Validation and Implementation of Hawgent on Pythagoras Theorem

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Abstract. Math lessons are abstract and complex for students to understand, so that the teachers need instructional media to develop by using technology to help their students get deep learning. This study aimed to validate the instructional media to teach the Pythagorean theorem and describe the students and the teachers' responses to the instructional media. The researchers implemented the ADDIE model in this study. The sample comprised 30 students in 7th grade and 5 teachers. The process of validation involved ten academics. The results of this study showed that the instructional material could be used. The results also showed that the students were happier when the teachers used the instructional media in the classroom.

1. Introduction
Mathematics is important knowledge for everyone because Math lessons in junior high school are very important for learning mathematics in senior high school and university. Everyone learns the basic concept of mathematics in school. Students who can understand the basic concept of mathematics will apply it in their everyday life [1–3]. But in reality, teachers often forget to explain the basic concept when explaining new knowledge [4]. Teachers often explain the formula and directly give example questions to students [5]. This causes students only to remember the formula and think that mathematics is boring.

Instructional media developed by using technology has been around since the 19th century in developed countries. Many studies showed positive results regarding the implementation of technology-based learning media [6–8]. The studies showed that technology could improve students' hard and soft skills [9]. Hawgent is a software developed in China to help teachers explain abstract mathematical concepts [10,11]. The newest edition of Hawgent in 2020 is easier to use and has an attractive appearance than the previous edition. Hawgent has been widely developed and implemented both in China and in other developing countries. Hawgent software can be downloaded for free at www.hawgent.com. After downloading, users can install the software in their personal computer and use it immediately.

Students find junior high school mathematics lessons are difficult [12]. This study is also in line with previous research that analyzed students' errors on the mathematics sub-topic at the junior high school level [13,14]. One of the mathematics topics in junior high school that students think is difficult is the Pythagoras theorem [15,16]. Pythagoras theorem is one of the basic foundations of mathematics problem-solving [17]. This is because there are a lot of everyday-related problems that are closely
related to Pythagoras. Other than that, Pythagoras is the basic knowledge of geometry. This is why there is a need for students to master the concept of Pythagoras. However, We found that students were having difficulties in mastering the concept and solving Pythagoras problems [18].

This study aimed to validate instructional media developed by using the Hawgent software to teach the Pythagorean theorem and describe the students’ and the teachers’ responses to the instructional media. The results of this study can be the basis for teachers in Indonesia to develop instructional media by using technology, especially during the COVID-19.

2. Method
Researchers used a Research and development method with ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. This model aims to solve the problem systematically according to the needs and problem characteristics [19,20]. The topic explained in this research using Hawgent dynamic mathematics software is the Pythagoras theorem. The Hawgent dynamic mathematics software was designed based on an initial observation of students’ difficulty learning the Pythagorean theorem. After Designing the Pythagoras theorem concept using Hawgent dynamic mathematics software, five media and five material experts would then test the learning media. At the implementation stage, the researcher explained the materials of the Pythagorean theorem by using Hawgent software and then asked the students what they felt about studying mathematics by using Hawgent dynamic mathematics software. The data in this research is collected in a formative way with always evaluating every data. The collected and evaluated data are the evaluation of difficulties teachers face when explaining Pythagoras using ICT, result from the media experts, result from the material experts, and implementation results when using Hawgent dynamic mathematics software. The instrument used in this research is a questionnaire on the difficulties faced by the teachers when teaching Pythagoras using ICT. The questionnaires would also be used to collect data from the material experts, media experts, and teachers in Bandung, Indonesia. The validation criteria from the media and material experts can be seen in Table 1.

| No | Interval | Criteria        |
|----|----------|-----------------|
| 1  | 81 % ≤ score ≤ 100 % | Very Good       |
| 2  | 61 % ≤ score ≤ 80 %  | Good            |
| 3  | 41 % ≤ score ≤ 60 %  | Average         |
| 4  | 21 % ≤ score ≤ 40 %  | Bad             |
| 5  | 0 % ≤ score ≤ 20 %   | Very Bad        |

3. Results and Discussion
3.1 Analysis
Before doing this research, We randomly picked 14 schools to make the initial observations and gave out questionnaires to 56 mathematics teachers to know why the teachers did not use technology to teach the Pythagorean theorem. The questionnaire result can be seen in the Table above (table 2).

| Statement                                           | Agree | Disagree |
|-----------------------------------------------------|-------|----------|
| Cannot operate the computer very well               | 11    | 45       |
| Confused on how to make an ICT based learning media | 50    | 6        |
| Schools facility is inadequate                      | 14    | 42       |
| Does not have the time to make a learning media     | 15    | 41       |

From table 3, we can see that from a total sample of 56 teachers, there were only 11 teachers who could not operate the computer very well while 45 others knew how to operate the computer pretty
well. In the second statement, 50 teachers were confused about making an ICT-based learning media on Pythagoras, while six others can make an ICT-based learning media on Pythagoras. For the third statement, 14 teachers said that the school’s facility is inadequate, which means that there is no computer or projector in class to support an ICT-based learning media, while 42 others said that the school’s facility is adequate to support the implementation of technology-based learning. In the last statement, 15 teachers said that they did not have the time to make an ICT-based learning media, while 41 others do have the time to make the ICT-based learning media on Pythagoras. From the results above, we concluded that most of the teachers in the school can use the computer pretty well. The school has the facility to support learning using ICT, and teachers actually have the time to make an ICT-based learning media. However, they are confused about how to make the ICT-based learning media for Pythagoras. Furthermore, in preliminary observations, we saw that school facilities had supported technology, but the teachers did not use school facilities properly.

3.2 Product design
The researcher developed practical and efficient instructional media based on the initial observation by using Hawgent for teachers. The proofing of Pythagoras formula is in animation that can move with an interesting back sound.

Figure 1. Pythagorean theorem and its many proofs using hawgent dynamic mathematics software.
3.3 Development of interactive multimedia

After the researcher had finished designing the instructional media to prove the Pythagorean theorem using Hawgent, the researcher presented the validation process in front of the media and material experts. At this stage, the academics decide whether the learning media can be used or not. Questionnaires were given to the media and material experts so that the learning media using Hawgent can be evaluated and the results are presented in Table 3.

**Table 3. Validation result from the material expert**

| No | Statement                                                                 | Average | Category   |
|----|---------------------------------------------------------------------------|---------|------------|
| 1  | The program is effective to help the students understand the mathematical concepts of the Pythagorean theorem | 97.00%  | Excellent  |
| 2  | The content/materials used based on the curriculum                        | 79.00%  | Good       |
| 3  | Examples and Illustrations                                                | 92.00%  | Excellent  |
| 4  | Language used                                                             | 80.00%  | Good       |

From the result above, we can see that from the program aspect, the program effectiveness to explain the basic concept of Pythagoras is 97.00% which falls in the excellent category. The content/materials used based on the curriculum falls in the good category with 79.00%, while the experts' aspect on Examples and Illustrations gave it 92.00% (excellent category). The last category about the language used, the experts gave it 80.00%, falls in the good category because the media uses two languages: English and Chinese. The overall average rating from the material aspect is 85.25% (excellent category). The results of the media expert are presented in Table 4.

**Table 4. Validation result from the media expert**

| No | Statement                      | Average | Category |
|----|--------------------------------|---------|----------|
| 1  | The Animation is very clear and interesting | 94.00%  | Excellent|
| 2  | Quality of figure and audio     | 87.00%  | Good     |
| 3  | Composition of text and picture | 91.00%  | Excellent|
| 4  | Easy to be used by teachers     | 83.00%  | Good     |

The aspects that the media expert evaluates are the animation, the figure and audio, the composition of text and picture and whether it is easy to be used by teachers. The animation and the composition of text and picture aspect were scored 94.00% and 91.00% respectively while the quality of figure and audio and the practicality aspect were scored 87.00% and 83.00% respectively. The overall average rating from the media aspect is 88.75% which is in the excellent category.

3.4 Implementation & evaluation

After the learning media is declared feasible and practical, we taught 56 teachers from 14 Bandung, Indonesia, to develop technology-based instructional media to teach mathematics in junior high school. Implementing the learning media to students on the Pythagoras theorem is also essential to know the students’ opinion on Hawgent. Questionnaires were given to 30 7th grade students and the result is presented in Table 5.
Table 5. Students statements on proofing pythagoras using hawgent.

| No | Students’ statement                                                                 | Students’ response | Average |
|----|-------------------------------------------------------------------------------------|--------------------|---------|
| 1  | I like that the teachers teach us by using technology-based instructional media.      | 3 13 14            | 4.37    |
| 2  | Hawgent makes me understand the Pythagorean theorem better.                          | 2 10 18            | 4.53    |
| 3  | Hawgent increases my learning interest.                                              | 2 10 18            | 4.53    |
| 4  | I hope that the teachers can use technology-based instructional media to teach other mathematical concepts. | 4 15 11            | 4.23    |
| 5  | Hawgent makes me excited about studying math.                                       | 3 16 11            | 4.27    |
| 6  | Hawgent motivates me to study math.                                                  | 3 15 12            | 4.30    |
| 7  | I do not feel bored when the teachers explain the Pythagorean theorem by using Hawgent. | 1 14 15            | 4.47    |
| 8  | Hawgent makes math lesson more interesting.                                         | 2 14 14            | 4.40    |

Based on the data, the average rating scale from the students is 4.39, which means that Hawgent dynamic mathematics software got a good response from the students. The table above shows that students are very enthusiastic and like the learning media using Hawgent dynamic mathematics software on Pythagoras. Most of the students also stated that Hawgent dynamic mathematics software could motivate students to continue learning mathematics. This finding is in line with previous research, proving that using technology in teaching and learning activities gets a good response from students. Some studies even show that technology integration in learning can improve students’ high-order thinking skills.

After implementing learning media using Hawgent dynamic mathematics software, We asked random teachers their opinion towards Hawgent dynamic mathematics software on Pythagoras. 5 out of 56 teachers gave their opinion that can be seen in table 6.

Table 6. Teachers’ responses towards hawgent.

| Teacher | Response                                                                 |
|---------|--------------------------------------------------------------------------|
| AB      | Hawgent made me excited to teach mathematics in class.                   |
| TT      | Pythagoras became more interesting.                                      |
| AP      | Hawgent made me understand the various way to prove the Pythagoras concept.|
| WH      | Hawgent can visualize difficult mathematical concepts.                   |
| ST      | I believe Hawgent can help the students to improve their hard and soft skills.|

As a token of appreciation for teaching how to use Hawgent to prove the Pythagoras theorem, a teacher made a Pythagoras tree animation using Hawgent and showed it to us (figure 3). This shows that the teachers can use Hawgent dynamic mathematics software, but they can also use their creativity to improve Hawgent dynamic mathematics software.
The researcher found unexpected findings that the teachers seemed enthusiastic when the researcher taught the teachers new materials and experience to develop pedagogical and technological skills. The teachers said they wanted to continue learning and training their technological and pedagogical skills. However, they were short on funds, and no one was willing to take the time to teach them how to develop technology-based instructional media. The researcher feels that there are many studies on developing technological pedagogical knowledge for pre-service teachers. However, the researcher has not found any study on developing technological pedagogical knowledge for on-service math teachers. The results of this study can be the basis of future studies.

4. Conclusion
This study developed instructional media to teach students of 7th grade the Pythagoras theorem. The researcher developed the instructional media by using hawgent based on the needs of the teachers and students. The validation results from the experts showed that instructional media could be implemented in the classroom. The results of the implementation of the instructional media were positive for both the teachers and students. The researchers concluded that technology is always in demand by teachers and students. The teachers must continue to develop their technological pedagogical knowledge and implement it when teaching in the classroom. The researcher suggests future studies on using this instructional media to compare the students’ higher-order thinking skills on the Pythagorean theorem between the control and experimental classes.

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