Hawgent dynamic mathematics software to improve problem-solving ability in teaching triangles

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Abstract. ICT is one of the mediums to improve the quality of education. ICT can make the teaching-learning process to be more interesting. Other than that, ICT is proved to be able to help students understanding the concept of a topic and improve the students’ mathematics ability. According to the difficulties faced by the students when learning triangles, researchers gave out questions to a random junior high school class and found out that the students’ understanding ability towards the basic concept of a triangle is still lacking. This research uses a combination of the ADDIE model and quasi-experiment to compares the class that uses Hawgent dynamic mathematics software with the class that uses the traditional teaching method. after observing the situation, researchers will then design an interactive learning media using Hawgent dynamic mathematics software that will help the student to understand the basic concept, improve their problem-solving ability. Research shows that interactive learning media such as hawgent can be used to teach triangles. The implementation result also shows that the students’ problem-solving ability that uses interactive learning media is better than that does not use the interactive learning media.

1. Introduction
Mathematics is one of the knowledge that is important in every education stage [1][2]. Triangle is one of the most basic Plane geometry figures and has become An important part of the junior high school mathematics geometry curriculum [3][4]. The purpose of the learning triangle is so that students can know the characteristics and usage of the triangle [5]. Some of the common usages of a triangle that can be found in our daily life are using the stability of the triangle to control a plane’s wings flexibility, making a villa roof more stable, and others.

Based on the research result of a junior high school student in Indonesia, It shows that students find triangles difficult to learn as they Unable to answer questions given and feel sleepy during class [6]. When students are asked to answer a problem, they are in a hurry to answer which resulted in making a mistake in answering. We can see that students did not understand the problem given that causes them to unable to solve it. Teachers are also having difficulties in explaining the triangle concept to the students.

Based on the aim of learning mathematics, the teaching focuses on the mathematics concept and students’ Mathematical Understanding Ability [7][8]. When teaching, teachers are encouraged to connect the mathematics concept into everyday life [9]. the students’ ability to master the mathematics concept and able to apply them into everyday life is very important as it can serve as a provision of them in the future [10]. Most of the students from primary school to university find mathematics as a
difficult and unattractive subject. In high school, there are a lot of complex concepts and a correct way of teaching is required so that they would master the basic concepts that are why a lot of students do not like mathematics.

In this era, technology can help in the education field to improve the students’ mathematical skills and understanding ability in the class [11][12]. Also, technology can allow students and teachers to collaborate as students nowadays are more interested and enthusiastic when they can do something on their own [13]. This kind of learning situation has great potential as it can direct the students with various representations and develop a deeper understanding of a certain mathematics concept. ICT can help teachers to show a figure example and a new way to present the basic concept of a certain topic. With the triangle topic, the traditional teaching method will not help the teacher to explain the comparison of the length of the moving point segment before and after [14]. An ICT based learning media will enable these data to be shown and known.

Hawgent dynamic mathematics software is a mathematics software from Guangzhou, China that is designed according to the needs of practitioners and academicians in the education field [15]. Hawgent has a lot of simple and dynamic features that can be easily operated according to the teachers’ needs. In the education field, Hawgent can be used to explain the concept of calculus, algebra, probability, velocity, geometry and others [14][16][17].

According to observation done in Indonesian schools, the triangle is a lesson for Junior High school students [14]. Considering this material is difficult, a media is needed to facilitate the students to understand the proofing and application. In this journal, we will explain the media that is used to learn triangle by using Hawgent dynamic mathematics software that is can to help students to improve students’ problem-solving ability and understand the basic concept of triangle better.

2. Methods
This research uses the ADDIE model (Analysis, Design, Development, Implementation and Evaluation) and quasi-experiment that compares students’ problem-solving ability to the class that uses Hawgent dynamic mathematics software with the class that uses traditional teaching method. This is done to know how significant is the impact of Hawgent dynamic mathematics software when teaching a triangle. The research data will be processed using Microsoft Excel and SPSS 21.

The validation of the product will be done by 3 media and 3 material experts. The data from the media and material expert will be analyzed by calculating the average score given by the media and material experts. The average score will then be categorized based on a criterion that can be seen in table 1.

### Table 1. Validation criteria from media and material experts.

| Score          | Validity criteria       | Description             |
|----------------|-------------------------|-------------------------|
| 3.26 ≤ x ≤ 4.00 | Valid/very good         | No revision             |
| 2.51 ≤ x ≤ 3.26 | Valid enough            | Need a little revision  |
| 1.76 ≤ x ≤ 2.51 | Not very valid          | Need a lot of revision  |
| 1.00 ≤ x ≤ 1.76 | Not valid               | Not to be used          |

3. Results and discussion

3.1. Analysis
Researchers observed schools see the difficulties faced by junior high school students when learning triangle. Researchers chose a random class to give out problems so that they would be able to know the difficulties faced by the students when learning triangle. The difficulties faced by 36 students on the triangle can be seen in table 2.
Table 2. Students’ interview result.

| Mistakes when solving problems | Number of students | Percentage |
|-------------------------------|-------------------|------------|
| Students’ concept understanding on triangle is low | 29 | 80.1% |
| Students did not write the steps when solving problem | 33 | 91.7% |
| Students were in hurry and made a mistake in answering | 16 | 44.4% |
| Students were confused when solving problem | 21 | 58.3% |
| Students were unable to understand the problem | 27 | 75.0% |
| Student can’t solve the problem at all | 12 | 33.3% |

3.2. Design
In the learning media making phase, Hawgent dynamic mathematics software is designed according to the initial observation on triangle and the national curriculum. The learning media uses animation that are interesting and moving pictures so that it can catch the students’ interest. Examples of learning media using Hawgent dynamic mathematics software can be seen below. Figure 1 is the reality and mathematical situation of the general's horse drinking problem.

![Figure 1](image1.png)

**Figure 1.** (a) Geometric model of "general drinking horse" (b) Mathematical situation.

In figure 2, Hawgent can show the size change of 'AP+BP'. Hawgent is able to show the size of 'AP+BP' as much as the students wants. From the picture above, we can see that when point P is in the middle position, the value is smaller; when point P goes to both sides, the value is larger and larger. It is convenient for students to observe and guess in the perception of dynamic changes.

![Figure 2](image2.png)

**Figure 2.** Geometric model of "general drinking horse" and Mathematical situation.

After guiding the students to contact the properties of line segments and triangles, the teacher makes them try to draw a picture to verify the conjecture which can be seen in figure 3. Hawgent dynamic mathematics software can show the best position of point P. It is found that we made point B
about symmetrical point B' of line L, then connect AB' and intersect line L with P. Point P is the result. Figure 3 shows the size comparison of ’AP + BP’ at point P and other locations.

![Figure 3](image)

**Figure 3.** (a) Position of point P (b) Size comparison of ’AP + BP’ at point P’ and point P

### 3.3. Development

After designing the learning media on triangle using Hawgent dynamic mathematics software, the next stage is for the media to be validated by the media and material experts to see the effectiveness of the learning media. Based on the validation result from the media expert (table 3) the pictures, animation of the learning media is very interesting and the average score given is 4.7 or 94% which falls in the excellent category. In the quality of figure and audio, the average score given is 4.5 or 90% which falls in the good category. For the text and picture component, the experts gave an average score of 4.4 or 88% which means that the content of the lecture presented by using Hawgent dynamic mathematics software to study triangle is clear. The total average percentage of all the components from the media expert is 90.67% which means that Hawgent dynamic mathematics software can be further validated by the material experts before being implemented in school.

**Table 3.** Assessment result from media expert.

| Validator         | Component                               | Number of items | Score validation | %  | Criteria  |
|-------------------|-----------------------------------------|-----------------|------------------|----|-----------|
| Media expert      | The animation is very clear and interesting | 5               | 4.7              | 94% | Excellent |
|                   | Quality of figure and audio              | 5               | 4.5              | 90% | Good      |
|                   | Composition of text and picture          | 5               | 4.4              | 88% | Excellent |
|                   |                                          |                 |                  |    | Average   |
|                   |                                          |                 |                  | 90.67% |          |

**Table 4.** Assessment result from material expert.

| Validator         | Component                               | Number of items | Score validation | %  | Criteria  |
|-------------------|-----------------------------------------|-----------------|------------------|----|-----------|
| Material expert   | Explaining the concept of triangle      | 5               | 4.6              | 92% | Excellent |
|                   | Explaining triangle using interesting story | 5               | 4.4              | 88% | Excellent |
|                   | Explaining triangle in depth            | 5               | 4.4              | 88% | Excellent |
|                   |                                          |                 |                  |    | Average   |
|                   |                                          |                 |                  | 89.33% |          |
Based on the assessment result from the material expert as shown in table 4, the explaining concept of triangle component got an average score of 4.6 which falls in the excellent category. For explaining the triangle using an interesting story, the experts gave an average score of 4.4 or 88% which falls in the excellent category. For explaining the triangle in-depth, the average score given was 4.4 which falls in the excellent category. The average total score given by the material experts is 89.33% which means that Hawgent dynamic mathematics software is ready to be implemented in school.

3.4. Implementation and evaluation
After Hawgent dynamic mathematics software on the triangle is stated valid and can be implemented in school, researchers then use 2 classes as samples. 1 class is the experimental class wherein they will use Hawgent dynamic mathematics software and the other class is the controlled class wherein they will use the traditional teaching method.

Table 5. Pre-test mean difference test.

|                  |        |
|------------------|--------|
| Mann-Whitney U   | 254.500|
| Wilcoxon W       | 920.500|
| Z                | -4.447 |
| Asymp. Sig. (2-tailed) | .000   |

Table 5 shows that the result of the Mann-Whitney value is 254.500 and the Asymp. Sig is 0.000. To find out whether or not the experimental class students’ problem-solving ability is doing better than the controlled class, a one-party test was done with the mean value of sig 0.000<0.05. With this result, we can conclude that the experimental class that uses Hawgent dynamic mathematics software is doing better than the controlled class that uses the traditional teaching method.

4. Conclusion
According to the research and discussion did, the development of learning media has been validated by the media and material experts that fall in the excellent category or it is useable and the test result on the students also falls in the good category. In the effectiveness test, the pre-test and post-test results have improved. With this, we can see that developing a learning media on triangle using Hawgent dynamic mathematics software effective for improving students’ problem-solving ability. Suggestions that were delivered based on the research result is that other mathematics topic needs a learning media such as Hawgent dynamic mathematics software to improve students’ problem-solving ability and help teachers explain the basic concept.

Reference
[1] Dini M, Wijaya T T and Sugandi A I 2018 J. Silogisme 3 1–7
[2] Zuyyina H, Wijaya T T and Senjawati E 2018 Sosiohumaniora 4 79–90
[3] Wijaya T T, Dewi N S S, Fauziah I R and Afrilian M 2018 Union J. Ilm. Pendidik. Mat. 6 19–28
[4] Puloo M M L, Juniati D and Wijayanti P 2018 J. Phys.: Conf. Ser. 1108 012063
[5] Lognoli D 2017 Int. J. Emerg. Technol. Learn. 12 28–40
[6] Warih P D, Parta I N and Rahardjo S 2016 Pros. Konf. Nas. Penelit. Mat. Pembelajarannya [KNIP] IJ KNMP (Surakarta: Universitas Muhamadiyah Surakarta)
[7] Cunhua L, Ying Z, Qunzhuan O and Wijaya T T 2019 J. Educ. 2 36–44
[8] Wijaya T T, Ying Z and Purnama A 2020 J. Cendekia J. Pendidik. Mat. 4 144–150
[9] Bernard M and Chotimah S 2018 AIP Conf. Proc. 2014 020013
[10] Sari D N O, Mardiyan M and Pramudya I 2020 J. Phys.: Conf. Ser. 1469 012159
[11] Suan L, Ying Z and Wijaya T T 2020 Int. J. Educ. Learn. 2 25–31
[12] Wijaya T T, Ying Z and Suan L 2020 J. Innov. Math. Learn. 3 15–23
[13] Al-Mashaqbeh I F 2016 Int. J. Emerg. Technol. Learn. 11 48–52
[14] Wijaya T T Sukma M Purnama A and Tanuwijaya H, 2020 J. Elem. Educ. 03, 03 p. 64–72.
[15] Wijaya T T 2021 Int. J. Educ. Res. Innov. 15 1–16.
[16] Wijaya T T Purnama A and Tanuwijaya H, 2020 JPMI – J. Pembelajaran Mat. Inov. 3, 3 p. 205–214.
[17] Wijaya T T Ying Z and Purnama A, 2020 Int. J. Emerg. Technol. Learn. 15, 10 p. 215–222.