54 Currently** |

Based on table 4.58, the average score of students' mathematical communication ability test results The experimental class in each school obtained higher results than the control class. After comparison and analysis, it can be concluded that there is a difference in the test results of students' mathematical communication skills between the class given the action and the control class.

It is known that in each school that was used as a research site, the use of *mobile learning teaching materials* equally had an influence on the results of students' mathematical communication skills with a medium effect. The factor that causes the research results to have the same influence in each school is because the researcher chose a research location designated as a Vocational School Center of Excellence with a particular concentration of expertise. Meanwhile, the classes chosen as research classes are classes with a concentration of superior expertise in each school.

Based on the explanation above, it shows that the *mobile learning teaching material development product* is an effective development product, because from the results of student responses and learning outcomes it is proven that it can improve the mathematical communication skills of class vocational school students in Tulungagung.

## CONCLUSION

The conclusion of this discussion is that this *mobile learning teaching material* is said to be effective based on student response questionnaire data and mathematical communication test results data obtained. The results of the student response questionnaire obtained a percentage of 95% with the criteria being very effective for use in learning. Meanwhile, the percentage of learning completion results was 98% with a very high learning completion interval. The use of mobile learning teaching materials has an influence on students' mathematical communication skills. The average score of the experimental class students' mathematical communication

ability test results in each school was higher than the control class. The average score for the experimental class at SMKN 1 Rejotangan was 85.00 while the average score for the control class was 76.15. The average score for the experimental class at SMKN 1 Boyolangu was 85.64, while the average score for the control class was 78.62. The average score for the experimental class at SMKN 2 Tulungagung was 82.79 while the average score for the control class was 75.99. After comparison and analysis, it was concluded that there was a difference in the test results of students' mathematical communication skills between the classes given the action and the control class.

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