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Research Article

Improving student mathematics learning outcomes through project-based learning models in online learning

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Abstract

This study aims to analyze the effect of project based learning assisted by google classroom and video conference on students' mathematics learning outcomes. This research is a quasi-experimental. Participants of the research, was 148 high school class XI students. The sample selection of the experimental class and the control class used a random sampling technique cluster. The experimental class was 29 people while 29 people were in the control group. Hypothesis testing was carried out using an independent sample t-test with SPSS 22.0 with a significance level. Based on the results of data analysis showed that the average post-test in the experimental class was 74.3 and the control class was 63.1. The results of hypothesis testing produce a probability significance value, meaning that the hypothesis is accepted. The mathematics learning outcomes of class XI high school students who were taught using a project based learning assisted by google classroom and video conference were better than of students who were taught using conventional learning

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Introduction

The development of education in the 4.0 revolution era is marked by digital technology in learning activities which makes learning activities take place continuously without space and time limits and the learning process in the current era must be relevant to the era of the industrial revolution 4.0 (Akmal & Santaria, 2020). With the rapid development in this revolutionary era, it is hoped that it will help a lot in the world of education as well (Reflianto & Syamsuar, 2018). However, there are still learning problems in Indonesia, including in mathematics (Izza et al., 2020).

One of the problems of learning mathematics in high school is the lack of learning that encourages students to apply the knowledge learned to solve real-world problems around them that give meaning to themselves (Asmuni, 2020). This is evidenced by the record achievement of the 2019 high school mathematics national exam results which were very low with an average value of 38.60 (Puspendik, 2019). The results of the 2019 national exam are still low, as a reflection of the low mathematics learning outcomes of students in Indonesia. This indicates that there is still a lack of student

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learning outcomes. The results of the 2019 national exam are still low, as a reflection of the low mathematics learning outcomes of students in Indonesia. This indicates that there is still a lack of student learning outcomes in the cognitive realm. This, of course, must receive serious attention, especially on cognitive learning outcomes to find solutions for the future (Oktaviana & Prihatin, 2018).

Learning activities are mostly dominated by teachers and giving homework does not accommodate the development of students' abilities in problem solving, reasoning, mathematical connection and communication (Aida et al., 2017). This causes student learning outcomes to be less than optimal because students do not get the opportunity to directly explore their knowledge and only rely on the teacher (Wijaya et al., 2016). In addition, according to Yulia (2020) during online learning students will become more passive to learn, between students and teachers there will be no direct or non-interactive interaction.

In learning mathematics, the selection of the right learning model will affect students' mathematics learning outcomes. This is supported by research by Nasution (2017) which states that student learning outcomes can be improved by using a good learning model, teachers should be able to plan good learning activities by choosing a learning model that fits the material to be delivered to students. This is in line with the results of research conducted by Hasri (2021) which states that the use of certain learning models can have a positive effect on student learning outcomes. The learning model chosen must be in accordance with the characteristics of mathematics learning, namely (1) tiered mathematics learning, (2) following the spiral method, (3) emphasizing deductive thinking patterns, (4) adhering to consistent truth (Mustafa et al., 2021). Learning model which can accommodate all student needs in learning is a *project-based learning* or can be abbreviated PjBL (Andita Putri, 2018) This is because the PjBL model is oriented towards processes and products as a result and provides opportunities for students to work on solving mathematical problems on their own in everyday life (Yutantin, 2018).

According to (Fatma, 2021), the advantages of the PjBL learning model are: (1) improve problem-solving skills, (2) making students more active and successful in solving complex problems, (3) increasing collaboration, (4) providing students with learning experiences and practices in organizing projects, (5) provide learning experiences that involve students in a complex and designed to develop according to the real world. PjBL Model has great potential to contain more interesting and meaningful learning experiences for adult students, such as high school students and college students (Salman et al., 2017).

In a study conducted by (Hasri, 2021) stated that student learning outcomes in the mathematics subject with the PjBL model have increased because students are actively building their own knowledge, but unfortunately this research can only be done in offline learning situations because the application of the PjBL model is not accompanied by learning media that can support online learning. By looking at the online learning situation and the suitability of the PjBL model in overcoming the problem of student learning outcomes, it is necessary to have learning media that will support the implementation of the PBL model syntax in online learning (Salsabila et al., 2020). This statement is supported by Riyandi et al. (2020) which states that the use of technology as a learning medium during the *COVID-19* is an alternative solution to be able to continue to carry out learning activities remotely(Gaffar & Biology, 2020). According to research conducted by Hamidy (2021) shows that *google classroom* is effective for the learning process and influences student learning outcomes. *Google classroom* can be a means of discussion, distribution of material, collection of assignments and even assessing the submitted assignments. According to(Suhada et al., 2020) the use Online learning becomes good and effective with google classroom.

In accordance with research conducted by (Subekti et al., 2020) which states that *video conferencing* is very practical to use for online learning. By conducting face-to-face, *online* teachers will find it easier to know the learning conditions of their students (Subekti et al., 2020) and in the delivery of material can also be explained directly on the spot. These two media are used, namely *synchronous* and *asynchronous* applied learning, the *synchronous* can be through *video conferencing media*. learning *asynchronous* media *google classroom*. Thus, it will be able to maximize the implementation

of learning with the PjBL model. This is in line with research conducted by Hamidy (2021) which states that *google classroom* and *video conferencing* can improve the quality of mathematics learning.

The novelty in this research is the use of the PjBL model assisted by *google classroom* and *video conferencing* to accommodate the digitization of learning during the pandemic to improve students' mathematics learning outcomes. With the application of the PjBL model which is considered appropriate to the needs of students in online learning, it is also accompanied by learning media that will make it easier for both students and teachers in learning.

Problem of Research

Based on the description above, the formulation of the problem in this study is as follows:
Is the learning outcomes in mathematics taught using the *project based learning* (PjBL) model assisted by *google classroom* and *video conferencing* better than the mathematics learning outcomes of students who are taught using conventional learning models.

Method

Research Model

This research belongs to the category of quasi-experimental. Quasi-experiments were used to observe the effect that emerged from the treatment given to each group in which variable control was only carried out on one variable that was observed to be very dominant (Sugiono, 2013). This study linked two groups, namely the experimental and control groups. For the experimental group to be taught using the PjBL while the control group was taught using conventional learning.

Participants

The study population was class XI in SMA Negeri 1 Selemadeg, Bali, Indonesia, total population is 148 students. The sample selection by *cluster random sampling technique.* XI MIPA 1 is the experimental class with as many as 29 people while the control group is class XI MIPA 2 with as many as 29 people. This research was conducted from February to March and it was conducted by giving different treatment between the experimental class and the control class. The experimental class was given treatment with a *project based learning* (PjBL) model assisted by *google classroom* and *video conference* , while the control class was given conventional learning treatment. After being given treatment then given *post-test*.

Math Achievement Test

The instrument in this study was a post-test in the form of a description test consisting of 5 *essays* that were used to measure student learning outcomes, especially in the cognitive domain. referring to the taxonomy of blooms then student learning outcomes can be divided into three, namely cognitive, affective and psychomotor. in this study focused on the cognitive dimensions of the new bloom taxonomy consist of six categories, namely C1, C2, C3, C4, C5, and C6. Implementation *post-test* was given at the end, namely after the two sample classes were given treatment. The post-test questions *contain* function derivative material. The post-test had been tested before the *post-test* was given to students. The instrument tests carried out are content validity tests, item validity tests using Carl Pearson's product moment correlation and reliability tests using *Alpha Cronbach's*. For the results of the calculation can be seen in appendix 1.

Data Analysis

Data on students' mathematics learning outcomes were obtained *post-test* which was given to the experimental class and the sample class after being given treatment. The *post-test* consists of 5 description questions. The research data were analyzed using a t-test (*independent sample t-test)* assisted by the SPSS 22.0 program. Prior to the t-test, the requirements analysis test was carried out, including the normality test using the *Lilifors* and the homogeneity of variance test using the Levene technique

Procedure

This researcher used the research design of the Posttest Only Control Group Design experiment. Experimental classes were given treatment with the Project based learning model assisted by Google Classroom and video conferencing while control classes were given treatment with conventional learning. Learning begins on February 21 and ends on March 31, 2022. In this study, the project based learning model assisted by Google Classroom and video conferencing will run projects based on the theme given by the teacher. While the control class with conventionally conducts its usual learning. The learning process is carried out online. In the experimental class, it uses google classroom media and video conferencing in the learning process.

Figure 1. Learning process with video conferencing

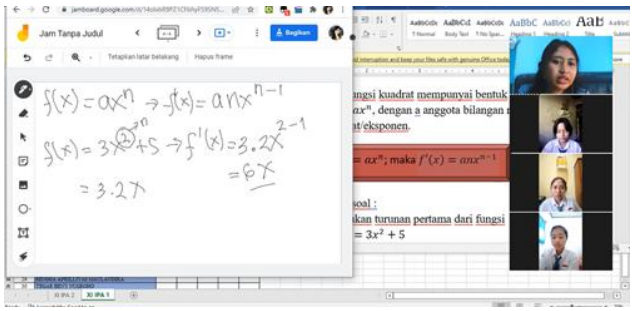

Figure 2. Learning process with video conferencing

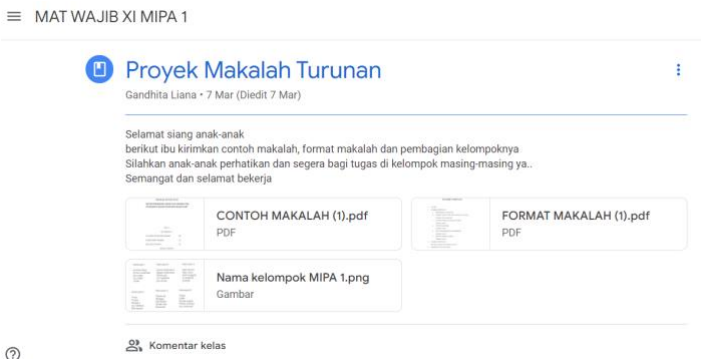

Figure 3. Learning process with google classroom

Results

To determine the effect of the PjBL model model assisted by *google classroom* and *video conferencing* on students' mathematics learning outcomes used testing with *independent sample t-test.*with SPSS 22.0 tools. The data used as research data were measured by the implementation of the *post-test* at the end of the treatment for the two sample classes scores *post-test*. The score is used as a reference to determine student learning outcomes, especially in the cognitive domain. The *post-test* are presented as follows:

Value Data *Post-test* Experimental Class

After being given treatment, the experimental class will carry out the *post-test* to obtain data in the form of scores that will be analyzed as data on students' mathematics learning outcomes. The number of students in the experimental class is 29 students. The following are descriptive statistics of the *post-test* presented in Table 1:

Table 1.

Post-test Experimental Class

N	Min	Max	Mean	Std. Deviation
29	50	95	74.31	10.58

Based on table 1 above, it can be seen that the average mathematics learning outcomes reached 74.31. Of the 29 students, there were 17 students with grades above the average, and the rest below the average 12 students. The minimum score obtained in the experimental class is 50 and the maximum value is 95. The standard deviation of the data is 10.58. For more details, the following is a group diagram of experimental class students based on the category of mathematics learning outcomes.

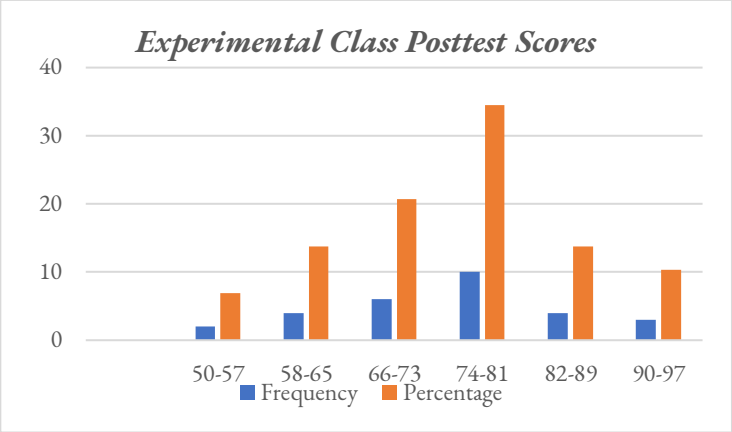

Figure 4. Scores distribution chart of control class

From the picture above, it is known that the percentage of students who score in the range of 50-57 is 7%, 58-65 is 14%, 66-73 is 21%, 74-81 is 34%, 82-89 is 14%, 90-97 is 10%.

Scores of *Post-test* Control Class

After being given treatment, the control class will carry out the *post-test* to get data in the form of scores that will be analyzed as data on students' mathematics learning outcomes. The number of students in the control class is 29 students. The following are descriptive statistics of the *post-test* presented :

Table 2. Post-test Control Class

N	**Min**	**Max**	**Mean**	**Std. Deviation**
29	35	90	63.1	13.850

Based on table 2 above, can be mentioned mathematics learning outcome reaches 63.1. Of the 29 students, there were 14 students who had grades above the average, and the rest were below the average of 15. The minimum score obtained in the control class is 35 and max is 90. With a std. Deviation of 13.85. For more details, the following is a group diagram of control class

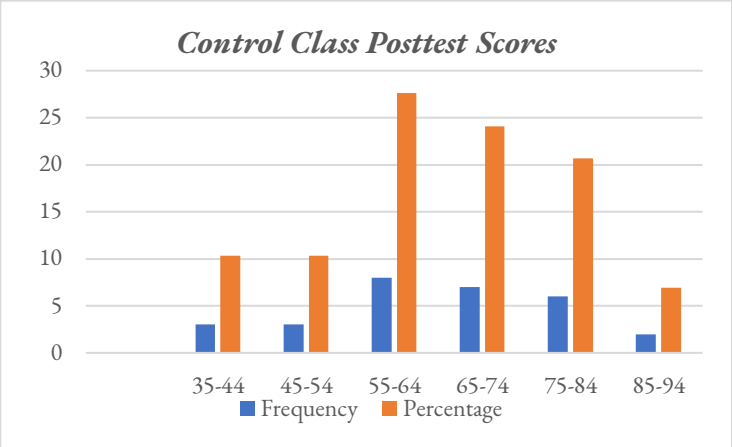

Figure 5. Scores distribution chart of control class

From the picture above, it is known that the percentage of students who score in the range of 35-44 is 10%, 45-54 is 10%, 55-64 is 28%, 65-74 is 24%, 75-84 is 21%, 85-94 is 7%.

Hypothesis Test

Testing is done to prove whether the proposed hypothesis is proven or not. Before entering the hypothesis test, a prerequisite test must be carried out first. The prerequisite tests include normality test and homogeneity test.

Normality Test of Research Data Normality

Test distribution data is used to find out.whether.data in a sample group used the origin of the normal population. The data can be declared normally distributed if the result of the probability significance value is > α :

Table 3. Normality value

Test of Normality			
	Kolmogorov-Smirnov		
	Statistic	Df	Sig
Experimental Class	0.135	29	0.189
Control Class	0.105	29	0.2

After the test of the normality test of the data on the value of students' mathematics learning outcomes above, it was obtained that the experimental class had a significant value and the control class obtained a significance value. From these data, it can be concluded that the significance of the probability of the experimental class and the control class was greater than 0.05. This means that the data on the mathematics learning outcomes of the experimental class and control class students is normally distributed.

Homogeneity Test of Research Data

After the data is declared to be normally distributed, the prerequisite test is continued with the homogeneity test. The homogeneity test is used to show whether the two-sample data come from populations that have the same variance (Sari et al., 2017). The data can be declared homogeneous if the results of the probability significance value >α. The homogeneity test results obtained are presented in Table 4 below:

Table 4. Homogeneity test

Test of Homogeneity of Variances			
Learning Outcomes:			
Levene Statistic	df1	df2	Sig
2.865	1	58	0.96

Based on the results of the analysis of the homogeneity test of the students' mathematics learning outcomes above, the significance probability value was obtained. From these data, it can be concluded that the experimental class and control class students' mathematics learning outcomes data had a homogeneous distribution of variance.

After passing the prerequisite test and the data is declared normally distributed and has a homogeneous variance, the test can be continued. Hypothesis testing in this study was conducted by using *Independent sample t test* with SPSS *version 22.0 for windows*.

Table 5. Hypotesis test

	df	Mean Difference	t	Sig.
Equal variances assumed	56	11.2	3.462	0.01
Equal variances not assumed	52.38	11.2		

Based on the table above, it shows that the probability significance value is 0.01 with the value because of the probability significance. This means that the mathematics learning outcomes of class XI high school students are taught using the PjBL model assisted by *google classroom* and *video conferencing* is better than the students' mathematics learning outcomes who are taught using conventional learning

Discussion and Conclusion

Student learning outcomes are very important in a student education cycle (Juniantari, 2017). Learning outcomes show a success in learning (Datu et al., 2022). Learning outcomes can be measured, one of which is by paying attention to the value of the test or the value in working on the task. Learning outcomes that can be measured through a score for doing assignments or tests are called learning outcomes in the cognitive domain. In order to obtain learning outcomes in the good category the teacher must be able to present a lesson that can stimulate students to understand the material being studied (Aida et al., 2017). Therefore, an increase in learning outcomes is very important because currently student learning outcomes, especially in mathematics, are at a low level every year (Puspendik, 2019).

Project-based learning that supports students' ability to express what they learn, asking questions and expressing their ideas allows them to form their own knowledge and relate their knowledge to everyday problems (Hutapea & Mariati, 2021). In a pandemic situation like the current one, learning is done online. In addition to selecting the right model, it is necessary to have a media that can support the learning process (Agar et al., 2022). *Google classroom* and *video conferencing* are effective media to collaborate with to support the implementation of the syntax of the PjBL model during this pandemic. This study examines the effect of a project-based model (PjBL) assisted by *google classroom* and *video conferencing* on students' mathematics learning outcomes. Two sample classes were applied, namely the experimental class and the control class.

In the experimental class, the PjBL model was applied with the help of Google Classroom *and* video *conferencing*. This means that students in the experimental class are taught the PjBL syntax and are assisted by google classroom learning media *and* video *conferencing* as a support support. In the experimental class, the learning process is dominated by making projects carried out by students in groups. The learning steps are: (1) Determining the fundamental questions: (2) Designing a project plan: (3) Designing a schedule; (4) Guiding students and seeing the progress experienced by students; (5) Checking the results obtained (6) Evaluating or providing criticism and suggestions (Prakarsa, 2013). In the process of working on this project, students will be able to form their own knowledge and be able to link the material they get with problems in everyday life (Salman et al., 2017). In the process of working on a project that has been structured, students will also get assignments and can be responsible for their work and groups. This will result in students being more active in learning (Hasri, 2021). The control class is taught with conventional learning. Conventional learning in this study means the model given by the teacher at the school. In the learning process, the control class is dominated by giving homework (PR).

After being given different treatments in the two sample classes, the *post-test*. *Post-test* was given to obtain data in the form of scores, which were used as research data. After the data was obtained, the data was tested by using the *independent sample t-test.* Based on the results of the tests that have been carried out, it is known that the mathematics learning outcomes of students taught by the PjBL model assisted by *google classroom* and *video conference* are better than conventional learning. It is also found that the average value of the experimental class is higher than the control class. This can happen because of the benefits obtained from the application of the PjBL model google *classroom* and *video conferencing*. This causes students' knowledge to be built properly and each student can explore more knowledge and solve problems related to everyday life better (Kusilawati et al., 2019).

In working on projects students are guided to turn their experiences into problem solving. The problems given are various, including problems made by students themselves and there are also problems given directly by the teacher. Students are given the freedom to explore various sources of literacy to solve problems that are already available. In making projects students are directed to make a summary of material taken from several literacy sources and is accompanied by problem solving. The entire project will be in the form of a paper. During project work activities, students are facilitated to ask questions they have through *video conference* or *google classroom.* As the final stage, students will collect the results of their projects and present them to friends and teachers through *video conference media*.

In line with research by (Hutapea & Mariati, 2021) which states that the PjBL model has a good effect on student learning outcomes, especially at the high school level. Using the project work, students will be able to form their own knowledge due to the literacy search stage and use this knowledge to solve problems. Goals set in project work, ensure learning efficiency with project work, and strengthen the basic knowledge that students already have before even that knowledge will increase after project work (Akyol et al., 2022). In addition to forming knowledge of project-based learning, it has a high impact on increasing student learning outcomes (Kusilawati et al., 2019). This statement is in line with research conducted by Eliza et al. (2019) which states that in the PjBL model students will be able to play an active role in learning and students can explore freely all the knowledge they want to use to complete projects. However, in several studies that have been carried out related to the application of the PjBL model, the use of learning media is less and some even do not use learning media at all.

Learning media is one of the important components in the success of the learning process (Riyandi et al., 2020). The high learning outcomes in the experimental class are also supported by appropriate learning media, namely *google classroom* and *video conferencing* actively and periodically to facilitate online meetings. This will cause students to be more enthusiastic about learning (Salsabila et al., 2020). This is in line with research conducted by which proves that many students are very happy with the application of *Google Classroom* when studying mathematics during a pandemic. Even students find it easy to apply to the *google classroom* at the stage of learning Mathematics(Gaffar & Biologi, 2020). In addition, the suitability of the results is also shown in a study conducted by Herni Ari Subekti, et al (2020) that state use *of video coverage* as an interactive learning media shows its practicality and effectiveness. With the use of *video coverage* students and teachers can be more flexible in delivering material and meet face to face even though they are limited by distance (Riyandi et al., 2020). This will have a good effect on the learning process. Because teachers will find it easier to supervise students in the learning process (Fitra Prisuna, 2021).

The implication of this research is to improve students' mathematics learning outcomes through the application of the PjBL model assisted by *google classroom* and *video conferencing.* Seeing the benefits of implementing the PjBl model with the help of *google classroom* and *video conference* shows that the contribution of this research is to determine a contribution to the appropriate learning model applied in the 4.0 revolution era and able to improve students' mathematics learning outcomes so that it can be used as a reference for teachers in the learning process at class. Based on data analysis and discussion of research results, it can be concluded that students' mathematics learning outcomes taught using the PjBL model *assisted by google classroom* and *video conferencing*, it is better than the students' mathematics learning outcomes who are taught using conventional learning

Recommendations

Based on the results of research that has been done and see that the PjBL model assisted by *google classroom* and *video conferencing* has a good influence on student learning outcomes, the PjBL model assisted by *Google Classroom* and *video conferencing* can be recommended, especially in the purpose of improving student learning outcomes. Because seeing the effect given to improving student learning outcomes. In addition, seeing the success of the implementation of the PjBL model, there are also limitations, namely the learning process using the PjBL model assisted by *Google Classroom* and *video conference*. Researchers feel that learning will be maximized with several solutions. One of them is for further research it is recommended to apply this PjBL model using the help of video tutorials to make it easier for students to know the stages of project work to be carried out, and when project collection is recommended to be accompanied by making video presentations to streamline presentation time and presentation of results. projects can be maximized.

Limitations of Study

In this study there are also limitations, namely in the collection and presentation of project results by students. In this study, students only collected and had little time to present their project results. So, within these limitations, a solution can be used, namely adding a video presentation at the end of the lesson to accommodate students so that they can present their projects optimally and can be watched by other students.

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Appendix 1. Math Achievement Test

Item validity tests

In this analysis, the data used is data on the results of the instrument trial test consisting of 5 questions. Validity analysis using product moment correlation with SPSS tool version 22.0 for windows.

Test criteria

1. Calculation results r_{xy} consulted in the table product moment with n=30 or df=n-2 If $r_{xy} > r_{tabel}$ then the question item is valid.

2. The level of significance used is α=5%

Correlations

		Q 1	Q 2	Q 3	Q 4	Q 5	Total score
Question 1	Pearson Correlation	1	0.281	0.143	0.027	0.108	0.343
	Sig. (1-tailed)		0.066	0.225	0.444	0.284	0.032
	N	30	30	30	30	30	30
Question 2	Pearson Correlation	0.281	1	0.109	0.277	0.336	0.364
	Sig. (1-tailed)	0.066		0.282	0.069	0.035	0.024
	N	30	30	30	30	30	30
Question 3	Pearson Correlation	0.143	0.109	1	0.02	0.421	0.769
	Sig. (1-tailed)	0.225	0.282		0.548	0.01	0
	N	30	30	30	30	30	30
Question 4	Pearson Correlation	0.027	0.277	0.02	1	0.013	0.351
	Sig. (1-tailed)	0.44	0.069	0.458		0.473	0.029
	N	30	30	30	30	30	30
Question 5	Pearson Correlation	0.109	0.336	0.421	0.013	1	0.727
	Sig. (1-tailed)	0.284	0.035	0.01	0.473		0
	N	30	30	30	30	30	30
Total score	Pearson Correlation	0.343	0.364	0.769	0.351	0.727	1
	Sig. (1-tailed)	0.032	0.024	0	0.029	0	
	N	30	30	30	30	30	30

From the table above, it is obtained that r_{xy} question 1 = 0.343, r_{xy} question 2 = 0.364, r_{xy} question 3 = 0.769, r_{xy} question 4 = 0.351 and r_{xy} question 5 = 0.727. From the table r product moment obtained r_{table} =0.306. It is thus obtained that the r_{xy} for all the questions > r_{table}. Based on the test criteria, it can be concluded that all the question items on the instrument are included in the valid criteria.

Reliability tests

In this analysis, the data used is data on the results of the instrument trial test consisting of 5 questions. Reliability analysis using Alpha Cronbach's with SPSS.

Test criteria

1. Calculation results r_{11} consulted in the table product moment with n=30 or df=n-2 If $r_{11} > r_{tabel}$ then the question item is reliabel.

2. The level of significance used is α=5%

Case Processing Summary

		N	percentace
Cases	Valid	30	100

Excluded	0	0
Total	30	100

Reabillity Statistic	
Cronbach's Alpha	N of Items
0.358	5

From the table above, it is obtained that r_{11}=0.358. from the table r obtained r_{table}=0.306. Thus obtained $r_{11} > r_{table}$. Based on the test criteria, it can be concluded that all question items on the instrument are included in the reliable criteria