THE IMPACT OF QUANTUM TEACHING LEARNING MODEL WITH PHET MEDIA ON STUDENT LEARNING OUTCOMES FROM DYNAMIC FLUID MATERIALS

AGUSTINI KHOLIDAH NASUTION[1], LIA AFRIYANTI NASUTION[2], ELIA PUTRI[3], ROFIQOH HASAN HARAHAP[4]

[1,2,3,4]Program Studi Pendidikan Fisika, Fakultas Keguruan dan Ilmu Pendidikan Universitas Muslim Nusantara Al-Washliyah Medan
Email: agustinikholidah.nst@gmail.com,
eliaputri@umnaw.ac.id, Liaafriyantinasution@umnaw.ac.id,
fiqoh20@gmail.com

Abstract

The lack of media use and teachers' continued reliance on the lecture and blackboard approach at IRA Medan Private High School are the driving forces behind this study's motivation. These factors make it simple for pupils to become bored and disinterested during the physics learning process. The goals are to create learning materials for physics using a snake and ladder game using Phet Media Assisted Quantum Teaching on the topic of Dynamic Fluid Momentum, to assess the validity of the materials based on expert opinions, and to assess the usefulness of the materials based on student opinions. Potential and problem-solving stages, data gathering, product design, design validation, and design revision are all part of the development and research process. Three people, including students from class XI IPA at SMA IRA Medan, two media specialists, and one material expert (a teacher), validated the product at the stage of product validation. The validation results of the snakes and ladders game using Quantum Teaching Assisted by Media Phet by two validators obtained a score of 4.11 in the appropriate category, and the results of the validation results of the media expert for physics teacher class XI IPA SMA Private IRA Medan obtained a score of 4.23 in the very feasible category, and obtained a score the average of the three experts is 4.15 with a decent category. Based on the responses of the students per aspect, they obtained an average percentage score of 78.67% in the practical category.

Keywords: Learning Media, Phet Media Assisted Quantum Teaching, Dynamic Fluids

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Abstrak

Minimnya penggunaan media dan ketergantungan guru yang terus menerus pada pendekatan ceramah dan papan tulis di SMA Swasta IRA Medan adalah kekuatan pendorong di balik motivasi penelitian ini. Faktor-faktor tersebut membuat siswa mudah bosan dan tidak tertarik selama proses pembelajaran fisika. Tujuan penelitian ini adalah untuk membuat bahan ajar fisika menggunakan permainan ular tangga menggunakan Phet Media Assisted Quantum Teaching pada topik Momentum Fluida Dinamis, menilai validitas bahan berdasarkan pendapat ahli, dan menilai kemanfaatan bahan berdasarkan pada pendapat siswa. Tahapan potensi dan pemecahan masalah, pengumpulan data, desain produk, validasi desain, dan revisi desain adalah bagian dari proses pengembangan dan penelitian. Tiga orang yaitu siswa kelas XI IPA SMA IRA Medan, dua orang ahli media, dan satu orang ahli materi (seorang guru), melakukan validasi produk pada tahap validasi produk. Hasil validasi permainan ular tangga menggunakan *Quantum Teaching* Berbantuan *Media Phet* oleh dua validator memperoleh skor 4,11

dengan kategori layak, dan hasil validasi ahli media guru fisika kelas XI IPA SMA Swsata IRA Medan memproleh skor 4,23 dengan kategori sangat layak, dan diproleh skor rata-rata ketiga ahli 4,15 dengan kategori layak. Berdasarkan respon peserta didik per aspek memproleh nilai rata-rata persentase sebesar 78,67% dengan kategori praktis.

Kata Kunci: Media Pembelajaran, *Quantum Teaching* dengan *Media Phet,* Fluida Dinamis

INTRODUCTION

Since active learning helps students realize their full potential, it is essential to the educational process. In order to alter and accomplish bigger life goals, education is the process of changing one's attitudes and thoughts. The development of the national education system depends on its ability to produce excellent human resources (HR) and compete in the global era. The issue of competition in all spheres of life is becoming more difficult in the current globalization era. One of them in terms of technology and science. Competitive resources are required as a result.

The formal education received in schools has an impact on the quality of human resources. It is only fitting that raising the standard of education becomes a top priority in order to keep up with modern society, adjust to the changes brought about by the global era, and produce a generation of people who are highly intelligent, morally upright, responsible, and skilled.

Physics is one of the key resources in this situation for enhancing student proficiency. Due to its connection to nature, physics is one of the scientific fields that calls for experimental investigation. Therefore, it has not demonstrated success in the physics session based on the existing minimal mastery criterion. Direct observation and interviews were used to gather information on student learning outcomes. Approximately 70% of students dislike physics classes. There is virtually little inherent curiosity among physics students.

The quantum teaching and learning paradigm is a dynamic learning shift due to its complexity and inclusion of all the linkages, interactions, and differences that improve learning chances. This quantum teaching method can improve student engagement, foster effective learning, and create a pleasant learning atmosphere. in a way that fosters a positive relationship between the teacher and the students and makes interaction between them fun. Bobbi DePorter's (2010) term "Quantum Teaching," which refers to novel techniques that speed up the learning process, defines the integration of aesthetic elements with targeted achievement across all academic areas. The Quantum Teaching methodology includes the design framework Grow, Experience, Name, Demonstrate, Repeat, and Celebrate.

Students that struggle with learning can benefit from the quantum teaching and learning model and be guided to think similarly. Quantum education has disadvantages as well, including the need for careful planning, a loving environment, equipment, enough room, and costs that are occasionally inaccessible. Therefore, a medium, named PhET, is offered in learning activities that apply the Quantum Teaching paradigm to address these shortcomings.

Free physics learning simulations are available from Physics Education Technology (PhET) that can be utilized in class or downloaded for this purpose. It may also be applied personally. PhET Colorado interactive simulation is a fun, research-based interactive simulation medium that is available as software and may be used to illustrate concepts or observed physical processes. According to Mubarok and Mulyaningsih (2014), students should be able to use this PhET media to incorporate the concepts they have studied into simulations that already exist.

In this instance, it can be said that there is a problem with the disparity in student learning outcomes between the PhET media-assisted Quantum Teaching learning model, the conventional learning model on fluid material, and the PhET media-assisted Quantum Teaching learning model on dynamic fluid subjects class XI semester I SMA IRA Medan Private High School.

METHOD

Students made up the population of this quantitative study, which included nine classes from semester 1 of class XI at SMA IRA Medan. Because every class in the population has the right to have the opportunity to become a research sample, two classes were randomly chosen as the research sample using the cluster random sampling methodology. Samples from this group were taken, primarily from two courses. The experimental class was taught using the PhET-assisted Quantum Teaching learning model, whereas the control class was taught using the conventional learning paradigm. Class XI IPA 1 served as the experimental class, and Class XI IPA 2 served as the control class, totaling 34 students.

Learning outcomes and student activity observation sheets were the devices utilized in this study to gather data. Tests of learning outcomes are used to evaluate how effectively students' cognitive work on the subject related to dynamic fluids has gone. Twenty multiple-choice questions with five responses (A, B, C, D, and E) each measure how well students have learned the subject on dynamic fluids. The cognitive elements of this issue are knowledge (C1), understanding (C2), application (C3), analysis (C4), evaluation (C5), and creation (C6). This test is administered twice, once as a pretest and once as a posttest, before and after the instructional procedure. if each incorrect response receives a score of 0, and the right response receives a score of 1. The score will then be determined using the following method based on the overall rating of each response:

$$Value = \frac{Number\ of\ correct\ answers}{Number\ of\ questions} \ x \ 100$$

After the data has been collected, it is processed using the data analysis methodologies listed below:

a. Average score
$$\bar{x} = \frac{\sum x_i}{n}$$

b. Standard deviation
$$S^2 = \frac{n \sum x_i^2 - (\sum x_i)^2}{n(n-1)}$$

A test/pretest of students' initial abilities (two-tailed t-test), particularly the two-tailed t-test, was used to determine how similar the students' beginning skills in the two sample groups were. An example of a hypothesis that can be tested is the following:

$H_0 : \mu_1 = \mu_2$: The experimental class's and control class's starting capacity are equal.

$H_a : \mu_1 \neq \mu_2$: The experimental class's starting capacity is different from the control class's.

If the study data are homogeneous and regularly distributed, Sudjana (2005) suggests using the formula below to test the hypothesis:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

The formula is: if the two classes are not homogeneous.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S\sqrt{\dfrac{S_1^2}{n_1} + \dfrac{S_2^2}{n_2}}}$$

S stands for "sum of variance," and its formula is:

$$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

The test criteria are: accept H0 if $-t_{1-\frac{1}{2}\alpha} < t < t_{1-\frac{1}{2}\alpha}$ with $t_{1-\frac{1}{2}\alpha}$ and t distribution using df =($n_1 + n_2$-2) and $\alpha = 0{,}05$. For other t prices H0 is rejected.

A hypothesis test (one-party t-test) was conducted to examine the impact of the Quantum Teaching learning paradigm on student learning outcomes.

The hypothesis:

$H_0 : \mu_1 = \mu_2$: There is no effect of the Quantum Teaching learning model assisted by PhET media on student learning outcomes in the subject matter of dynamic fluid in class XI SMA IRA Medan T.P 2022/2023

$H_a : \mu_1 \neq \mu_2$: There is an influence of the Quantum Teaching learning model assisted by PhET media on student learning outcomes in the subject matter of dynamic fluid in class XI SMA IRA Medan T.P 2018/2019.

Test criteria: H_0 if $t < t_{1-\alpha}$, with $t_{1-\alpha}$ with df = $(n_1 + n_2$-2) and opportunities $(t_{1-\alpha})$ and $\alpha = 0{,}05$.

RESULTS AND DISCUSSION

Research result

This study was carried out in the odd-numbered semester in class XI at the IRa Medan Private High School on Jl. Combined No. 192 in Medan. A quasi-experimental research methodology was used to determine whether the treatment given to the students had any impact. The fluid dynamics learning outcomes of students are anticipated to be improved by the PhET media-assisted quantum teaching learning approach. Nine classes were chosen at random to represent the population. In this study, class XI Mipa 8 served as the experimental class employing the quantum teaching learning model, with class XI IPA 2 serving as the control class.

### Test results demonstrating student learning

Assessments with multiple choice questions are used to gauge student learning results. Each class receives a pretest to gauge their level of starting proficiency. Under the premise that the data is homogeneous and normally distributed, the two-party hypothesis test and t test were used to compare the results of the pretest. Table 1 displays the frequency distribution of the results of the pretest on dynamic fluid material for the experimental class and control class.

**Table 1.** Pretest Score Data for Experiment Class and Control Class

Experiment Pretest		Pretest Control	
Value	Frequency	Value	Frequency
15	2	10	1
20	4	15	3
25	6	20	3
30	6	25	6
35	5	30	6
40	4	35	6
45	2	40	3
50	1	45	2
Amount	915	Amount	865
Average	30,5	Average	28,83
Standard Deviation	9,03	Standard Deviation	9,06
Variance	81,63	Variance	82,21

Figures 1 and 2 show the frequency distribution of the pretest data for students in the control and experimental classes:
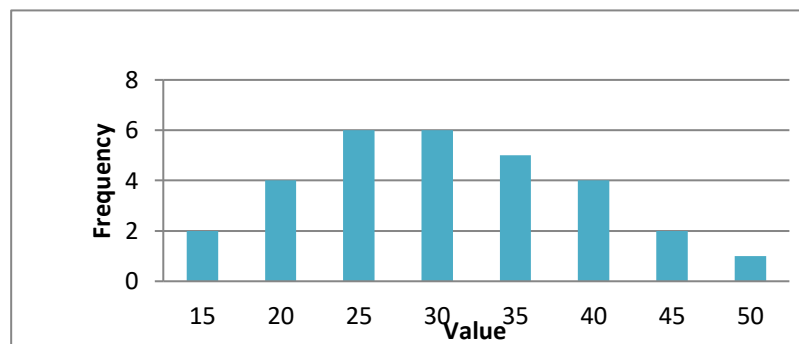
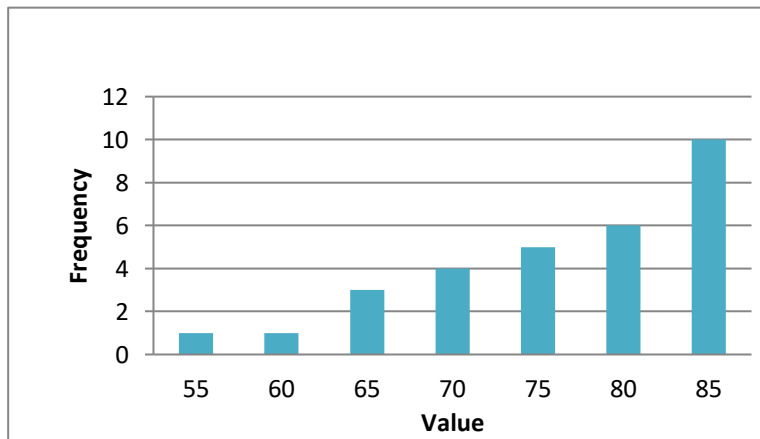**Figure 1.** Relationship between frequency and experimental class pretest scores
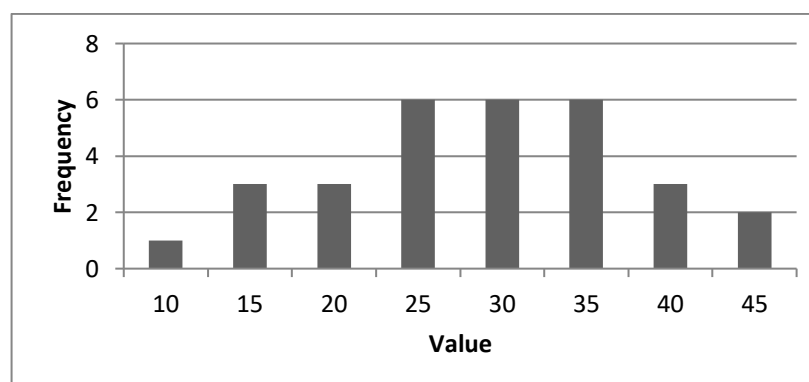
Figure 2. The relationship between frequency and control class posttest scores

Following the pretest, both classes got varied interventions. The experimental class, in contrast to the control class, employs the Quantum Teaching learning approach with the use of PhET media. At the conclusion of the study, both classes took a posttest to assess how well students had learnt as a result of the intervention. The posttest results for both classes are shown in Table 2.

Table 2. Posttest Score Data for Experiment Class and Control Class

Posttest Experiment		Posttest Control	
Value	Frequency	Value	Frequency
55	1	20	1
60	1	30	5
65	3	35	2
70	4	40	9
75	5	45	5
80	6	50	1
85	10	55	6
		60	1
Amount	2295	Amount	1265
Average	76,5	Average	42,17
Standard Deviation	8,52	Standard Deviation	9,79
Variance	72,67	Variance	96,005

Figures 3 and 4 show the frequency distribution of the pretest data for the students in the control and experimental classes:

Figure 3. The correlation between posttest scores and frequency for experimental classes
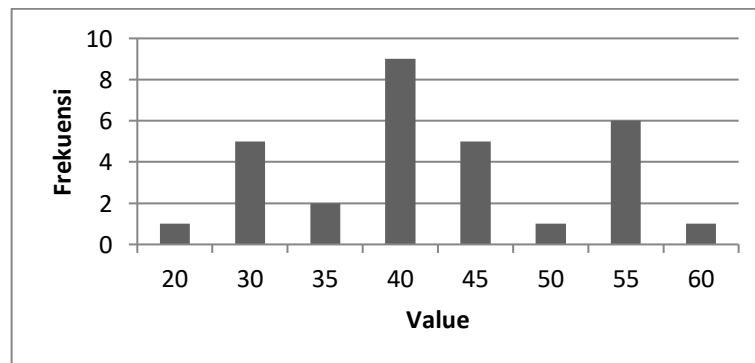
Figure 4. The relationship between frequency and control class posttest scores

As a prerequisite for treatment, the above data was tested by normality test and homogeneity

test.

Data analysis test

After gathering data from the outcomes of the pretest and posttest of students from the experimental class and the control class, normality tests and pretest homogeneity tests were conducted as data analysis tests. The data analysis process involved determining the homogeneity of the data by comparing variants for resemblance and the data's normalcy using the Lilliefors test.

Normality test

A normality test is carried out to determine if the data is normally distributed or not. The normality test for the experimental class and the control class is computed using the Lillifors test on the pretest and posttest data. The results of the normalcy test are listed in Table 4:

Table 4. Data Normality Test for the Two Sample Groups

No	Data	L_{count}	L_{table}	Conclusion
1.	Experiment Class Pretest	0,128	0,161	Normal Distribution
2.	Control Class Pretest	0,096		Normal Distribution
3.	Experiment Class Posttest	0,159	0,161	Normal Distribution
4.	Posttest Control Class	0,154		Normal Distribution

The pretest and posttest data for both groups were normally distributed, as shown in Table 4 where Lcount <Ltable.

Homogeneity Test

A homogeneity test is performed to determine whether or not the sample is homogeneous. The outcomes of calculating the pretest and posttest data from the two groups are shown in Table 5.

Table 5. Data Homogeneity Test of the Two Sample Groups

No	Data	Variance	F_{count}	F_{table}	Conclusion
1.	Experiment Class Pretest	81,63	0,993	1,873	homogeneous
2.	Control Class Pretest	82,21			
3.	Experiment Class Posttest	72,672	1,321	1,873	homogeneous
4.	Posttest Control Class	96,005			

Table 5 proves that value $F_{count} < F_{table}$, on pretest (0,993<1,873) and on posttest (1,321<1,873). Based on these calculations, the pretest and posttest data in both classes are homogeneous.

Research Hypothesis Test

A one-party hypothesis test is utilized in the pretest while a two-party test is used in the pretest to evaluate hypotheses.

Pretest data t test

Table 6 displays the computational results for the pretest data.

Table 6. Calculation of Pretest t test

Data	Average	t_{count}	t_{table}	Conclusion
Experiment Class	30,5	0,715	1,84	The initial ability of

Control Class	28,83			students of both classes is the same

From Table 6 the value of Ho is accepted because of the criteria $-t_{1-\frac{1}{2}\alpha} < t < t_{1-\frac{1}{2}\alpha}$ (-1,84<0,715< 1,84) fulfilled. The beginning skills of students in the experimental class and students in the control class do not differ, hence tcount is in the Ho area. After the pretest results in both classes were normal, homogeneous, and showed no significant difference, the two courses were handled using the Quantum Teaching model assisted by PhET media while the control class employed traditional learning.

Posttest Data t test

A one-tailed t test was used to assess the efficacy of the stated therapy, which was the Quantum Teaching learning model supported by PhET media. The posttest calculation results are shown in Table 7.

Table 7. Calculation of Posttest t test

Data	Average	t_{count}	t_{table}	Conclution
Experiment class	76,5	14,48	0,15	The consequences of student learning when using the Quantum Teaching learning model with PhET media vary substantially.
Control class	42,16			

According to Table 7. When using the Quantum Teaching model with the aid of PhET media, the experimental class received an average score of 76.5, while the control class received an average score of 42.16 when using the conventional approach. According to Table 7, when tcount>ttable(14.48>0.15), Ho is rejected while Ha is accepted. The Quantum Teaching model and PhET media provide significantly different student learning outcomes, according to the one-tailed t test results. This demonstrates that students' learning outcomes for the dynamic fluid material in class XI SMA IRa Medan T.P 2022/2023 are impacted by the Quantum Teaching approach supported by PhET media.
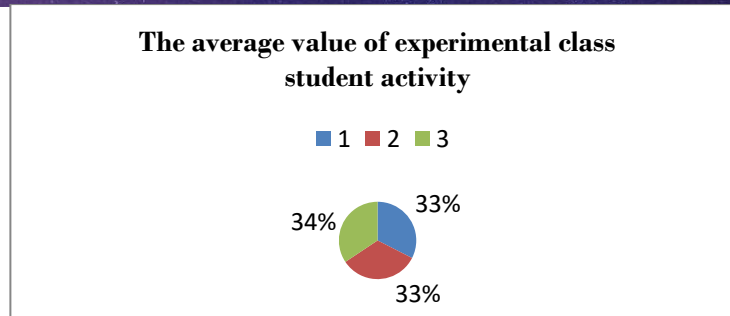
Student Activity

Table 8 lists the experimental class's daily learning activities for students:

Table 8. Development of Student Activities

Meeting	Value	Information
I	82,2	Active
II	83,3	Active
III	86,89	Very Active

Because they were taught utilizing the Quantum Teaching learning model with assistance from PhET media, as shown in Table 8, the learning activities of the experimental class students increased from meeting I to meeting III with an average overall score of 84.13 in the active category.

The average value of experimental class student activity

■ 1 ■ 2 ■ 3

33%
33%
34%

Figure 5. Relationship between activity assessment criteria and the number of students

Figure 5 shows that from the first meeting to the third meeting, there was an increase in the average % of experimental class student involvement. The percentages of the first, second, and third meetings' student activity scores are 33%, 33%, and 34%, respectively. This shows that quantum teaching and learning approaches have the potential to increase student engagement in addition to improving learning outcomes. With an average score of 76.5, the improvement in student learning outcomes shows that this activity also significantly affects their results. The outcomes demonstrated a considerable improvement in student performance in the Dynamic Fluid Curriculum XI Semester II SMA IRa Medan T.P 2022/2023 following the use of the quantum teaching approach.

RESEARCH DISCUSSION

The experimental class employed the Quantum Teaching paradigm assisted by PhET media, while the control class learned using traditional means. In this study, two classes in grade XI took part and received various therapies. In comparison to the control class's usage of conventional models, the class XI Semester I SMA IRa Medan Medan's employment of the PhET media-assisted quantum learning model produced improved learning outcomes. The difference in rising learning outcomes between the experimental class and the control class serves as evidence of this.

Student Learning Outcomes Using the PhET Quantum Teaching Learning Model with Media-Assisted Learning

Learning results in the experimental class increased by 46, from an average pretest score of 30.5 to a posttest score of 76.5. Twenty objective items in all were used for the pre- and post-tests. According to the findings of the two samples' normality tests, the pretest values were normally distributed and came from a homogeneous population with an X2count that did not exceed an X2table.

Student Learning Outcomes With Conventional Learning Models

The average pretest score was 28.83, and the average posttest score was 42.16, so the experimental class's learning outcomes only went up by 13.33. Twenty objective questions from the same set of instruments were utilized for both the pre- and post-testing. According to the findings of the two samples' normality tests, the pretest values are normally distributed and were drawn from a homogeneous population where X2count does not exceed X2table.

Student Activity

When pupils are actively engaged in the learning process, researchers watch over them. The amount of student participation increased slightly but not significantly at each meeting. Since students are actively participating in the learning process, the average value at the first meeting is 82.2 (active).

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Student participation actually improved at the third meeting, with an average score of 86.89, whereas it grew marginally at the second meeting to 83.3 (active). The first meeting had already gotten the pupils involved, so learning could go on without any issues.

Effect of PhET Media Assisted Quantum Teaching Learning Model

A one-tailed t test was used to analyze the results of the posttest hypothesis test, and the results are as follows: the tcount value is 14.48, the ttable value is significant (= 0.05), and the value for dk = n1 + n2-2 is 0.15. This demonstrates that tcount is more valuable than ttable. The results of the test reject Ho and accept Ha, proving that the PhET media-assisted quantum teaching learning model affects students' learning outcomes at IRa Medan Medan Private High School. Figure 6 shows the effects of quantum teaching and learning.
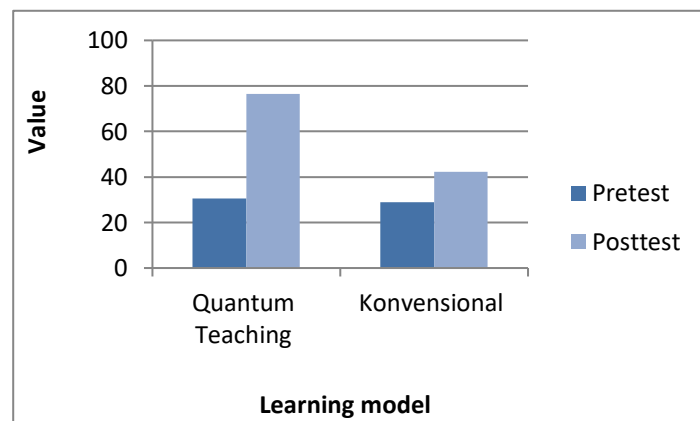
Figure 6. The relationship between the value of learning outcomes and the learning model

The growth stage (first), where students' interest in learning the subject matter is affected, is the first of six stages in which the quantum teaching and learning paradigm is applied. Throughout this phase of development, PHEt media informs and supports students. During the natural (second) stage, students have the chance to identify and react to perceptions that have been made in relation to the subject matter to be studied. The researcher Student Worksheet to complete. Students undertake an experiment to gain additional insight into the difficulty during the Name (third) stage. In Student Worksheet, students work together with researchers to process data and examine the findings of observations made during experiments. Students present their experimental findings in front of the class in the fourth step, Demonstration, and if necessary, respond to questions from other groups. Students summarize the results of their conversations and apply them to real-world situations in the Repeat (fifth) stage. Researchers in this field assist in drawing conclusions about the material being investigated. in the sixth stage of the celebration. The winning group will receive applause in the final round.

According to Rohman et al. (2017), quantum teaching and learning can enhance students' learning outcomes for optical content with a typical cognitive value. In cycle I, between 70.43 and 80.43. grew from 61% to 87%, the traditional completeness. From cycle I to cycle II, the average student's affective value in terms of interest increased by 68% and 85%, respectively. The average psychomotor cycle I value is 70%, and it rises to 84% in cycle II.

According to Indrasati et al. (2016), the combination of the quantum learning model and

worksheets based on cartoons for physics at SMA Negeri 4 Jember had a substantial impact on learning results and student motivation. According to research by Baroroh et al. (2017), there are statistically significant variations in how well students learn physics when using the Quantum Teaching learning paradigm instead of Flash media. Direct learning and student learning activities are considered to be very active with an average of 84.40%.

According to Ningrum et al. (2015), the verbal representation ability of 18.28, mathematics of 15.52, graphics of 14.72, and drawing of 15.12 in physics class XI were all impacted by the quantum learning model with practical approaches. Similar findings were made in Silalahi's (2014) study, which discovered that adopting the Quantum Teaching learning model had an impact on student learning outcomes, which were 79.69, as opposed to 75.17 when using conventional methods.

Lack of classroom mastery skills and ineffective time management during the learning process is a challenge for researchers. Researchers should try to prepare themselves once again so that they can carry out the learning process in accordance with what has been planned.

CONCLUSION

1. Experimental class students who study fluid dynamics using the quantum teaching learning model with PhET media obtain an average posttest score of 76.5 fulfilling the Minimum Completeness Criteria, which is 75 in the overall category.
2. The average posttest score of 42.16 achieved by control class students by applying conventional learning to dynamic fluid material does not meet the Minimum Completeness Criteria, namely 75 in the overall category.
3. The quantum teaching learning model produces an average student learning activity of 84.13 in the active category.
4. The results of data analysis with the one-sided t test and significant = 0.05, tcount = 14.48 and tcount = 0.15 can be used to conclude that the quantum learning model has significant implications for student learning outcomes in fluid dynamics material with a pretest and posttest comparison of around 30.5 and 76.5.

SUGGESTION

1. Schools pay more attention to managing the use of physics laboratories which are important for the learning process
2. Teachers must be able to teach using a learning model that encourages students to learn more actively, such as the approach used in this study.
3. In order to be more confident and create an interesting and interactive learning atmosphere, students are encouraged to better prepare themselves before participating in teaching and learning activities.
4. It is believed that further researchers can prepare themselves again to carry out learning procedures according to what has been planned.

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