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EVALUATING THE IMPACT OF AUDIO-VISUAL MEDIA ON LEARNING OUTCOMES OF DRAWING ORTHOGRAPHIC PROJECTIONS

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ABSTRACT

This study aimed to evaluate learning outcomes of drawing orthographic projections between two groups of students: one group that learnt orthographic projections via audio-visual media and the other group through written material. An experimental design was used to determine the percentage increase in learning outcomes of both methods with factorial values. The samples were students from State Vocational High School (S-VHS) and Private Vocational High School (P-VHS) of Semarang city, Indonesia. The control group and the experimental group had 30 students each. Data analysis was carried out using two-way ANOVA with interaction and descriptive statistics. The results showed that there were significant differences in learning outcomes in orthographic projections. The findings of the study showed the highest increase in learning outcomes was in S-VHS at 61.06% (high category), followed by P-VHS with 52.04% (high category). The P-VHS students who received written teaching materials scored 43.34% (sufficient category), while S-VHS scored 37.86% (enough category). Based on these results, it was concluded that audio-visual media can be used to improve students' competency drawing orthographic projections.

Contribution/Originality: This paper draws the attention of authors and teachers who teach mechanical drawings to help improve learning outcomes. The paper's primary contribution is establishing the use of audio-visual media as a suitable tool to improve the basic competencies of drawing orthographic projection.

1. INTRODUCTION

Currently, the whole world is the Coronavirus pandemic commonly called COVID-19, which entered Indonesia in March 2020 and has not yet subsided. The Minister of Education and Culture Number 4 of 2020 issued a circular concerning the implementation of educational policies during such an emergency period. The circular laid down that all teaching and learning activities would be carried out individually from home either online or remotely. All teachers were accordingly directed to join online learning. However, due to many challenges, the implementation of these policies proved very difficult. Putri et al. (2020) found that the challenges experienced by students, teachers, and parents regarding online learning include limited communication, lack of discipline and technological skills, as well as high Internet charges. Subsequently, students requested that online lessons and assignments be carried out in groups, to help those facing issues with internet speed, cellphones, laptops, and computers (Allo, 2020).

Furthermore, teachers in Semarang mostly used the google classroom online platform. This was used to overcome the problem of expensive internet bills and weak signals in student residential areas. During lectures, most teachers used only the written materials accompanied by assignments that were uploaded through google classroom. This learning method made it difficult for students to understand, therefore they had low learning outcomes. The number of students whose learning outcomes met the minimum acceptable criteria in mechanical engineering ranged from 40% to 45%. These learning difficulties prompted students to ask whether physical learning methods be sustained. However, this could be avoided if teachers adopted audio-visual media.Zhang, Zhou, Briggs, and Nunamaker Jr (2006) stated that it was important to integrate interactive audio-visual media into the e-learning system. This was because the use of media aids could improve students' scientific perspectives (Abiodun, Oginni, Adegorite, & Saibu, 2015; Ghory & Ghafory, 2021).

1.1. Learning Using Audio-Visual Video Media

Ashaver and Igyuve (2013) explained the importance of audio-visual video media in teaching and learning process, which included activation of several senses and expansion of experience. It also promoted participation, stimulated interest, and became a source of learning information. Furthermore, this learning process helped students to optimally understand studying concepts with assisted teaching tools (Alshatri, Wakil, Jamal, & Bakhtyar, 2019). Meanwhile, worksheets and media models or artificial objects were used as learning tools in the teaching and learning processes. The student worksheet was used because it was useful in many ways for academic achievement (Lee, 2014), while the media model was used because it resembled an actual object, which could be seen from all sides (Onasanya, 2004). Therefore, it helped to observe the views in drawing an orthographic projection.

1.2. Student Worksheets and Media Models to Improve Learning Outcomes

As previously described, audio-visual video media was used with student worksheets and media models as tools. These worksheets were written materials consisting of individual activities that were carried out during learning procedures (Töman, Akdeniz, Odabasi Çimer, & Gürbüz, 2013). Meanwhile, the media model was a three-dimensional type that represented real objects (Heinich, Molenda, & Russel, 1996). Both tools were used to demonstrate how the orthographic projection image was viewed. Each students' worksheets were sequentially presented, showing the front, top, and right-side views using the media model. Consequently, this result was used in drawing the front, top, and right sides of the orthographic projection image. This was done by displaying the adjusted media model to the view and then drawing on the worksheet. Students who utilized audio-visual media for learning accepted and appreciated the concept of the orthographic projection image being studied this way. Meanwhile, while displaying the audio-visual media, the students were accustomed to the principle of drawing orthographic projection for the first and third quadrant, which was pulled and pushed respectively. Subsequently, the student worksheet was taken and a three-dimensional image was displayed with the view directions. The media model was taken where the front view was adjusted to those on the students' worksheet. This model was moved according to the first and third quadrant's principle of drawing the orthographic projection, and the results obtained for the front, top, and right-side views were drawn on the worksheet. Meanwhile, the worksheet function would display the front, top, and right-side views when drawing an orthographic projection.

In the course of learning, all activities were videotaped and voices were also recorded. Furthermore, the use of worksheets in learning helped the students master the principles of drawing orthographic projections. According to Hidayah and Maruf Nur (2014), the worksheets were found suitable as teaching materials. These results are reinforced by Celikler and Aksan (2012), who reported that using worksheets for learning in the experimental group showed significant and higher outcomes than the teaching method of the control group. Similarly, (Korakakis, Boudouvis, Palyvos, & Pavlatou, 2011) believed that the use of media models contributed to effective learning. The use of audio-visual media equipped with worksheets could improve learning outcomes compared to

only written materials. The learning outcomes focused in this study relate to the ability to draw orthographic projections after using audio-visual video and written teaching materials.

1.3. Drawing the Orthographic Projection

Orthographic projection drawing is one of the basic competencies which need to be mastered by Vocational High School students in Indonesia. In fact, orthographic projection is a way of viewing an image perpendicularly to a plane where the projection is obtained (Reddy, 2008). Therefore, by looking at the projection image, the reader interprets the workpiece to be made. There are two types of orthographic projection images, known as first and third angle projection. The principle of first angle projection is 'push principle' according to which the object to be drawn is located in a box between the viewer and the projection plane. While taking the front view of an object, the front side is pushed back to the projection plane; however, while taking the top view, the top side is pushed downward into the projection plane and the right-side view is pushed to the left of the projection plane. This procedure applies to the left, bottom, and rear side views. In the first angle projection, all the views drawn are inverted as compared to actual reality, with six views including the front, top, right, left, bottom, and rear view located behind, below, left, right, top and right side of the left view respectively.

The principle of third angle projection is pulling, according to which the object to be drawn is located in the box while the projection plane is located between the object and the viewer. When viewed from the front, the front side is pulled forward in the projection plane, and when viewed from the top, this side is pulled upwards and drawn forward towards the projection plane. Furthermore, when viewed from the right, this side is pulled to the right of the projection plane, with the same procedure applicable to the left, bottom and rear view. In the third angle projection, the view is drawn according to the actual reality, where there are six views, which include the front, top, right, left, bottom and rear, located in front, top, right, left, below, and the left side of right view or on the right side of front view respectively.

Based on this description, there are clearly six orthographic projection images in both the first and third angle projections. However, often in the drawing, three views are usually sufficient for selection, which are the front, top, left or right (Nayarana, Kannaiah, & Reddy, 2006).

When drawing an orthographic projection view, it is also necessary to pay attention to the type of line used in accordance with the existing rules which include that the thick lines should be used for the visible part while thin lines are utilized in sizing, projection, shading, cross-sectional and fold lines. Free, dashed, and axis lines are also used for partial pieces, invisible parts center lines, symmetry and trajectory respectively, while two-point axis lines are used to draw moving parts, trajectories, and lines in front of the view (Nayarana et al., 2006). Apart from describing a complete image view, it is also accompanied by information regarding the size description. Some of the basic principles of making dimensioning are numbered as follows: (1) All dimensional information necessary to describe a component clearly and completely has to be written directly on a drawing. (2) Each feature needs to be dimensioned only once on a drawing i.e., the dimension marked in one view need not be repeated, (3) Dimensions should be placed on the view where the shape is best seen. (4) As far as possible, dimensions should be expressed preferably in millimeters, without showing the unit symbol (mm). (5) Dimensions should be placed outside the view as far as possible. (6) Dimensions should be taken from visible outlines rather than from hidden lines, (7) No gap should be left between the features and the point where the extension line begins, and (8) Centre lines crossing should be carried out by a long dash and not a short dash (Reddy, 2008).

1.4. Research Objectives

This study aimed to evaluate the learning outcomes of drawing orthographic projections between State and Private Vocational High School students that received lectures using audio-visual video media and written teaching

materials. Furthermore, the percentage (%) increase in learning outcomes between the students was also determined.

2. METHOD

2.1. Sample

The sample was determined by using raffled proportional random sampling which was gradually carried out in stages beginning from the State Vocational High School in Semarang city, Indonesia; gradually moving to other schools like the Central Java State Vocational High School, State Vocational High School 1, State Vocational High School 4 and State Vocational High School 5. All these schools offered a competent study program in Mechanical Engineering specialization. Based on the raffled results, Vocational High School 1 Semarang was selected as the sample of this study.

Among the private schools, under the Private Vocational High School, there were two Schools with Mechanical Engineering competency study programs, namely Karangpanas Technical Education Institute Vocational High School and Texmaco Vocational High School. After conducting the raffling, Texmaco Vocational High School was selected as the sample of the study. In the next stage, a raffle was again carried out between four classes of State Vocational High School 1 Semarang. One experimental class with a population of 35 students and one control class totaling 36 students were identified. Likewise, two classes at Texmaco Vocational High School were also selected: one class as the experimental group with a population of 34 students and another class as control group totaling 33 students. In a learning experiment research, each sample group, according to Pagano (2009), should be 30. Therefore, the experimental class group that was taught using audio-visual media consisted of 30 students, while the control group taught through written teaching materials comprised 30 students. Similarly, the two groups at Private Vocational High School had 30 students in both experimental and the control groups.

2.2. Research Procedure

The research procedure commenced by preparing student worksheets and media models. An audio-visual video media was utilized to record the demonstrations of teaching how to draw orthographic projection using worksheets and media models. The impact of this teaching was assessed by two instructional media experts. They showed that the quality, communicative, appropriateness, and practicality aspects of the audio-visual had a feasibility validity value with Content Validity Ratio = 1 which is greater than the criterion value = 0.99 (Lawshe, 1975). The two experts later used the Kappa formula (Cohen, 1960) and obtained a value = 0.762. According to Landis and Koch (1977), its value was greater than 0.61 and included the Substantial Category on Strength of Agreement. Therefore, the audio-visual video media was valid, reliable, and usable in the learning process.

A performance test was also conducted for data retrieval, and a pre-test was done by testing students using a validated performance test. The pre-test aimed to determine the initial ability of the experimental group which consisted of students who had received learning through audio-visual media and the control group, who had used the written teaching materials. The results of both groups shared the same initial ability, which meant that the post-test results were different. This led to the conclusion that the result of any learning in posttest would be different if the pretest had the same initial ability. Furthermore, an experimental treatment was also carried out with a factorial design to observe the effects caused by several factors (Oliveira, Lima, Yamashita, Alves, & Portella, 2018). After completing the learning process, a post-test was carried out using a performance test to evaluate students' learning outcomes.

2.3. The Performance Tests of Drawing Orthographic Projections and its Criteria

A performance test, which is a form of third angle projection, was used to evaluate the learning outcomes of orthographic projection drawing. Before using the test, the contents concerning the material, construction, and

language were validated. The material aspects were evaluated to ensure whether (1) there was a front view, (2) there was a top view, (3) there was a right-side view, and (4) there was a dimensioning. Meanwhile, for the construction aspect, the basis included: (5) whether the formulation of the questions was easy to understand, and (6) whether there was a clarity of pictures on the questions. The language aspect included: (7) whether the language used was communicative, and (8) enjoyed correctness of sentence writing. The content of these aspects (indicators) was assessed by nine (9) experts of mechanical engineering drawing with over 10 years of experience, who checked the appropriateness of five options. The expert's assessment results towards the test aspects were analyzed for validity using the Content Validity Ratio (CVR) formula, followed by the Content Validity Index (CVI) formula. The formula for Content Validity Ratio (CVR) was stated by Lawshe (1975) is as follows:

$$CVR = \frac{ne - \frac{N}{2}}{\frac{N}{2}} = (2ne/N) - 1$$

Where it is the number of expert raters (panelists) stating that it is appropriate, while N is the total number of expert raters that made the overall assessment. The CVR acceptance criteria for 9 experts was ≥ 0.78 Lawshe (1975). The Content Validity Index (CVI) was determined by dividing the total CVR obtained by the number of experts. According to Polit and Beck (2006), the criteria for CVI acceptance occurs when the value obtained is ≥ 0.78. In order to ascertain that the CVR and the CVI obtained were jointly agreed by experts, the rater's reliability was measured as a Percent Agreement (McHugh, 2012). Nurjannah and Siwi (2017) explained that the inter-rater reliability is measured by calculating the rater agreement, divided by the total number of ratings, which can be formulated as follows:

$$Percent\ Agreement = \frac{Agreement}{Agreement + disagreement}\ x\ 100\%$$

The acceptance criteria for agreement between assessors is when the value obtained is ≥ 80% (McHugh, 2012). The validity results of CVR, CVI, and experts' reliability assessment towards the performance test of drawing orthographic projections can be seen in Table 1.

Table-1. Validity of CVR, CVI, and reliability of performance tests in drawing orthographic projections

The aspect (indicator) being assessed	Expert									∑ (ne)	CVR	Description	Agreement
	E1	E2	E3	E4	E5	E6	E7	E8	E9				
Front view	1	1	1	1	1	1	1	1	**1**	9	1	Valid	1
Top view	1	1	1	1	1	1	1	1	1	9	1	Valid	1
Right side view	1	1	1	1	1	1	1	1	1	9	1	Valid	1
Dimensioning	1	1	1	1	1	1	1	1	1	9	1	Valid	1
The formulation of questions is easy to understand	1	1	1	1	1	1	0	1	1	8	0.78	Valid	0.78
The picture on the questions is clear	1	1	1	1	1	1	1	1	1	9	1	Valid	1
The language used is communicative	1	1	1	1	1	0	1	1	1	8	0.78	Valid	0.78
Correct sentence writing	1	1	1	1	1	1	1	1	1	9	1	Valid	1
Correct word writing	1	1	1	1	1	1	1	1	1	9	1	Valid	1
∑	9	9	9	9	9	8	8	9	9	79	8.78	Valid	8.78
				`CVI							0.98	Valid	98 %

Based on these results, it appears that all the aspects (indicators) assessed included the front, top, and right-side view. The dimensioning and picture in the question were clear; the wordings and entire sentence writing were also correct with a Content Validity Ratio value (CVR) = 1. Meanwhile, the value of the question formulation was also easy to understand and the language used was communicative with a CVR = 0.78. For the overall test results, the Content Validity Index (CVI) value = 0.98. Therefore, the results obtained showed that all aspects (indicators) and overall performance tests for drawing orthographic projections were valid as the CVR and CVI values obtained were greater than 0.78. Furthermore, to find out whether the valid CVR and CVI values are consistent with the results of the expert's agreement, it was confirmed from the value of the Percent Agreement (% Agreement). The Percent Agreement (% Agreement) value of 98% was greater than 80%, hence, the experts agreed on the CVR and CVI assessments and gave the verdict that all aspects (indicators) of the items and overall performance tests on drawing orthographic projections were valid and reliable.

The learning outcome was assessed via performance tests of orthographic projection drawing achieved by students using the following guidelines (rubrics): the accuracy of the front, top, and right-side view, as well as image size. Detailed assessment guidelines for each indicator (aspect) can be seen in Table 2.

Table-2. Guidelines for assessing performance tests of drawing orthographic projection.

Indicator	Assessment Criteria				
	All Wrong	25% Correct	50% Correct	75% Correct	100% Correct
Front View	0	10	15	20	25
Top View	0	10	15	20	25
Right Side View	0	10	15	20	25
Image Size	0	10	15	20	25

The average learning outcomes achieved in drawing orthographic projections by students was obtained by utilizing the following category criteria: scores of 0 to 25 (low), 26 to 50 (sufficient), 51 to 75 (high), while 76 to 100 (very high). Hence, to find the percentage (%) increase in learning outcomes, the formula used was as follow;

$$\% \text{ Increased learning outcomes} = = \frac{Postest\ Value - Pretest\ value}{Pretest Value}\ x\ 100\%$$

To find out the percentage (%) increase in learning outcomes of drawing orthographic projections achieved by students, the categories were as follows: 0% to 25% as low, 26% to 50% as sufficient, 51% to 75% as high and 76% to 100% as very high.

3. RESULTS

3.1. Pre-Test

To determine whether the experimental and control groups samples had the same initial ability, a pre-test was conducted for the two groups of both the State and Private Vocational High Schools. All calculations in this study used IBM SPSS ver. 25.0 application and the acceptance criteria were at the significance level (probability) of 0.05 (5%). The pre-test results obtained were further analyzed using the one-way variant analysis test and the results are summarized in Table 3.

Table-3. Pretest results.

Learning Outcomes	Sum of Squares	df	Mean Square	F	Sig. (p)	Criteria
Between Groups	25.208	1	25.208	0.441	0.508	0.05
Within Groups	6747.118	118	57.186			
Total	6773.126	119				

Table 3 reveals that the learning outcome between groups had the F value of 0.441 and sig value (p) = 0.508 greater than (>) 0.05, hence, the null hypothesis (Ho) was accepted while the alternative hypothesis (Ha) was rejected. The learning outcomes between the experimental and control groups were the same therefore, it was concluded that both the State and Private Vocational High Schools had the same initial ability in drawing orthographic projections before receiving learning treatment.

3.2. Data Normality and Homogeneity Test

The data from the post-test results were tested for normality and homogeneity considering that the two-way variance analysis test with interaction as a parametric statistic. Hence its usage needed to satisfy the normality and homogeneity. The normality test was conducted with the Kolmogorov Smirnov method while the homogeneity test was by Levene statistical test. The acceptance criterion of the significance (sig.) value obtained was ≥ 0.05. The normality test results using the Kolmogorov Smirnov are shown in Table 4.

Table-4. Results of the Kolmogorov-Smirnov normality test.

School	Group	Kolmogorov-Smirnov			Criteria
		Statistic	df	Sig. (p)	
State Vocational High Schools	Experimental Group	0.135	30	0.174	0.05
	Control Group	0.127	30	0.200	0.05
Private Vocational High Schools	Experimental Group	0.133	30	0.183	0.05
	Control Group	0.150	30	0.083	0.05

Table 4 shows that the State Vocational High School experimental group has a Kolmogorov-Smirnov statistical value = 0.135 and sig. (p) = 0.174 > 0.05, while the control group of the State Vocational High School has Kolmogorov-Smirnov statistical value = 0.127 and sig. (p) = 0.200 > 0.05. The experimental group of Private Vocational High Schools shows Kolmogorov-Smirnov statistical value = 0.133 and sig. (p) = 0.183 > 0.05, while the control has Kolmogorov-Smirnov value = 0.150 and sig. (p) = 0.083 > 0.05. Based on these results, the sig. (p) value in each group was > 0.05, hence the learning outcomes for all data groups are normal.

For the homogeneity test, the Levene statistic was used, the results are shown in Table 5.

Table-5. The results of the Levene statistical homogeneity test.

F	df1	df2	Sig. (p)	Criteria
0.826	3	116	0.482	0.05

Table 5 shows the value of F = 0.826 and the value of sig. (p) = 0.482 > 0.05. Hence, the data on learning outcomes to draw orthographic projections are homogeneous.

3.3. Post-test

The Post-test was conducted to evaluate learning outcomes after learning with audio-visual media in form of demonstrations with student worksheets and model media in the experimental class group, compared to other students who were taught with ordinary teaching materials in the control group. The post-test data were analyzed using two-way analysis of variance. The interaction results can be seen in Table 6.

Based on the results in Table 6, the use of the learning method obtained a value of F = 16,780 with sig. value (p) = 0.000 < 0.05. Based on the school, the value of F = 2071 with sig. (p) = 0.153 > 0.05, meanwhile, the value obtained due to the interaction between learning methods usage and school forms was F = 3.542 with sig. (p) value = 0.062 > 0.05. Therefore, evaluating these results, it was clear that the use of learning methods resulted in different outcomes for drawing orthographic projections. However, the results for school form and its interaction

with learning method were same (not different). Furthermore, the difference in outcomes before and after learning using either the audio-visual video media or written teaching materials in both experimental and control groups can be seen in Table 7. The results reveal the average pre and post-test scores together with the percentage increase in both pretest and post-test

Table-6. Post-test results

Source	`Type III Sum of Squares	df	Mean Square	F	Sig. (p)	Criteria
Corrected Model	1522.500	3	507.500	7.464	0.000	0.05
Intercept	664540.833	1	664540.833	9774.311	0.000	0.05
Learning Methods (LM)	1140.833	1	1140.833	16.780	0.000	0.05
School Form (SF)	140.833	1	140.833	2.071	0.153	0.05
LM * SF	240.833	1	240.833	3.542	0.062	0.05
Error	7886.667	116	67.989			
Total	673950.000.	120				
Corrected Total	9409.167	119				

Table-7. Average values of pre-test, post-test, and improvement of learning outcomes.

School	Treatment Group	Pretest	Post-test	Increase Percentage (%)
		Average	Average	
State Vocational High Schools	Experimental Group	49.67	80.00	61.06
	Control Group	51.50	71.00	37,86
Private Vocational High Schools	Experimental Group	49.33	75.00	52.04
	Control Group	50.00	71.67	43.34

Table 7 reveals that the average pre-test score for State Vocational High School students was = 49.67 (sufficient category), however after receiving experimental learning using audio-visual video media, the average post-test score increased to 80.00 (very high category), an increase of 61.06% (high category). Meanwhile, for the control class, the average pre-test score was = 51.50 (high category), after having been taught by using written teaching materials.

The average post-test score was 71.00 (high category), with an increase of 37.86% (sufficient category). For the Private Vocational High School student, the average pre-test score was = 49.33 (sufficient category), however after receiving experimental treatment using audio-visual media, the average post-test score was 75.00 (high category), showing an increase of = 52.04% (high category). Meanwhile, for the control class, the average pre-test score was = 50.00 (enough category) after having been taught using written teaching materials, the average post-test score was 71.67 (high category), showing an increase of 43.34% (enough category).

Furthermore, the increase in learning outcomes was accompanied by an increase in the percentage (%) of students whose learning outcomes had met the minimum completeness criteria (score ≥ 75) and can be seen in Table 8.

Table-8. Total percentage (%) of students who have met the minimum completeness criteria

School	Treatment Group	Cumulative Percent (%)
State Vocational High Schools	Experimental Group	74.30
	Control Group	42.90
Private Vocational High Schools	Experimental Group	63.60
	Control Group	45.20

It is evident from Table 8 that the number of students that achieved the minimum completeness criteria using audio-visual video media was 74.30%, while 42.90% received written teaching materials. For Private Vocational High Schools, 63.60% of students achieved the minimum completeness using audio-visual video media, while those that received written teaching materials were 45.20%. Therefore, it is clear that using audio-visual video media produced better learning outcomes that met the minimum completeness criteria than using written teaching materials.

4. DISCUSSION AND CONCLUSION

The results showed that the use of audio-visual media and written teaching materials as learning methods produced different learning outcomes for drawing orthographic projections. This is because audio-visual media use senses of sight and hearing to reinforce each other during lessons. This is different when only written materials are used as it only emphasizes the sense of sight. It should also be kept in mind that the use of audio-visual media with student worksheets demonstration and equipped with model media will be more easily acceptable. This is possible due to the use of media models which strengthens the concepts in student worksheets, thereby making it easy to understand the material being studied. This result is consistent with Awasthi (2014) who explained that learning via the audio-visual media is easy, effective, and permanent because it activates all sensory organs. The use of audio-visual video media for learning is, therefore, more acceptable based on the large contribution of this method to learning. The use of student worksheets also plays an important role in concept as suggested by Kolomuc, Ozmen, Metin, and Acisli (2012) who argued that the use of enhanced worksheets is an effective way to improve students' understanding.

The results confirmed that there were no differences in learning outcomes in orthographic projections drawing of students. This suggests that learning by using audio-visual media together with worksheets demonstrations and model media can be used in both State and Private Schools. Therefore, this learning method should be generally used at all educational levels. Olube (2015) found that student responses to the learning process of audio-visual media were high, hence the use of this model could improve students' social and intellectual abilities. Furthermore, the audio-visual video media could be used for other subjects as acclaimed by Al-Khayat (2016), which showed that using audio-visual aids and computerized materials exerted a positive effect on students' achievement in the experimental group. These results were further reinforced by Chahardeh and Khorasani (2017), which stated that pre-teaching of new vocabulary items used audio-visual media positively affecting the reading and comprehension abilities of intermediate students.

There was an increase in learning outcomes, and the percentage of students who measured the minimum completeness criteria higher in the audio-visual group compared to those that used written materials. This showed that learning with audio-visual aid was more easily accepted and preferred by students. This result is consistent to that of Alshatri et al. (2019), which examined the effects of using different learning media (visual, audio, and audio-visual) to teach mathematics in elementary schools, especially in grades 7 to 9. Furthermore, the results showed that the preferred teaching method was audio-visual media with a rating of 80%, compared to visual and audio media with a rating of 6% and 14% respectively. These results are in line with Ali et al. (2013), which stated that virtual lectures encouraged students to actively participate in teaching and learning process. Therefore, it was recommended that lecturers should use this method in teaching, especially for certain topics in technical drawings that required students to master visualization skills.

Mujiarto, Komaru, Pratiwi, Muhammad, and Sayuti (2019) found that media learning utilization in the form of multimedia animation of technical drawings increased the mechanical engineering skills of students, especially in drawing materials for orthographic projections, and improved their competence. Moreover, the use of audio-visual media in learning received positive perceptions from teachers and students as stated by Shabiralyani, Hasan, Hamad, and Iqbal (2015) showed that most teachers and students had positive perceptions concerning the use of audio-

visual media aids. In addition, Rezaie and Barani (2011) showed that teachers too had a relatively good perception of audio-visual media devices based on their role in learning, hence these devices were effective and capable of improving learning.

Based on these explanations, it can be concluded that audio-visual media and written teaching materials produced different learning outcomes for drawing orthographic projections. Furthermore, the school form and its interaction with the learning method produced the same outcomes. The highest increase in learning outcomes was in State Vocational High School students = 61.06% (high category), followed by Private with 52.04% (high category). The Private students that received written teaching materials were 43.34% (sufficient category), while State was 37.86% (enough category). There was also an increase in learning outcomes accompanied by the number of students that attained the minimum completeness criteria of 74.30% and 42.90% respectively for those that received learning using audio-visual and written materials in State schools. Meanwhile, for private schools, the number of students who achieved the minimum completeness criteria in the audio-visual media group was 63.60%, while those that received written teaching materials were 45.20%. Based on these results, the audio-visual learning method is recommended for use when drawing orthographic projections due to its potential to achieve high learning outcomes.

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