Implementation of ICT using Hawgent dynamic mathematics software to teach probability

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Abstract. Technology is one of the media to enhance the quality of teaching. Technology can cause the teaching-learning process to be more interactive and less tedious. According to Indonesia's national examination result, the probability topic still got a low score in the past three years. This data is supported with the observation on junior high school students that students' mathematics ability towards the basic concept of Probability is still low. This research aims to make education in education to guide Senior High School students to understand Probability. This study uses a mix of research development using the ADDIE model and quasi-experiment to analyze the class that uses technology Hawgent with the class that uses the conventional teaching method. According to this observation, researchers designed technology-based learning using Hawgent to support a Senior High School student to grasp the basic concept of Probability better and improve students' learning outcomes. According to the validation and discussion, the Hawgent's development as learning media has been validated by the media and material experts that falls in the excellent category or is applicable. The test result on the students also falls in the satisfying category.

1. Introduction

Mathematics is one of the knowledge that is essential in every education phase [1]. Probability is one of the topics taught at junior and Senior High School levels [2]. The purpose of learning probability is so that Senior High School students can understand the Probability of a simple or complex event. Probability is an important topic because it is closely related to our everyday life [3]. The application of Probability in everyday life includes choosing a seating arrangement in the cinema, choosing the class prefect, fashion color combination, etc.

Based on previous studies of Senior high school students in Indonesia, Senior High School students find Probability hard to understand as Senior High School students cannot respond to the teachers' questions and feel sleepy during class time [4]. When the teachers gave students practice questions, they could not explain the Probability correctly [4]. It can be seen that students were having difficulties in grasping the probability concept but unable to express it to the teacher. Due to this, teachers are also having difficulties explaining the probability concept to the students.

In this century, technology-based learning can support the education field to enhance the students' mathematical abilities and understanding ability in the school [5]–[7]. Furthermore, technology-based learning can allow Senior High School students and lecturers to collaborate as Senior High School students are more excited and enthusiastic when Senior High School students can do some research on their own [8]. This type of learning condition has high potential as it can direct the Senior High School students with different representations and enhance a deeper understanding of a specific mathematics

concept. Technology-based learning media can help lecturers to appearance a figure illustration and a new method to show the essential content knowledge of a particular topic [9], [10]. With the probability topic, A traditional teaching method cannot help the teacher explain the Probability of getting a six from 250x dice rolling or the Probability of getting heads from 500x coin throwing. Technology will enable these data to be exposed and known.

Hawgent is a mathematics software from China. The software is designed according to the lack of practitioners and academicians in the education field. Hawgent has many dynamic and straightforward features that can be conveniently operated according to the teachers' needs [11], [12]. In the education field, Hawgent can explain the concept of calculus, algebra, Probability, velocity, geometry, and others [13]–[15]. This research explains how to produce a learning media on probability material using Hawgent based on the preliminary study result of students' difficulties on Probability.

2. Experimental Method

This study uses a mix of research development using research and development (RnD) with ADDIE framework [16] and quasi-experiment that compares the class that uses Hawgent with the class that uses the conventional teaching method. This research is done to see how significant is the impact of Hawgent when teaching Probability. The research data processed using Microsoft Excel and SPSS 19.

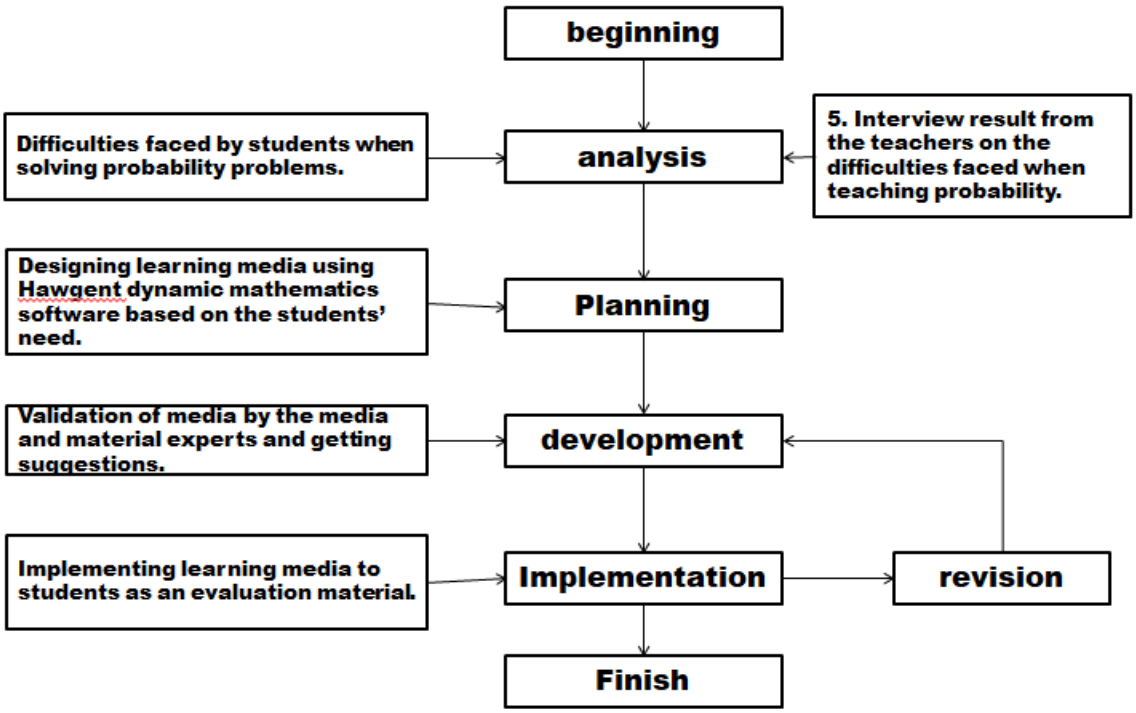


Figure 1. The steps for making learning media on probability material.

The steps to produce the learning media can be seen in Figure 1. In the analysis phase, researchers went to schools to analyze students' difficulties when learning Probability and find out the standard curriculum competence. We designed a learning media on probability material based on the observation result and national standard curriculum competence in the design phase. In the development phase, the product made using Hawgent. After the product is finished, three material experts and three media experts validated the learning media on probability material. After the media is revised according to the material and media experts' input, the learning media then be implemented in school. In the implementation phase, researchers go to schools and ask for a response from the teachers and students on the learning media using Hawgent on Probability to evaluate the learning media. In the evaluation phase, the learning media can then be modified based on the lecturers' and

students' suggestions. However, this research only focuses on designing the learning media until the validation of a product is worthy of being used.

This research used questionnaires to collect data from material experts and media experts. The validation of the product was done by two material experts and two media experts. The media and material expert's data was interpreted by interpreting the material experts and media experts' average score. The average score was then classified based on a criterion (Table 1).

Table 1. Assessment criteria for material and media experts.

Rating score	Criteria
$\bar{x} > 4.2$	Excellent
$3{,}4 < \bar{x} \leq 4.2$	Good
$2{,}6 < \bar{x} \leq 3.4$	Sufficient
$1{,}8 < \bar{x} \leq 2.6$	Poor
$\bar{x} \leq 1.8$	Very poor

3. Result and Discussion

3.1. Analysis phase

Based on Indonesia's national examination result data in 2017-2019 (Figure 2), we can see that the national exam result on Probability is not satisfying. In 2017, students' mastery of Probability was only 56.4%, and in 2018 there was an improvement of 1.89%, which is 58.31%. However, in 2019 the students' mastery of Probability falls by 2.29% compared to 2018 and is 1% lower than in 2017. With this, we can see that the students' mastery of Probability within these three years did not significantly improve.

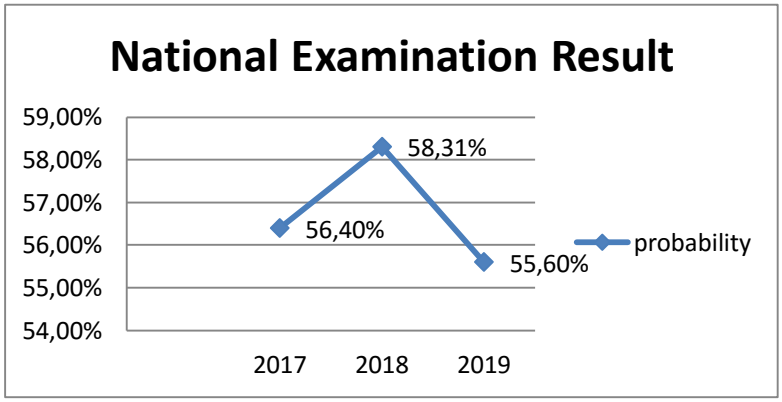


Figure 2. National examination result on Probability.

After seeing the national examination result, researchers observed schools analyze the struggles faced by Senior high school students in mastering probability. The researchers choose a random class to give out questions. The difficulties faced by 32 Senior High School students on Probability can be seen in Table 2.

Tabel 2. Student's work result on Probability.

Students' difficulties	students	%
Senior High School Students' basic concept on Probability is poor	28	87%
Students did not explain the steps when solving questions	27	84%
Students were in haste and made a miscalculation when solving a problem	24	75%
Students were frustrated when solving probability questions	10	31%
Students were careless when solving a problem	8	25%
Students were unable to grasp the questions	18	56%
Student cannot figure out the questions at all	4	12.5%

According to Table 2, 87% of the students lacked basic concept understanding towards Probability, while 84% were unable to write the steps when solving the problems. 75% of the students were in haste to answer and made mistakes in answering the question, 31% of the students were confused on how to solve the probability question, 25% of the students were careless when solving, 56% did not understand the problem and 12.5% were unable to solve the problem at all. The interview result with the students can be seen in Figure 3.

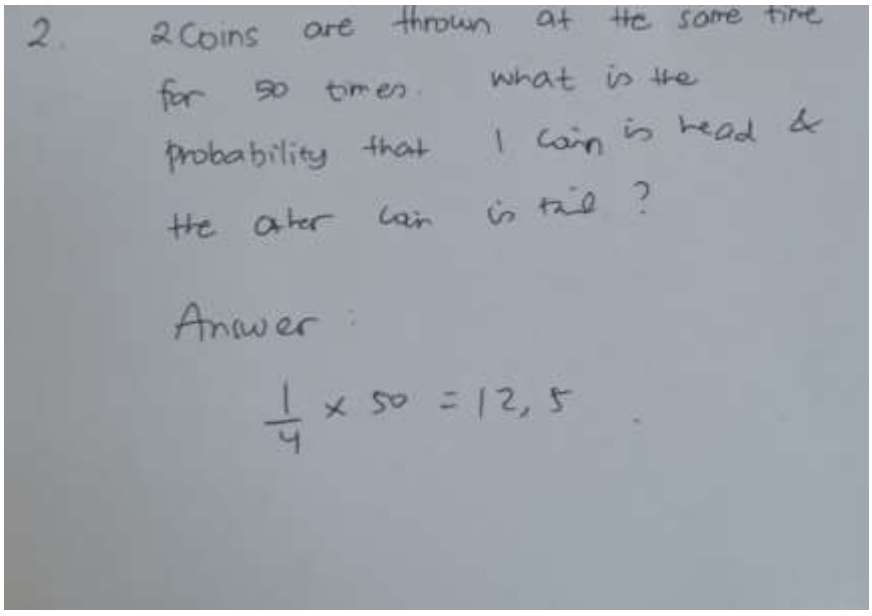


Figure 3. Students did not explain the steps in solving the question.

R : What do you understand about question 2?
S4 : What are the Probability of getting ahead and a tail when two coins are thrown for 52x.
R : And?
S4 : My answer is 12.5
R : ok, why don't you write the steps or the formula?
S4 : Because I can do it. So, there is no need to write the formula.

Based on the student's interview, students are very confident with their answer when their answer was wrong, and they did not know about it. This fact is because students did not explain the steps in solving the question. Due to this, researchers are more eager to produce learning media on Probability with Hawgent.

3.2. Design phase

In the learning media design phase, Hawgent is produced according to the preliminary observation on Probability and the national syllabus. The technology-based learning media uses animation that is attractive and moving animation so that it can advance the students' interest. The illustration of learning media using Hawgent can be seen in Figure 4.

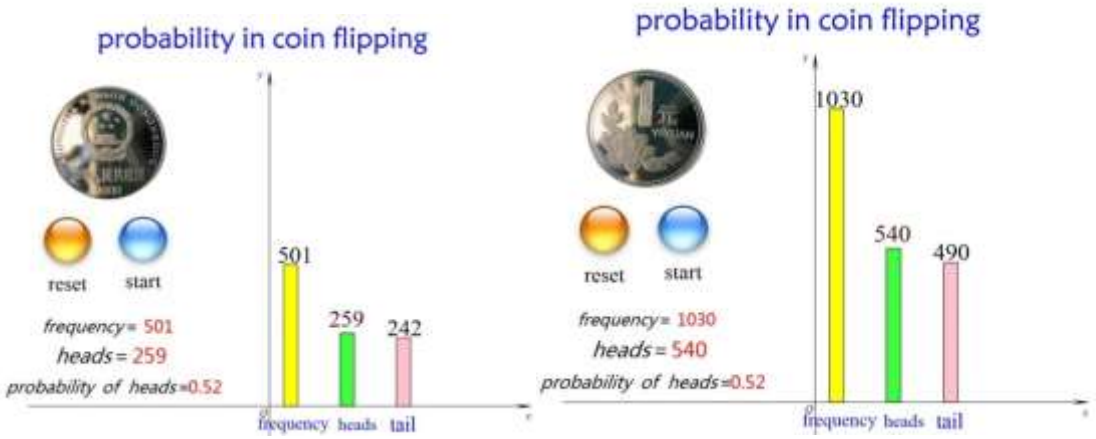


Figure 4. Probability for 501x coin throwing and Probability for 1502x coin throwing.

In Figure 4, Hawgent can show the Probability of getting heads or tails on coin throwing. The Probability of a coin is the basic concept of Probability. Hawgent can show the coin throws as much as the students want. From the picture above, we can see that getting heads from 501x and 1502x throws is almost the same: 52%.

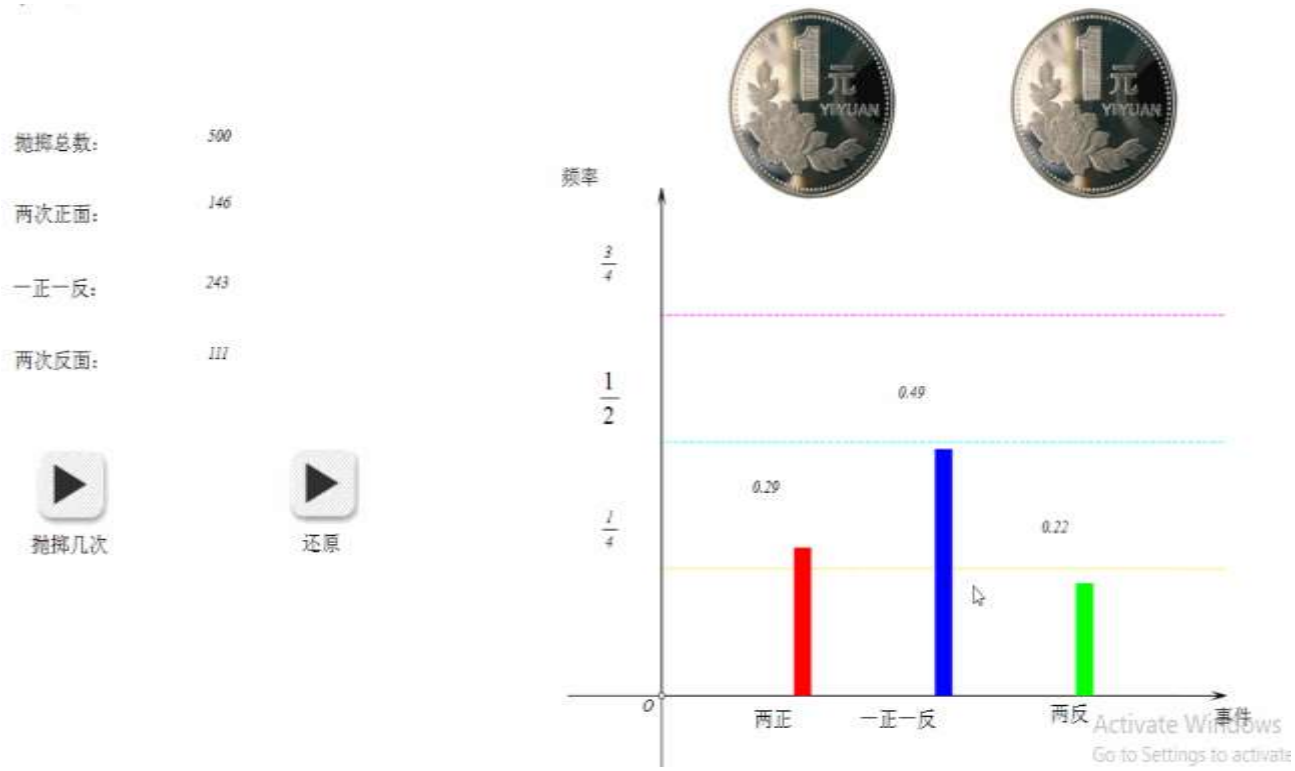
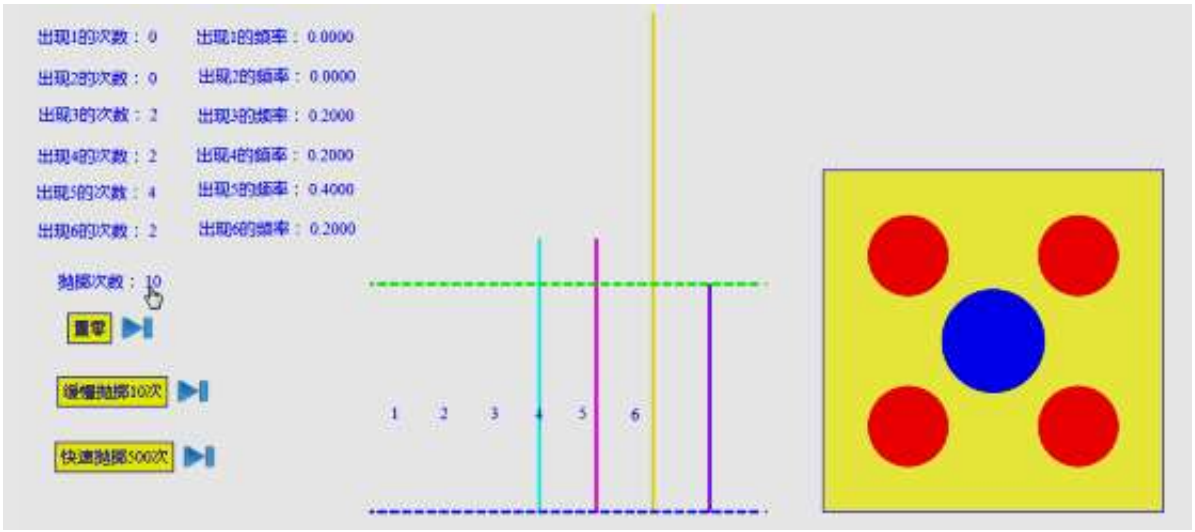
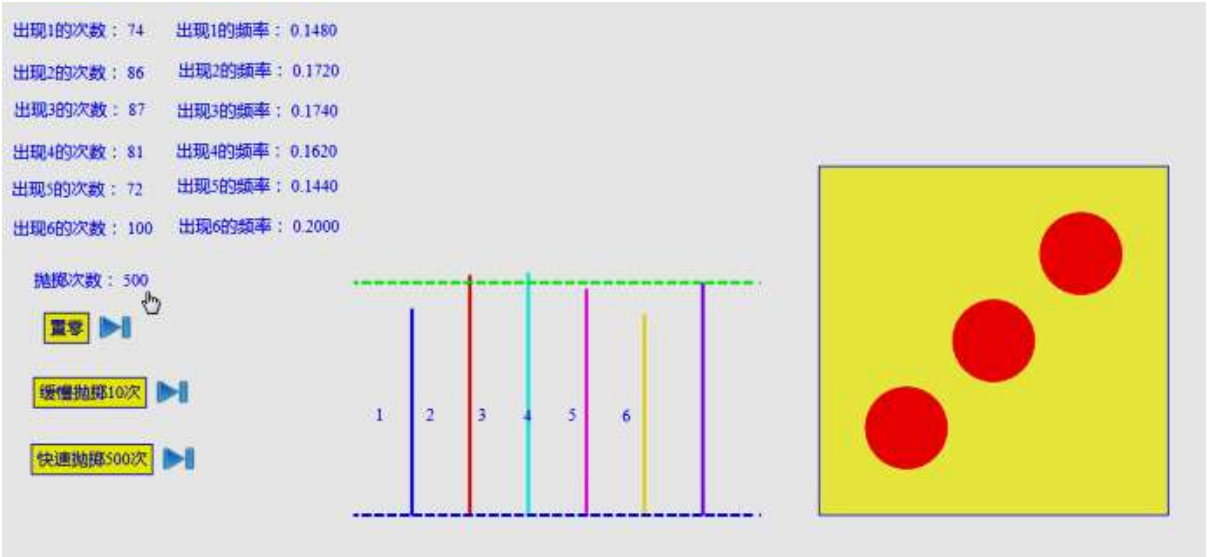


Figure 5. Probability for 500x double coin throws.

After the teacher explained the basic concept of Probability to the students, the teachers then increase the experiments' difficulty level into double coin throws, which can be seen in figure 5. Hawgent can show the chance of getting heads-heads, heads-tails, or tails-tails of the two coins. We can see that the chance of getting heads-heads, heads-tails, or tails-tails from 501x and 1502x throws are almost the same. We can see that getting heads and tails is 48-49%, while the chance of getting heads-heads is 26-29%, and tails-tails is 22-26%. Other than that, Hawgent can also show the chance of getting a specific number in dice, as shown in Figure 6.



(a)



(b)

Figure 6. (a) Probability for 10x dice throwing & (b) Probability for 500x dice throwing.

3.3. Validation stage

After designing the learning media on Probability using Hawgent software, the learning media validated by the material experts and media experts to analyze the learning media's efficiency. Based on the validator's validation decision (Table 3), the pictures, animation, and display of the learning media are beautiful, and the average results are 4.6 or 92%, which falls in the excellent category. In the media practicality component, the average score given is 4.8 or 96%. This data means that Hawgent dynamic mathematics software is straightforward and practical for the teachers to use. The

experts gave an average score of 4.0 or 80% for the students' attractive component, which means students are delighted to use Hawgent software to learn Probability. The average sum percentage of all the components from the validator is 90%, which means that the material validator can further validate Hawgent software before being implemented in school.

Tabel 3. validation from Media Expert.

	Component	item	point validation	%	Criteria
Media expert	Picture, animation, display	4	4.6	92%	Excellent
	Media practicality	4	4.8	96%	Excellent
	Students' interest in the media	4	4.1	82%	Good
			average	90%	Can be implemented in school

Based on the validation result from the material expert in Table 4, the probability component got an average score of 4.8, in the excellent category. The validator gave an average score of 4.5 or 90% for teaching Probability using coin and dice throwing, which falls in the good category. For teaching probability in-depth, the average score given was 4.4, which falls in the excellent category. The material experts' average total score is 91.33%, which means that Hawgent is qualified to be implemented in school.

Table 4. Validation results from Material Expert.

	Aspect	items	point validation	%	note
Material expert	Explaining what is Probability	4	4.8	96%	Excellent
	Explaining Probability using coin and dice throwing	4	4.5	90%	Good
	Explaining Probability in depth	4	4.4	88%	Excellent
			Average	91.33%	Feasible

3.4. Implementation stage and Evaluation

After Hawgent software on Probability is stated feasible and can be realized in Senior High school, researchers then use two classes as random samples. One class use Hawgent software, and the other class use the conventional teaching method.

Tabel 5. Normality Test.

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Controlled	.175	32	.014	.930	32	.039
Experimental	.196	32	.003	.892	32	.004

Table 5 shows the class's pre-test normality test using Hawgent and the class that uses the conventional teaching method. The class's significant results using Hawgent and the class that uses the conventional teaching method on their Kolmogorov-Smirnov normality test are 0.014 and 0.003, respectively. The two classes' result is below 0.05, and the data should be further tested with the test difference of non-parametric, which is the Mann-Whitney test.

The result of the Mann-Whitney value is 480.000, and the Asymp. Sig is 0.662. Because the significant value is more than 0.05, there is no big difference in the students' initial understanding of

Probability. This research continued by teaching both the class using Hawgent and the class that uses the traditional teaching method with two different methods.

Table 6. Normality Test of Post Control Class and Experiment.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Control	.131	32	.175	.951	32	.151
Experimental	.192	32	.004	.791	32	.000

Table 6 shows the post-test normality test of the two classes. The class's significant results using hawgent and the class that uses the traditional teaching method on their Kolmogorov-Smirnov normality test are 0.175 and 0.004, respectively. The normality test result of the class using hawgent is 0.004, and it is lower than 0.05, which means that the data should be further tested with a non-parametric Mann-Whitney test.

The result of the Mann-Whitney value is 269.500, and the Asymp. Sig is 0.001. In order to find out whether or not the class using hawgent is doing better than the controlled class, a one-party test was done with the mean value of sig 0.001/2 = 0.0005<0.05. With this result, we can conclude that the experimental class that uses Hawgent dynamic mathematics software is doing better than uses the traditional teaching method. This result is in line with Mr. Zhang's research that shows that technology can help improve students' mathematical ability [17].

4. Conclusion

Based on the analysis and expert validation, the development of technology-based learning media has been validated by the material expert and media experts that fall in the excellent category, which means it is applicable. The test result on the students also gets a good category. In the effectiveness test using the N-gain, the pre-test and post-test result has improved. With this, we can see that developing a learning media on Probability using technology can be stimulating and efficient for the students to use. Teachers can keep developing technology-based learning media as it may help students to understand mathematics concepts.

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