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Teaching Using Tools and Means of Learning Math with the Support of Geogebra Software in Calculating the Angle between Two Lines in Space

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Abstract

Teaching using math tools and means with the support of GeoGebra software is one of the five important types of teaching to develop mathematical competence that the Mathematics General Education program offers in Vietnam. Currently, GeoGebra software has been introduced into teaching since 6th grade. Students have been exposed to and familiar with the command buttons, interface, and important features of GeoGebra software. Therefore, the way of teaching using math tools and means with the support of GeoGebra software in calculating the angle between two straight lines in space is a teaching method that meets the new situation of education. Teaching with the help of GeoGebra software helps students have an intuitive and vivid view. Students are more passionate and interested in knowledge, especially knowledge of spatial geometry. Our article focuses on surveying teaching using math learning tools and means with the help of GeoGebra software, giving the teaching process as well as teaching methods using tools and means to learn math with the support of GeoGebra software in calculating the angle between two lines in space.

Keywords: Tools and means for learning math, GeoGebra software, the angle between two lines in space, process, method.

1. INTRODUCTION

The 2018 Mathematical General Education Program in Vietnam clearly states that “Math content is usually logical, abstract, and general. Therefore, in order to understand and learn math, math programs in high schools need to ensure a balance between "learning" knowledge and "applying" knowledge to solve specific problems. In the process of learning and applying mathematics, students always have the opportunity to use modern technological means and teaching equipment, especially electronic computers and calculators to support the process of performing, exploring, discovering knowledge, and solving mathematical problems". Also according to the 2018 General Education Program in Mathematics, the educational objective is "Contributing to the formation and development of mathematical competence with the requirements: raise and answer questions when reasoning and solving problems; use reasoning, induction, and deductive methods to understand different ways of solving problems; establish a mathematical model to describe the situation, thereby providing a solution to the mathematical problem posed in the established model; implement and present the solution to the problem and evaluate the implemented solution, reflect the value of the solution, generalize to a similar problem; be able to use math learning tools and means in learning, discovering and solving math problems" (Vietnam Ministry of Education and Training, 2018).

According to the Mathematical General Education Program in 2018 in Vietnam, math forms and develops students' mathematical competence including the following core components: mathematical thinking and reasoning ability; mathematical modeling competence; ability to solve mathematical problems; mathematical communication competence; ability to use math learning tools and means. In teaching and developing capacity, the ability to use math learning tools and means is one of the most important competencies.

The ability to use tools and means of learning mathematics is shown in the following. Firstly, students know the names, effects, usage rules, ways of preserving common visual aids, and scientific and technological means (especially means of using information technology), for learning math. Second, students can use math learning tools and means, especially scientific and technological means, to explore, discover and solve math problems (in line with cognitive characteristics of different age groups).). Thirdly, students recognize the advantages and limitations of supporting tools and means to have a reasonable use. The ability to use math learning tools and means has many different components, such as skills in using calculator software, skills in using Microsoft Excel software, etc. However, we realize that one of the important skills is the skill of using GeoGebra software. The main features of GeoGebra can be mentioned as simulating mathematical graphs of algebra, geometry, and spreadsheets, supporting drawing tools in math, fast and accurate execution, easy to use, and common in the learning process. GeoGebra software is one of the important math learning tools of the high school program, especially now GeoGebra software has been taught since grade 6. The application of GeoGebra software in teaching math in general and spatial geometry in particular helps learners promote their ability to use math tools and means and be active in learning activities.

In the world, there have been many researches on the use of mathematics learning tools and means such as Asmin et al (2019) in the article "Development of Mathematics learning tools through GeoGebra - Aided problem based learning to improve solving capability capability" Mathematical problems of high school students"; Yismaw Abera Wassie & Gurju Awgichew Zergaw (2019) in the article "Some of the Potential Afferdances, Challenges and Limitations of Using GeoGebra in Mathematics Education"; Natalija Budinsky et al (2018) in the article "Ideas for using GeoGebra and Origami in Teaching Regular Polyhedrons Lessons"; Lal Kumar Singh (2018) in "Impact of Using GeoGebra Software on Students' Achievement in Geometry: A Study at Secondary Level"; Elena Semenikhina & Marina Drushlyak (2014) in "Computer Mathematical Tools: Practical Experience of Learning to use them"; Masniladevi et al (2017) in the study "Teachers' ability in using math learning media"; Kristof De Witte et al (2014) in the publication "Application of GeoGebra in Stereometry teaching"; Natalya V.Rashevska et al (2020) in the article "Using augmented reality tools in the teaching of two-dimensional plane geometry"; Serpil Yorganci et al (2018) in the paper "A study on the views of graduate students on the use of GeoGebra in mathematics teaching".

In Vietnam, there are also some authors who do research on teaching spatial geometry in grade 11 as well as dynamic geometry software, for example, Nguyen Thanh Hang (2018) with his master's thesis "Teaching quadratic functions in high school from a modeling point of view with GeoGebra software"; Dang Van Bieu (2016) with his master's thesis "Using Geometer's Sketchpad software in teaching the topic of circles, 9th-grade geometry"; Nguyen Hoang Bich (2013) with master's thesis "Using Geometer's Sketchpad software as a support tool in teaching, learning, solving some problems on functions and graphs"; Luu Hong Nhung (2016) with master's thesis "Using Geometer's Sketchpad software in teaching geometry theorems in grade 8"; Hoang Thuy Nguyen (2010) with the master's thesis "Research on the use of Cabri 3D software by teachers in teaching 9th-grade spatial geometry in the chapter of parallelism and perpendicular relations in high school (advanced level)"; Dang Thi Bich Ngoc (2015) with a master's thesis "Using Cabri 3D software in teaching and exploring spatial geometry in grade 12, basic level, high school math"; Nguyen Thi Phuong (2020) with her master's thesis "Designing exploratory teaching situations in the topic of circular blocks - geometry 12 with the support of GeoGebra software".

With the above surveys, we found that the topic of teaching using mathematical tools and means with the support of Geogebra software in calculating the angle between two lines in space is necessary, still new and no one has studied it. Therefore, our paper will focus on this topic. The article focuses on answering two questions:

1. How is the teaching process using tools and means of learning math with the support of GeoGebra software in calculating the angle between two lines in space?
2. How do we teach using tools and means of learning math with the support of GeoGebra software in calculating the angle between two lines in space?

2. LITERATURE REVIEW

2.1. Teaching process using math tools and means with the support of GeoGebra software in calculating the angle between two lines in space

Step 1: Consider and determine the ability to use math tools and means with the support of GeoGebra software in calculating the angle between two lines in space

Not all problems of calculating the angle between two lines in space can be used by GeoGebra software. Therefore, we need to consider and determine the ability to use mathematical tools and means with the support of GeoGebra software in the problem of calculating the angle between two lines in space. Only problems that apply the support of GeoGebra software can we apply this teaching process.

Step 2: Use tools and means to learn math with the support of GeoGebra software to calculate the angle between two lines in space

We need to detect the moving and the fixed elements of the problem, as well as the relationship between the conclusion and the hypothesis. From there, we use tools and means of learning math with the support of GeoGebra software to calculate the angle between two lines in space.

Step 3: Solve the math

We use the method of synthetic geometry to prove and calculate the angle between two lines in space. We need to know how to apply proficiently the methods of calculating the angle between two lines in space.

Step 4: Draw conclusions

From the solution of the problem, based on the data of the given problem and the obtained results, we will calculate the angle between two lines in space.

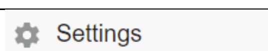
Step 5: Deepen the solution (if any)

Find other solutions, expand the problem to a more general problem, find the problem similar to the original problem, find the inverse problem, etc. Deepening the solution is not always possible, but when done, it will give us a meaningful pedagogical result that helps students develop thinking.

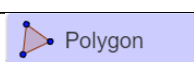
2.2. Teaching method using mathematical tools and means with the support of GeoGebra software in calculating the angle between two lines in space

Example 1

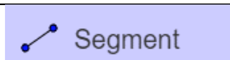
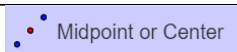
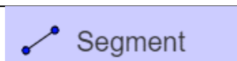
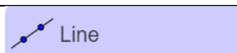
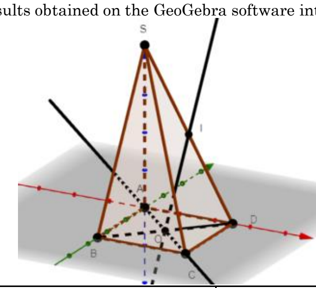
Given pyramid S.ABCD whose base ABCD is a square with center O, with each side equal to 5, SA is perpendicular to the base and $SA = 5\sqrt{3}$ *. Calculate the approximate angle between the two lines SB and AC?*

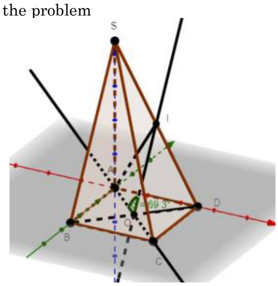
<table>
<tr><th colspan="2">Teacher's activities</th><th>Student activities</th></tr>
<tr><td colspan="3">Step 1: Consider and determine the ability to use math tools and means with the support of GeoGebra software in calculating the angle between two lines in space</td></tr>
<tr><td colspan="2">- The knowledge of calculating the angle between two intersecting and diagonal lines in space can be used with mathematical tools and means with the support of GeoGebra software.</td><td>- Students absorb and listen</td></tr>
<tr><td colspan="3">Step 2: Use math tools and means with the support of GeoGebra software to calculate the angle between two lines in space</td></tr>
<tr><th>Numerical order</th><th>Shapes</th><th>Steps</th></tr>
<tr><td>1</td><td>
</td><td>How to customize color:
- Select the object, right click select Settings

- Select the color icon. Color

To change the color of the object.</td></tr>
<tr><td>2</td><td>
</td><td>- Select the box Input
Enter $A(0,0,0)$
$B(0,-5,0)$
$C(5,-5,0)$
$D(5,0,0)$
$S(0,0,5sqrt3)$</td></tr>
<tr><td>3</td><td>
</td><td>- Select the icon Polygon

- Choose 4 points A, B, C, and D in turn to form a square ABCD.
- Choose 3 points S, A, and B respectively to form a triangle SAB.
- Choose 3 points S, B, and C respectively to form a triangle SBC.
- Choose 3 points S, C, and D respectively to form a triangle SCD.
- Choose 3 points S, A, and D in turn to form a triangle SAD.</td></tr>
</table>

4		- Select the icon **Segment** - Click on point *A* and point *C* to form a line segment *AC*. - Click on point *B* and point *D* to form a line segment *BD*.
5		- Select the icon **Intersect** - Click to select the line segments *AC* and *BD* or click at the intersection of *AC* and *BD* to form point *O*.
6		- Select the icon **Midpoint or Center** - Click to select the *SD* line to make it appear midpoint *I* of *SD*.
7		- Select the icon **Segment** - Click on point *O* and point *I* to form a straight line *OI*.
8		- Select the icon **Line** - Click on point *O* and point *I* to form a line *j* passing through two points *O, I*. - Click on point *A* and point *C* to form a line *k* passing through two points *A* and *C*.
9	Input...	- Select the command input bar **Input** - Enter Angle(*j, k*)
Results obtained on the GeoGebra software interface 		
10	α = Goc(j, k) → 69.3°	The result obtained on **the Display area** is the angle of the two lines SB and AC.
	Teacher's activities	**Student activities**
11	- To calculate the angle between two lines *SB* and *AC*, we must construct a line parallel to *SB* and intersect *AC*. So on the line *AC*, we have point *A*, point *C*, and mid point *O* of *AC*, but from point *A* and point *C* if we build lines parallel to *SB*, we "hardly" find the relationship angle between two lines *SB* and *AC*. Meanwhile, from point *O*, we build a line *OI* parallel to *SB*, then *OI* is the median of triangle *SBD*, making it easy to find the solution to the problem. Now the angle between the two lines *SB* and *AC* is the angle between the two lines *OI* and *AC*. $(\bar{S}B, AC) = (\bar{O}I, AC) = \hat{A}OI$	- Students absorb and listen.

<table>
<tr><td>12</td><td>Let's check the angle $\widehat{AOI}$</td><td>$\alpha = \text{Goc}(A, O, I)$
$\rightarrow 69.3°$
The verification results show that the angle of two lines SB and AC is close to $69,3^{\circ}$.</td></tr>
<tr><td colspan="3">Step 3: Solve the math problem</td></tr>
<tr><td colspan="2">Teacher's activities</td><td>Student activities</td></tr>
<tr><td colspan="2">Please solve the problem

</td><td>- Let I be the midpoint of SD. Then OI is the median of triangle SBD, so we infer $OI // SB$. From that:
$(\widehat{SB, AC}) = (\widehat{OI, AC}) = \widehat{AOI}$

Considering triangle SAB right angled at A, we have:
$SB^2 = SA^2 + AB^2$
$\Leftrightarrow SB^2 = \left(5\sqrt{3}\right)^2 + 5^2$
$\Leftrightarrow SB = 10$

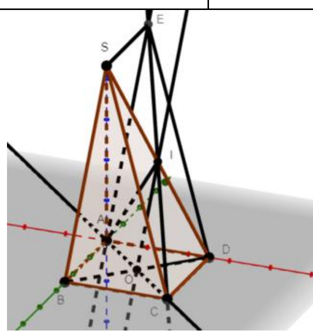
Consider triangle SBD whose OI is the median:
$OI = \frac{SB}{2} = \frac{10}{2} = 5$

Considering triangle SAD right angled at A, we have:
$SD^2 = SA^2 + AD^2$
$\Leftrightarrow SD^2 = \left(5\sqrt{3}\right)^2 + 5^2$
$\Leftrightarrow SD = 10$
$AI = \frac{SD}{2} = \frac{10}{2} = 5$
(Since AI is the median in right triangle SAD.)
$AO = \frac{AC}{2} = \frac{5\sqrt{2}}{2}$

Considering triangle AOI, we have:
$AI^2 = OI^2 + OA^2 - 2OI.OA.\cos\widehat{AOI}$
$\Leftrightarrow \cos\widehat{AOI} = \frac{\sqrt{2}}{4}$
$\Leftrightarrow \widehat{AOI} \approx 69,3^{\circ}$</td></tr>
<tr><td colspan="3">Step 4: Draw conclusions</td></tr>
<tr><td colspan="2">- From the solution to the problem in step 3 and the results found on the math learning tools and means with the support of GeoGebra software in step 2, would you please tell me if the solution for the given problem is correct?</td><td>So $(\widehat{SB, AC}) = \widehat{AOI} \approx 69,3^{\circ}$

- The results of the solution of the problem by the mathematical method completely coincide with the results found on the math learning tools and means with the support of GeoGebra software, so the problem solution given is completely correct.</td></tr>
<tr><td colspan="2">- The use of tools and means of learning mathematics with the support of GeoGebra software in the problem of calculating the angle between two lines in space has the effect of verifying the solution of the problem. If by steps and precise modeling operations on math learning tools and means with the support of GeoGebra software, we get the same results as the mathematical solution, then we say the mathematical solution is completely correct. Conversely, if the results do not coincide with the solution by mathematical methods, it proves that we are wrong in our argument and proof.</td><td>- Students absorb and listen.</td></tr>
</table>

Step 5: Deepen the solution (if any)	
Teacher's activities	**Student activities**
- To find the angle between two lines *SB* and *AC*, we construct a parallelogram *SBAE*, so *SE* is parallel and equal to *AB*, deducing that *SE* is parallel and equal to *CD*. Hence *SEDC* is a parallelogram and *I* is the mid point of *SD*, so *I* is also a mid point of *EC*. - On the other hand, *O* and *I* are the midpoints of *BD* and *SD* respectively, so *OI* is the median of triangle *SBD*, so *OI* is parallel to *SB* and *AE*. Now the angle between the two lines *SB* and *AC* is also the angle between the two lines *AE* and *AC*. $\widehat{(SB, AC)} = \widehat{(AE, AC)} = \widehat{EAC}$ - So, in addition to constructing the shape from point *O*, we can also construct the shape from point *A* on line *AC* and parallel to *SB*.	- Students absorb and listen.



$\widehat{(SB, AC)} = \widehat{(AE, AC)} = \widehat{EAC}$

We will calculate the angle $\widehat{EAC}$

We have $CD \perp AD$ ($ABCD$ is a square)

$CD \perp SA$ (Because $SA \perp (ABCD)$)

In the (SAD) plane, $AD \cap SA = A$

$\Rightarrow CD \perp (SAD)$

But $BD \subset (SBD)$

$\Rightarrow CD \perp BD$

Considering triangle *SAD* right angled at *A*, we have:

$SD^2 = SA^2 + AD^2 = \left(5\sqrt{3}\right)^2 + 5^2$

$\Leftrightarrow SD = 10$

$ID = \dfrac{SD}{2} = \dfrac{10}{2}$ (Because *I* is the midpoint of *SD*)

Considering triangle *ICD* right angled at *D*, we have:

$IC^2 = ID^2 + CD^2 = 5^2 + 5^2 = 50$

$\Leftrightarrow IC = 5\sqrt{2}$

We infer $EC = 2IC = 10\sqrt{2}$ (Because I is the midpoint of EC)

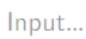
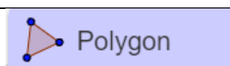
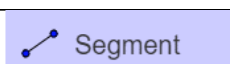
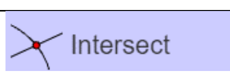
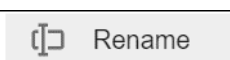
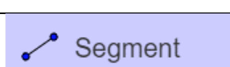
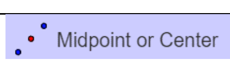
We have: $EA = SB = \sqrt{SA^2 + AB^2} = \sqrt{\left(5\sqrt{3}\right)^2 + 5^2} = 10$ và $AC = 5\sqrt{2}$

Considering triangle *EAC*, we have:

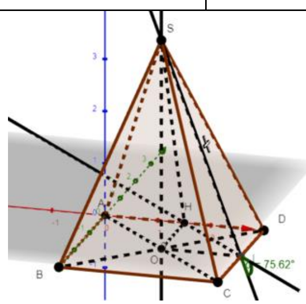
$$EC^2 = EA^2 + AC^2 - 2.EA.AC.\cos\widehat{SAC}$$
$$\Leftrightarrow \left(10\sqrt{2}\right)^2 = 10^2 + \left(5\sqrt{2}\right)^2 - 2.10.5\sqrt{2}.\cos\widehat{EAC}$$
$$\Leftrightarrow \widehat{EAC} \approx 110,7^0$$

The angle between the two lines must be acute, so the angle between the lines *SB* and *AC* is close to
$180^\circ - 110,7^\circ = 69,3^\circ$

- The teacher gives a problem similar to the following **Example 2** Given a regular quadrilateral pyramid, *S.ABCD* whose base is a square with center *O*, sides equal to 3, *SO*=4, *I* is the midpoint of side *CD*. Calculate the approximate angle of two lines *AC* and *SI*.	- Students think and find the solution to the problem.

Numerical order	**Shapes**	**Steps**
1		- Select the box **Input** Enter $A(0,0,0)$ $B(0,-3,0)$ $C(3,-3,0)$ $D(3,0,0)$ $S(1.5,-1.5,4)$
2		- Select the icon **Polygon** - Choose 4 points *A, B, C, D* in turn to form a square *ABCD*. - Choose 3 points *S, A, B* respectively to form triangle *SAB*. - Choose 3 points *S, B, C* respectively to form triangle *SBC*. - Choose 3 points *S, C, D* respectively to form triangle *SCD*. - Choose 3 points *S, A, D* respectively to form triangle *SAD*.
3		- Select the icon **Segment** - Click on point *A* and point *C* to form a line segment *AC*. - Click on point *B* and point *D* to form a line segment *BD*.
4		- Select the icon **Intersect** - Click to select the line segment *AC* and BD or click the intersection position of *AC* and *BD* to form point *O*.
5		- Right click select **Rename** - Rename the intersection of *AC* and *BD* to point *O*.
6		- Select the icon **Segment** - Click on point *S* and point *O* to form a line segment *SO*.
7		- Select the icon **Midpoint or Center** - Select the line segment *CD* so that it appears midpoint *I*.

8	Đổi tên	- Right click select **Rename** - Rename the midpoint of *CD* to point *I*.
9	Parallel Line	- Select the icon **Parallel Line** - Select point *I* and line segment *AC* to form a line *k* passing through point *I* and parallel to *AC*.
10	Line	- Select the icon **Line** - Choose 2 points *S* and *M* to form a straight line l.
11	Input...	- Select the command input bar **Input** - Enter Angle(*k*, *l*)
12	α = Goc(k, l) → 75.62°	The result obtained on ***the Display area*** is the angle of the two lines *SI* and *AC*.



Let *H* be the midpoint of *AD*
Consider triangle *ACD* where *IH* is the mean line

$$\Rightarrow IH // AC$$

$$\widehat{(AC, SI)} = \widehat{(IH, SI)} = \widehat{SIH}$$

$$IH = \frac{AC}{2} = \frac{3\sqrt{2}}{2}$$

$$OH = \frac{CD}{2} = 1,5$$

Considering triangle *SOH* right angled at *O*, we have:

$$SH = \sqrt{SO^2 + OH^2} = \sqrt{4^2 + (1,5)^2} = \frac{\sqrt{73}}{2}$$

$$\Delta SOH = \Delta SOI \Rightarrow SH = SI = \frac{\sqrt{73}}{2}$$

Considering triangle *SHI*, we have:

$$SH^2 = SI^2 + HI^2 - 2SI.HI.\cos\widehat{SIH}$$

$$\Leftrightarrow \widehat{SIH} \approx 75,62^\circ$$

Vậy $\widehat{(AC, SI)} = \widehat{(IH, SI)} = \widehat{SIH} \approx 75,62^\circ$

3. PEDAGOGICAL EXPERIMENT

3.1. Organization of pedagogical experiments

- The pedagogical experiment was conducted at Duong Van Thi high school (Thu Duc city) in the school year 2021-2022.
- Experimental period: From January 15, 2022, to March 30, 2022.
- Experimental class: 11A1 including 49 students. Math teacher: Nguyen Huynh Nam.
- Control class: 11A7 including 47 students. Math teacher: Nguyen Huynh Nam.

We designed lesson plans and implemented the teaching content "Calculating the angle of two planes" for both classes. For the experimental class, the teacher will teach according to the lesson plan "Developing capacity to use tools and means of learning mathematics through teaching spatial geometry in grade 11 with the support of GeoGebra software". For the control class, the teacher will teach according to the program distribution. The given spatial geometry problems must ensure the following contents:
- Clearly define the key knowledge and skills to be achieved.
- Arrange to suit learning time and general knowledge level of students.
- Activities in the teaching process must help students develop their ability to apply, explore and discover tools and means of learning mathematics through teaching spatial geometry in grade 11 with the support of GeoGebra software.

3.2. Quantitative assessment

To test the feasibility and evaluate the effectiveness of the cases, we gave the experimental class and the control class a 45-minute test. Quantitative analysis is based on test results.
Based on the student's expressions of change during the lessons and tests, we have noticed the following.

Table 3.1. The frequency distribution table of the mean scores of the 45-minute test after the experiment of the experimental class and the control class (Source: Author)

THE MEAN SCORES	11A1 (Experimental)	11A7 (Control)	Total
5.0	0	2	2
5.5	0	4	4
6.0	2	5	7
6.5	5	6	11
7.0	7	7	14
7.5	8	8	16
8.0	9	7	16
8.5	7	5	12
9.0	6	3	9

9.5	4	2	6
10	1	0	1
Total	**49**	**49**	**98**

We conduct a test of the normal distribution for the sample set which is the average score of the first semester of both experimental and control classes. As a result, we get the following graph:

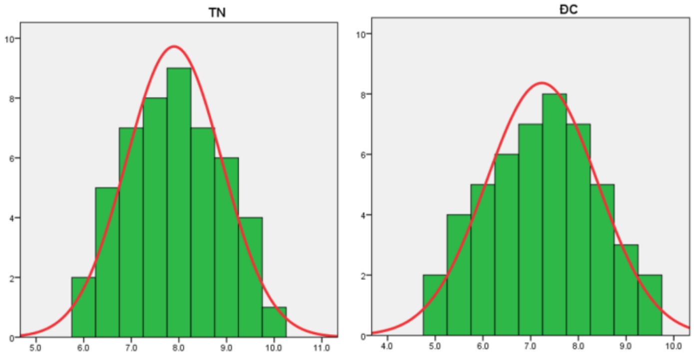


Figure 1. Distribution of 45-minute math test scores of two experimental and control classes

(Source: Author)

We find that the distribution graph is bell-shaped (Figure 1). Distributions of this form are called "Normal distributions". So we continue to study this sample.

From Table 3.1, we obtain a graph of the frequency distribution of Math scores of the two experimental and control classes in the first semester of the school year 2021-2022 as follows:

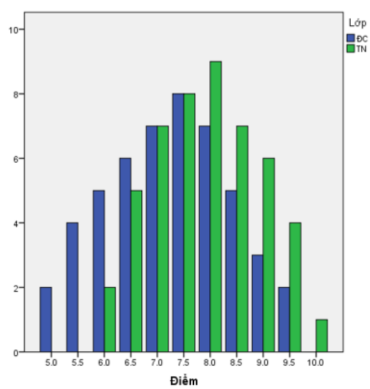


Figure 2. The graph shows the frequency distribution of 45-minute math test scores after the experiment of the experimental and control classes

(Source: Author)

From chart 2, it can be seen that the heights of the score columns and the distribution of scores of the two classes do not have much difference. The scores of the experimental class range from 6.0 to 10 points and focus mainly from 7.0 to 9.0 points. The scores of the control class range from 5.0 to 9.5 points and most of them are in the range of 5.5 to 8.5 points.

Table 3.2. Table of specific parameters of statistics about the average score of 45-minute math test after the experiment of two classes *(Source: Author)*

	Class	**Mean**	**Variance**	**Standard Deviation**
Scores	Experimental	7.898	1.010	1.0051
	Control	7.235	1.366	1.1686

From Table 3.2, we have:

- The average score of the 45-minute test of the experimental class in the first semester is 7.898 points.

- The average score of the 45-minute test of the control class in the first semester is 7.235 points.

- The standard deviation and variance of the control class are higher than that of the experimental class, showing that the dispersion of scores around the mean of the control class is higher than that of the experimental class. We conduct a T-test (Table 3.12) to accurately assess the difference or equivalence between the mean scores of the two classes. We test the following two hypotheses with significance level $\alpha = 0,05$.

$H_0:$ "The average score of the 45-minute math test of the experimental class and the control class is similar".

$H_1:$ "The average score of the 45-minute math test of the experimental class is higher than that of the control class".

Table 3.12. The average T-test table of the average score of the 45-minute math test of the experimental and control classes in SPSS *(Source: Author)*

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ĐĐiểm	Equal variances assumed	1.279	.261	3.012	96	.003	.6633	.2202	.2262	1.1004
	Equal variances not assumed			3.012	93.898	.003	.6633	.2202	.2261	1.1005

- Levene test has a value of $Sig. = 0,261 > \alpha = 0,05$, so the variance of the two classes, although there is a difference, is not significant, and should be considered equivalent, using Independent sample T-test results corresponding to the case that the equal variances of two classes are assumed.
- By Independent sample T-test, we see that $Sig.(2-tailed) = 0,003 < \alpha = 0,05$, so hypothesis H_0 is rejected, accepting hypothesis H_1. Therefore, the mean score of the experimental class is higher than that of the control class at the 5% level of significance.

Thus, by the method of testing between classes with equivalent academic abilities, I found that the experimental class after being taught with an experimental lesson plan uses math tools and means with the support of GeoGebra software, the test results are better and the student's performance in the learning process changes in a positive direction. It can be seen that the experimental situations applied to the experimental class are completely feasible and achieve certain effectiveness in teaching.

4. CONCLUSION

Teaching using math learning tools and means with the support of GeoGebra software in general and teaching using math learning tools and means with the support of GeoGebra software in calculating the angle between two lines in space in particular, are modern teaching methods. This method is associated with the application of information technology to help learners have an intuitive, vivid view, connecting theory, and application to problem-solving. Thanks to the features of dynamic geometry software, GeoGebra software helps teachers move shapes to different states. Students can see the connection between the problem and the solution. Students when learning with the GeoGebra software tool showed more interest and understanding of the lesson. Compared with the traditional teaching method of blackboard and white chalk with traditional teaching tools such as rulers, compasses, etc., the teaching method using GeoGebra tools helps students understand the lesson better. Lectures are more engaging for students. In addition, teaching using math learning tools and means with the support of GeoGebra software is one of the five types of teaching to develop mathematical competence. Therefore, this teaching method needs to be studied further.

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