The Effect of Interactive Mathematics Learning Media toward Mathematical Conceptual Understanding on Probability of Hearing-impaired Students

I M Suarsana1a, G A Mahayukti1, I K Sudarma1 and A A G S Pujawan1
1Universitas Pendidikan Ganesha, Singaraja, Bali, Indonesia

E-mail: *suarsana1983@gmail.com

Abstract. This study aimed at determining whether the Interactive Mathematics Learning Media (IMLM) has a positive effect on hearing-impaired students' mathematical conceptual understanding (MCU) on probability. This research applied an experiment with post-test only control group design in which 36 students got involved. The intervention at the experimental group was learning assisted with IMLM. A descriptive approach of the qualitative phase was done toward some respondents which were selected purposively on the population. The MCU data was collected using an essay test. The MCU data were analyzed using one-tailed of t-test with the significance level of 5%. The result showed that using IMLM has a significant effect on students’ MCU. Students in the experimental group were more motivated, more involved in learning because IMLM has accommodated their special needs namely the principle of facial orientation and visual representation compared with those in the conventional learning.

1. Introduction

Probability is one of the learning topics in the seventh-grade mathematics subjects of Special Junior High School for hearing-impaired students. The material includes experiments, sample space, events and probability of an event. Some research results reveal that the achievement of mathematics learning outcomes on probability material, especially for normal students, still needs to be improved ([1],[2],[3],[4],[5],[6]). Embedding mathematical concepts of probability material on normal children is not easy. Moreover, for hearing-impaired students, the problem becomes more complex due to communication barriers (hearing loss). Compared with normal students on their age, the learning performance of hearing-impaired students is still very low and far behind if compared to normal students ([7],[8]).

Mathematics learning for hearing-impaired students cannot be considered the same as normal students. Two things that become attention are the characteristics of hearing-impaired students and the characteristics of mathematics itself. Some learning barriers for hearing-impaired students include: weak to access information ([9],[10]), limitations of communicating with other teachers/students ([11],[12]) and low learning motivation because they feel they are not comfortable and sometimes frustrating in expressing ideas/questions ([13],[14]). Hearing-impaired students are often called visual learners because they absorb more information by looking at using their visual senses ([15],[12]). Therefore, learning material should be made as simple and equipped as possible with visual representation ([16],[17]). While mathematical characteristics are related to abstraction ideas. Therefore the presentation of material must also be carried out as simple as possible and represent it in a variety of...
ways ([18],[19],[20],[21],[22],[23]). Mathematical representations can be made with concrete objects, manipulative models, tables, diagrams, graphs, drawings, sketches, mathematical models and computer simulations ([21], [18], [19]).

With the rapid development of ICT, multi-representation learning is no longer difficult and expensive. Various computer applications are available to support interactive media development. Interactive media is a multimedia learning environment such as interactive video and computer-assisted learning, computer-assisted instruction (CAI). In CAI, students interact directly with interactive multimedia, such as simulations, games, and drill and practice. Students not only see images and hear sounds but can provide active responses. Some of the advantages of using interactive multimedia are: (a) consists of various media formats (multiple representations); (b) Encouraging students’ active participation; (c) students can start learning flexibly; and (d) can provide a more real learning experience, in the form of simulations or imitations of actual phenomena ([24]). Many research results showed that the use of interactive media in learning mathematics in normal students is very effective. However, there is still very limited research on the effectiveness of interactive assisted learning media for hearing-impaired students. Several research results related to the use of interactive media in learning for hearing-impaired students showed that there are significant effects on student motivation and learning outcomes ([25],[16],[26]), but these studies have not been conducted specifically for learning mathematics for hearing-impaired students.

Based on the explanation above, the results of previous studies showed that the use of interactive media proved effective in improving the mathematics learning outcomes of normal students, but so far no research has been found specifically examining the effect of interactive media use on the MCU of hearing-impaired students. Therefore, the focus of this research is to answer the question: is there a significant influence from the use of interactive learning media on the MCU of hearing-impaired students?

2. Method

2.1. Research Design
This research is a quasi-experimental research which used post-test only control group design. The experimental group was given on probability learning using interactive learning media while the control class was the previous mathematics learning, that the teacher delivers the material using total communication.

| Table 1. Post-Test Only Control Group Design |
|---------------------------------------------|
| Group | Treatment | Post-Test |
|-------|-----------|-----------|
| X     | Y         |           |

X = probability learning with interactive media
Y = post-test in MCU

2.2. Participants
The population in the study consisted of 36 hearing-impaired students in class VII who were spread out in special classes of deaf people in 9 Special Schools in the Province of Bali in the academic year 2017/2018. Sampling was performed by using simple random sampling technique through drawing on existing classes to get the control class and experimental group. As an experimental group, students of class VII SLB Negeri 1 Singaraja with 9 students and the control class were students of class VII SLB Negeri 1 Klungkung with 5 students.

2.3. Instrument
The MCU of hearing-impaired students was measured using an essay test consisting of 5 items with MCU indicators referring to the 3 indicators established by [27], namely: (i) Describe concepts in their own words, (ii) Identify or give example of non-example of concepts, and (iii) Use the concept correctly in a variety of situations. Before being used, the test was tested through the content validation process by experts, and the test was declared suitable to be used. Furthermore, the test was tested to determine the validity and reliability empirically and the results obtained that by using the moment product correlation coefficient formula, the five items are in valid categories. The results of the calculation of reliability by using the Cronbach alpha formula obtained the test reliability coefficient was 0.65 which indicated that the test was in reliable category.

2.4. Technique of Data Analysis

Data on the MCU of hearing-impaired students collected through the post-test. The students answered the answer by using the rubric in Table 2. The scores of all students were then analyzed using inferential statistics t-test with a significance level of 5%. Before the t-test was carried out, the assumption was tested first in the form of normality test and homogeneity of variance. The normality test used the Kolmogorov-Smirnov test while the variance homogeneity test used the F test.

| Table 2. ScoringRubric |
|-----------------------|
| Indicator | Score | Description |
| Describe concepts in their own words | 2 | Re-express the concepts in their own words correctly |
| | 1 | Re-express the concept in their own words but remain incompletely true |
| | 0 | Not making an answer or make an answer but far from what is expected |
| Identify or give example a non-example of concepts | 2 | Identify those included in the example or not examples of concepts correctly |
| | 1 | Identify those that include examples or are not examples of a concept but are not completely true |
| | 0 | Not making an answer or make an answer but far from what is expected |
| Use concept correctly in a variety of situations | 4 | Apply concepts in various situations, the final calculation and answer are correct. |
| | 3 | Correctly apply concepts in various situations, most calculations are correct, but the final answer is wrong. |
| | 2 | Correctly apply concepts in various situations correctly but the final calculation and answer are wrong. |
| | 1 | It is not true to apply concepts in various situations |
| | 0 | Not writing the answers, or just repeat the information provided. |

3. Findings

Of the 5 MCU test items given, 1 item was used to measure the "Describe concepts in their own words" indicator with a maximum score of 2, two items were used to measure the indicator "Identify or give example of non-example of concepts" with a maximum score per item of 2, and 2 items were used to measure the indicator "Use concept correctly in a variety of situations" with the maximum score per item of 4. Thus, the ideal total maximum score is 14. Overall score data for each group per indicators are presented in Table 3.

| Table 3. Percentage of MCU Achievements per Indicator |
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| MCU Indicator                                      | Achievement Percentage |
|----------------------------------------------------|------------------------|
|                                                   | Experimental group     | Control Class      |
| Describe concepts in their own words               | 72.2%                  | 50%                |
| Identify or give example anon-example of concepts  | 69.4%                  | 50%                |
| Use concept correctly in a variety of situations   | 61.1%                  | 37.5%              |
| **Total**                                         | **64.3%**              | **42.9%**          |

In Table 3 we can compare the percentage of achievement in the two groups per each indicator item in MCU. The experimental group achieved a higher percentage of MCU in each indicator. To ensure that there is a difference in concept understanding in both groups, statistical tests were carried out. The results of data analysis needed for statistical tests are presented in Table 4.

Table 4. The MCU Post-Test Score

| Variable | MCU Post-Test Score |
|----------|---------------------|
|          | Experimental group  | Control Class   |
| n        | 9                   | 5               |
| $\bar{x}$| 9.1                 | 6               |
| s        | 2.26                | 2.45            |

The results of the normality test with the Kolmogorov-Smirnov test for the significance level of 5% in the experimental group (n = 9) obtained Dcount (0.111) < D-table (0.43) which showed the data distribution ability to understand the MCU of the experimental group was normally distributed. While the results of the normality test for the control group (n = 5) obtained Dcount (0.197) < D-table (0.56) which showed that the distribution of data on the ability to understand mathematical concepts in the control group was also normally distributed. Thus, both groups were normally distributed. Furthermore, the variance homogeneity test with the F test for a significance level of 5% with the numerator = 8 and the denominator = 4 obtained Fcount (0.85) < F-table (6.04) which means there was no difference in variance between the experimental group and the control group.

Based on the results of the test for normality and homogeneity of variance in both populations, then the research hypothesis was tested using a two-tailed t-test with a significance level of 5% and degree of freedom (df) = 12. The results of the analysis show t-count (2.40) > t-table (2.17) which means that there was a difference in the average score of the ability to MCU of hearing-impaired students with interactive media assisted learning with hearing-impaired students with conventional learning.

4. Discussion

Hypothesis test results showed that there were differences in MCU between hearing-impaired students with interactive media assisted learning and hearing-impaired students with conventional learning. The use of interactive learning media in mathematics learning has proven to have a significant effect on the MCU, especially for Junior High School Hearing-impaired students. Thus, the results of this study have complemented what has been obtained by [28] that the use of interactive media is not only effective to improve the MCU of normal students but also for hearing-impaired students. In addition, the results of this study also complement the results of previous studies on the effectiveness of the use of interactive media in mathematics learning, namely (i) improving mathematical problem solving skills [29], (ii) giving a positive influence on the formation of student learning interest ([30],[31]), (ii) improving student learning outcomes [32] and (iii) improving students' mathematical reasoning [33].

The difference in the MCU in the two groups of students due to differences in the treatment of learning given that the experimental group of learning used interactive media meanwhile the teacher in control group used conventional learning in the order of (i) the teacher explains/demonstrates knowledge
with total communication, carried out over and over until the student feels that they can understand the material, (ii) the teacher gives an example of the problem, (iii) the teacher assigns students to practice the problem. The characteristics of the media used have been adapted to the special needs characteristics of hearing-impaired students as visual learners and have also been attempted to present an absurd mathematical concept that becomes more real. This interactive media for learning probability has been equipped with a probability simulation/demonstration of an event, where students can interactively conduct experiments such as coin throwing, dice throwing, card retrieval with computer, according to ([16], [34]). Visual media that moves and is able to explain events as real as possible is the best medium for hearing-impaired students. Through the use of media, errors/bias in receiving information from teachers to students due to hearing limitations of hearing-impaired students can be minimized. Students will be able to capture the message/information in the media clearly so that it will indirectly affect the increase in vocabulary treasury and eventually also have an impact on improving language skills. These indications appear from the results of the research shown in Table 2, that the indicator of "Describe concepts in their own words" showed that the achievement of students in the experimental group was much higher than the control group. Students in the experimental group were better to express their understanding in written language. The vocabulary used in the answers they wrote was more diverse.

In addition, the presentation of the concept of probability with various representations such as concrete representations, verbal, drawing, numerical, tables, graphs and computer simulations also makes students more easily understand the concept of probability as argued by [35] that forms of various representations are important tools to build students' understanding. Students can remember longer material/concepts that are taught because the material is presented using many approaches. Students' understanding will be more comprehensive/complete. Students will be avoided by misunderstanding concepts. Presentation of material with diverse representations will be expensive and tiring if performed without using ICT advancement because the teacher must present repeatedly, students get bored quickly and the teacher gets tired.

The use of interactive media has made students more enthusiastic about learning. Students become more actively involved in learning ranging from observing the media, asking teachers, interacting with the media, conducting experiments, and trying to find the right answers to the problems given. Learning progress of each student can be tracked from their progress completing hierarchical media bills that students will be able to continue the next material if the previous material bill has been responded correctly. [32] stated that the use of interactive media will make students learn in a happy and motivated atmosphere to learn mathematics. Interactivity, varied content, educational games and practice questions with immediate feedback provided in the media have given interesting learning experiences for students. The atmosphere and motivation to learn are important factors that influence student learning outcomes as revealed by [36] that the atmosphere and motivation of learning have a positive correlation with student learning outcomes.

Apart from research findings that the use of interactive media is effective to improve the MCU of hearing-impaired students, it is also important to convey some of the difficulties/challenges faced in the implementation of this interactive media in the classroom such as (1) the teacher's technological literacy skills that still need to be improved especially in development interactive media, (2) variations in the ability of hearing-impaired students who are very diverse both in terms of language skills and mathematical abilities, and (3) limited supporting facilities and possible technical problems that are quite disturbing.

5. Conclusion
Based on the results of the study it can be concluded that the use of IMLM has a significant influence on the MCU of hearing-impaired students. These results have implications for the importance of providing learning media that can accommodate the characteristics of deaf children in order to minimize learning barriers due to their limited communication. In this study, the existing influence has not been reviewed in terms of students' level of hearing, initial mathematical abilities, language ability, and
students' technological literacy abilities. Therefore, further research can be conducted by paying attention to that variables.

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