Project-Based Learning Audio-Visual Learning Media: Improving Chemistry Learning Outcomes

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Abstract: This study aims to analyze the feasibility of audio-visual media based on project-based learning assisted by the Adobe Flash CS4 application on electrolyte and non-electrolyte solutions and the effectiveness of audio-visual media based on project-based learning for class X Electrolyte and non-electrolyte solutions. The research method used in this study refers to Borg and Gall, which was carried out at the Bina Bersaudara Private High School in Kec.Selesai, which is located on Jalan Jamin Ginting, Kuta Parit, Kec. Done Langkat Regency. Class X IPA I and Class X IPA II Academic years 2022-2023 There are 40 (forty) students in class X IPA 1 and students in class X IPA II, totaling 32 (thirty-two) students from SMA Bina Bersaudara Kec. The results showed that: (1) project-based learning-based audio-visual media assisted by the Adobe Flash CS4 application that has been tested has obtained a percentage value of 86% with the criteria of "very feasible" to be used in the material for electrolyte solutions and non-electrolyte solutions for class X IPA. and (2) Audio-visual media based on project-based learning assisted by the Adobe Flash CS4 application, which has been tested, gets a score of 95% with the criteria of "effective" and obtains t table -2172 < t count < 2.172 so that Ho is rejected and Ha is accepted. It is concluded that there is a difference in student learning outcomes using learning media that do not use media that are used in the material for electrolyte solutions and non-electrolyte solutions for class X IPA.

Keywords: audiovisual learning media; project-based learning; chemistry

1. INTRODUCTION

In studying chemistry, students are faced with three worlds: the real world (macroscopic), the world of atoms (microscopic), and the world of symbols. One of the problems in learning chemistry is teaching students to understand the relationship between real life and molecular aspects, so technological media are needed. learning according to the needs of chemistry learning so that interaction activities between teachers and students achieve a predetermined goal. According to Suryani [1], the success of a learning process occurs when the goals set during the learning process have been achieved.

In this regard, the researchers developed a project-based learning audio-visual media learning model to increase the effectiveness of students in learning so they don't get bored and to improve student learning outcomes in chemistry class X SMA. One learning strategy that is considered to change abstractness in chemistry lessons is project-based learning. Project-based learning is learning that provides opportunities for teachers to manage learning by involving project work.

especially in the material "Chemical Bonds" at SMA Bina Bersaudara class X, students find it difficult to learn and understand the material, and as a result, many students get grades below the standard passing grade of 75 (seventy five). So researchers try to create a development model design entitled "Development of Project-Based Learning Audio-Visual Media in Chemistry Class X SMA", The development of the learning design is expected to attract students' interest in learning so that the learning process runs effectively and improves student learning outcomes in chemical bonding material.

1.1 The Nature of Learning and Learning Outcomes in Chemistry

Gagne and Briggs [2] define instruction or learning as a system that aims to help the student learning process and contains a series of events that are designed and arranged in such a way as to influence and support the internal student learning process. At first glance, the notion of teaching is almost the same as that of learning but is basically different. In learning, the conditions and situations that enable the learning process must be designed and considered in advance by the designer or teacher. Teaching and learning activities are the core activities of educational institutions. Many factors influence the achievement of positive learning outcomes, which are the result of the interaction between teaching activities, the learning environment provided by the school, and the skills, knowledge, attitudes, and behaviors of its students.

According to cognitive learning theory, learning is a change in perception and understanding. Kleden in Angkowo and Kosasih [3] argues that learning basically means practicing something, while learning something means knowing something. Cronbach gives the meaning of learning: "Learning is shown by a change in behavior as a result of experience." Harold Spears gives limitations on learning, namely: "Learning is to observe, to read, to imitate, to try something yourself, to listen, to follow directions, while Geoch said: "Learning is a change in performance as a result of practice" [4]. Historically, learning research has dealt primarily with the effects of three types of regularity in the environment: (1) regularity with the presence of one stimulus at different points in time, (2) regularity with the presence of two stimuli (both at the same time). in time, as in one-trial learning, and at various moments

in time; and (3) regularity in the presence of behavior and stimuli (also at a point in time and at different points in time).

Learning is a process that is carried out by providing education and training to students to achieve learning outcomes. Changes as a result of the learning process can be proposed in various forms, such as changes in knowledge, understanding, attitudes and behavior, skills, abilities, reaction power, receptiveness, and other aspects that exist in individuals who learn [5].

Meanwhile, according to other experts, "Learning is anything that can bring information and knowledge to the interactions that take place between educators and students" [6]. So it can be concluded that learning is a process that is carried out by providing education and everything that can bring information and knowledge to the interactions that take place between educators and students.

According to Rusmono [7], learning outcomes are changes in individual behavior that include the cognitive, affective, and psychomotor domains. This change in behavior is obtained after students complete their learning program through interaction with various learning resources and learning environments. "Learning outcomes are behaviors that can be observed and show one's abilities. According to Sudjana [8] "defining student learning outcomes is essentially a change in behavior as a result of learning in a broader sense, covering the cognitive, affective, and psychomotor fields"

1.2 Audio Visual Media-Based Learning
Learning media have an important role in supporting the quality of the teaching and learning process. Media can also make learning more interesting and fun. The learning medium that is currently being developed is audiovisual media. According to Benson, Florence Odera [9] The media is expected to play a critical role in enhancing academic performance. Media is expected to play an important role in increasing academic achievement.

Suranto [10] states that the media is a means used to convey messages from a communicator to a communicant. Gagne [11] argues that media are various types of components in a student's environment that can stimulate them to learn.

The benefits and functions of learning media, according to Kemp and Dayton in Prasetyo [12], suggest the benefits of using media in learning are: (1) the delivery of material can be uniform; (2) the learning process becomes clearer and more interesting; (3) the learning process becomes more interactive; (4) time and energy efficiency; (5) improving the quality of student learning outcomes; and (6) the media allows the learning process to be carried out anywhere and anytime. (7) The media can foster students' positive attitudes towards the material and the learning process; (8) The teacher's role can be changed in a more positive and productive direction. Audio-visual media in learning, Audio-visual media is a combination of audio and visual media that is self-created, such as slides combined with audio tapes [13].

According to Sanjaya [14], audio-visual media is media that has sound elements and image elements that can be seen, for example, video recordings, slides, sound, and so on. From the explanation of the experts above, it can be concluded that audio-visual media is a combination of audio and visual media that is self-created, such as slides combined with audio

cassettes, for example, video recordings, slides, sounds, and so on. Types of Audio-visual Media According to Syaiful Bahri Djamarah and Zain [15], audiovisual media is divided into two categories: (1) silent audio-visual, namely media that displays sounds and images such as sound frames (sound slides). (2) audio-visual motion, namely media that can display elements of sound and moving images, such as films and videos.

Advantages of Audio-visual Media, according to Atoel [16], states that audio-visual media has several advantages or uses, including: (1) clarifying the presentation of messages so that they are not too verbalistic (in the form of words, written or spoken). (2) overcoming the limitations of space, time, and sensory power, such as: objects that are too large being replaced with reality, images, film frames, films, or models. (3) Audio-visual media can play a role in tutorial learning. Arsyad [17] says that using learning media will attract more students' attention so that it can foster learning motivation. In learning activities, motivation can be said to be the overall driving force within students that creates, guarantees continuity, and provides direction for learning activities so that learning objectives can be achieved.

1.3 Project Based Learning (PjBL)-Based Learning in Chemistry Lessons
Project-based learning (PjBL) is an effective way to develop science process skills (KPS) and students' scientific literacy knowledge [18]. Therefore, the researcher chose PjBL as a learning model that will be developed in chemistry subjects so that students are effective in the learning process. The essence of project-based learning activities is to provide direct experience to students so that they can interpret symbols, theories, and the benefits of learning chemistry [19]. This needs to be done considering that the symbols and theories are abstract in nature.

Interest in something whose benefits are not known will be very small. If it weren't for the grades given by the teacher, students would not be interested in studying chemistry. It is necessary to direct students to be able to use chemistry in everyday life, find the meaning of chemistry in life, provide opportunities for students to be active in learning, and produce a product based on problems in the surrounding environment. Learning with PjBL (project-based learning), students design a problem and find their own solution.

Project-based learning has the advantage of its characteristics, namely helping students make decisions and frameworks, helping students design processes to determine an outcome, training students to be responsible for managing information carried out on a project that is carried out, and finally producing a real product of the student's results themselves, which are then presented in class and in real life.

Implementation of learning using the PjBL model will not work well if students have low achievement motivation [20]. Achievement motivation is the need to do well or strive for success, which is proven by persistence and effort in facing difficulties.

Project-based learning is a complex of activities based on challenging questions or problems that involve students in project design, problem solving, decision making, or investigative activities and give them the opportunity to work independently to produce original products [21]. Project-based

learning is an effective way to develop students' science process skills and scientific literacy knowledge [22]. The characteristics of the Project-Based Learning model include that students are faced with concrete problems, find solutions, and work on projects in teams to overcome these problems.

1.4 The Nature of Learning Media

According to Miarso [23], media is a tool that aims to provide stimulation for students so that the learning process runs optimally. Meanwhile, according to another opinion regarding the effectiveness of the media, Hamalik [24] emphasized that the media used by educators to convey information to students properly can affect the effectiveness of learning activities.

Furthermore, regarding Hamalik learning [25], learning is a combination composed of human elements (students and teachers), materials (books, blackboards, chalk, and learning tools), facilities (rooms, audio classes), and interrelated processes. affect achieving learning goals. From the explanation of the theory above, it can be concluded that learning media is a tool used by educators in a combination that is composed of human elements, materials, and learning facilities arranged to achieve learning objectives.

Media is a tool used by teachers and students to receive information and achieve learning goals. According to Kustandi and Sutjipto [26], "learning media is a tool that can help the teaching and learning process and serves to clarify the meaning of the message conveyed, so that it can achieve learning goals better and more perfectly". Various learning media can be used by teachers to convey learning material to students in a variety of ways so that it is not boring.

Kemp and Dayton [27], for example, identify several benefits of media in learning, namely: (1) the delivery of subject matter can be uniform; (2) the learning process becomes clearer and more interesting; (3) the learning process becomes more interactive; (4) Efficiency in time and effort; (5) Improving the quality of student learning outcomes; (6) Media allows the learning process to be carried out anywhere and anytime; (7) Media can foster a positive attitude towards learning materials and learning processes; (8) Media can change the role of the learner in a more positive and productive direction; (9) Media can make abstract subject matter more concrete; (10) Media can also overcome the limitations of space and time; and (11) Media can help overcome the limitations of the human senses.

The development of learning media using Adobe Flash CS4 software needs to be implemented in educational environments, especially for science lessons such as chemistry. Adobe Flash CS4 is an application that can be used to design and build presentation tools, publications, or other applications such as learning media. Daryanto [28] explained that the selection of learning media using Adobe Flash CS4 is appropriate and provides benefits for teachers and students. Using Adobe Flash Player, we must have Yahoo Mail, Facebook, and several other social media accounts for the linking process. Based on the opinion above, it can be concluded that Adobe Flash CS4 is software that can be used as a learning media design that benefits both teachers and students.
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Figure 1. Main display of chemistry learning media products using Adobe Flash CS4 software

The research problem is formulated as follows: (1) Is audio-visual media based on Project Based Learning assisted by the Adobe Flash CS4 application suitable for use in class X IPA electrolyte solutions and non-electrolyte solutions; and (2) Is the audio-visual media based on Project Based Learning assisted by the Adobe Flash CS4 application effectively used in the material for electrolyte solutions and non-electrolyte solutions for class X IPA SMA?

2. METHOD

The research model used is Research and Development or Research and Development (R&D). Sukmadinata [29] states that the research and development (R&D) method is a strategy or research method that is powerful enough to improve practice. The research method used in this study refers to the research and development model presented by Borg and Gall [30]. According to Borg and Gall [31], research and development in education is based on industrial research and development models, where research results are used to design new products and procedures that are then field tested systematically, evaluated, and refined until they meet specific criteria, namely effectiveness, quality, and standards.

This research will be conducted at the Bina Bersaudara Private High School, Kec.Selesai, which is located on Jalan Jamin Ginting, Kuta Parit, Kec. Done Langkat Regency. Class X IPA I and Class X IPA II for the 2022–2023 academic year The subjects in this study were students of class X SMA IPA, which consisted of two classes, namely: first-class students in class X IPA I, totaling 40 students, and second-class students in class X IPA II, totaling 32 students. The object of this study is the subject of chemistry on chemical bonding competition material in the form of audio-visual media with the help of project-based learning-based Adobe Flash CS4.

This research model refers to the Borg & Gall model with slight adjustments according to the research context of the 10 steps, namely: first, research and information gathering; second, planning; third, preliminary product development; fourth, initial field testing; fifth, revision of the first product; sixth, main field trial; seventh, operational product revision; eighth, operational field trial; ninth, final product revision; tenth, dissemination and distribution.

 a feasibility test on project-based learning audio-visual media to improve student learning outcomes in class X, SMA Bina Bersaudara Kec. Completed, in the form of material experts, instructional media experts, and instructional designers with the appropriate criteria in Table 1 below:

Table 1. Feasibility Interpretation

Intervals	Interpretation	
0.00 – 2.49	Not Good	Not feasible
2.50 – 3.32	Less Good	Less Eligible
3.33 – 4.16	Good	Eligible
4.17 – 5.00	Very Good	Very Eligible

(Source: Sriadhi [32])

his research was said to be successful if the results obtained from the questionnaire met the criteria of "Very Good" or "Very Eligible" and "Good" or "Decent" with a score interval of 3.33-5.00.

The practicality of the learning model developed in this study was measured using a questionnaire assessing the use of the learning model in the learning process. The practicality value can be calculated using the formula in Table 2 below:

Table 2. Criteria for the Practicality of the Learning Model

Score Intervals	Criteria
3,5 – 4,00	Very Practical
3,00 – 3,49	Practically Without Repair
2,50 – 2,99	Practically Needs Improvement
2,00 – 2,49	Less Practical
1,00 – 1,99	Impractical

The effectiveness of the learning model developed depends on having two types of data, namely qualitative and quantitative. Qualitative data is generated from preliminary or feasibility studies, either in literature studies or field studies. Quantitative data were obtained from student learning outcomes using quasi-experiments, namely comparing pre-test and post-test scores of students using audio-visual media with the help of Adobe Flash CS4 based on the developed project-based learning. In this study, the data obtained were student learning outcomes from the experimental and control classes with the assessment criteria as seen in Table 3 below:

Table 3. Assessment Criteria

Value	Criterion	Percentage (%)
A	Very Good	81-100%
B	Good	61-80%
C	Enough	41-60%
D	Less Good	21-40%
E	Very Poor	0-20%

Data collection was carried out using a questionnaire by distributing questionnaires to the respondents, namely material experts, media experts, design experts, and students. The respondents gave an assessment of the quality of the audio-visual media with the help of Adobe Flash CS4 based on project-based learning with the following research criteria:

Table 4. Scoring Rules

No	Category	Score
1	Very Good	5
2	Good	4
3	Enough	3
4	Less Good	2
5	Very Poor	1

(Source: Arikunto, [33])

The research results of each respondent were used to calculate the average score obtained. The average score obtained is then converted into a qualitative value using the formula and basic guidelines to determine the level of validity as follows:

$$P = \frac{\sum x}{\sum x^1} \times 100\%$$

Information:
P = Large Percentage
$\sum x$ = Number of Validator Answer Scores
$\sum x^1$ = Total Highest Answer Score

Table 5. Product Validation Criteria

Percentage %	Validity Level	Information
80 – 100	Very valid	Not Revised
60 – 79	Valid	Not Revised
40 – 59	Invalid	Some Revisions
20 – 39	Invalid	Revision
0 - 19	Very invalid	Revision

(Source: Arikunto [34])

Analisis Data Efektivitas media audio visual dengan bantuan *Adobe Flash CS4* berbasis *Project Based Learning*

Normality test.
To determine the average value, the formula is used, namely:

$$\bar{x} = \frac{\sum f_i \, x_i}{\sum f_i}$$

To calculate the standard deviation (s), the formula is used, namely:

$$s = \sqrt{\frac{n\sum x_i^2 - \left(\sum x_i\right)^2}{n(n-1)}}$$

By testing criteria:
If Lo < Lt then the sample is normally distributed and if Lo > Lt then the sample is not normally distributed

Homogeneity Test.
Examination of the variance homogeneity test aims to determine whether the sample data has a homogeneous variance or not. Test the homogeneity of variance using the F test, with the following hypotheses:

$H_0 : \sigma_1^2 = \sigma_2^2$ the two populations have the same variance..

$H_a : \sigma_1^2 \neq \sigma_2^2$ the two populations have different variances

$$F_{hit} = \frac{\text{var} \, ians \, terbesar}{\text{var} \, ians \, terkecil}$$

Kriteria Pengujian adalah :
$F_{hit} < F_{tab1/2 \, \alpha(v1, v2)}$, Ho accepted
$F_{hit} > F_{tab1/2 \, \alpha(v1, v2)}$, Ho is rejected

Data processing shows that Fcount < Ftable, then H0 is accepted. It can be concluded that the two samples have a homogeneous variance. If data processing shows that Fcount > Ftable, then H0 is rejected and Ha is accepted, it can be concluded that the two samples do not have a homogeneous variance..

Research Hypothesis Test.

Testing the hypothesis in this study was carried out using the one-party t-test formula where the statistical hypothesis being tested can be formulated as follows:

H_a: There are differences in the learning outcomes of students who study by using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning and students who learn by not using learning media.

H_0: There is no difference in the learning outcomes of students who study using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning and students who study without using learning media.

To find out the significant differences of student learning outcomes. The t test formula is as follows:

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

The test criteria are that Ha is accepted if tcount < ttable and Ho is rejected if tcount > ttable, which is obtained from the t distribution list with dk = (n - 1) and level α = 5%. To see the value of the effectiveness of audio-visual media with the help of Adobe Flash CS4 based on project-based learning that is being experimented on, the effectiveness calculation formula is used as follows:

$$X = \frac{\text{number of students who completed}}{\text{total number of students}} \times 100\%$$

3. RESULTS AND DISCUSSION
3.1 RESULTS

ssessment results by Validation of Linguists; Material Expert Validation; Learning Design Validation; Small Group Trial; Large Group Trial for all aspects of the assessment is determined by the average score. The results of the assessment are then analyzed and determined whether or not it is appropriate to develop audio visual media with the help of Adobe Flash CS4 based on Project Based Learning. The average percentage of the results of the assessment is in Table 6 below:

Table 6. Feasibility of audio visual media with the help of Adobe Flash CS4 based on Project Based Learning

No	Categorization	Percentage of average score%	Criteria
1.	Material Expert Validation	80,00	Is very feasible
2.	Media Expert Validation	90,00	Is very feasible
3.	Learning Design Validation	80,00	Is very feasible
4.	Preliminary Field Test	89,00	Is very feasible
5.	Main Trial	89,70	Is very feasible
6.	Operational Trial	87,00	Is very feasible
Average		85,95	Is very feasible

Based on Table 6 it can be concluded that the scoring intervals for material expert validation, media expert validation, learning design validation, initial field trials, main trials, and operational trials show an average of 85.95 with very feasible criteria. So

the application of audio visual media with the help of Adobe Flash CS4 based on Project Based Learning is very feasible.

Data normality checks are used to determine whether the sample comes from a normally distributed population. The test was carried out using the Liliefors test on two sample groups. A summary of the data normality test can be seen in Table 7 below:

Table 7. Summary of Data Normality Test

No	Class	L count	L table	Conclusion
1	Student learning outcomes are taught using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning	0,12	0.15	Normal
2	Student learning outcomes are taught by not using audio visual media with the help of Adobe Flash CS4 based on Project Based Learning	0,14	0.15	Normal

In the table above, it is found that the data on student learning outcomes taught using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning is normally distributed. This is known from the large Lcount <Ltable at a significant level of 5%, namely 0.12 <0.15. Data on learning outcomes taught using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning is normally distributed. This is known from the large Lcount <Ltable at a significant level of 5%, namely 0.14 <0.15.

To test the homogeneity of the research data, Fisher's test was used. Based on the calculation of homogeneity, it is obtained that the data on student learning outcomes that are taught using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning is homogeneous. It is known from the Fcount <Ftable at a significant level of 5%, namely Fcount (1.42) <Ftable (1.80). Data on student learning outcomes taught using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning is homogeneous. It is known from the Fcount <Ftable at a significant level of 5%, namely Fcount (1.25) <Ftable (1.80). A summary of the homogeneity test can be seen in Table 8 below:

Table 8. Summary of Data Homogeneity Test

No	Class	F count	F table	Conclusion
1	Student learning outcomes are taught using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning	(1,42)	(1,80)	Homogeneous

2	Student learning outcomes are taught by not using audio visual media with the help of Adobe Flash CS4 based on Project Based Learning	(1,25)	(1,80)	Homogeneous

Student Learning Outcomes Using audio-visual media with the help of Adobe Flash CS4-based Project Based Learning in Chemistry Subjects are Higher Than Learning Outcomes Using conventional Learning Models. Testing the hypothesis used is a different test. From the calculation results obtained tcount = 2.14 while ttable = 1.66. Because tcount = 2.14 > ttable = 1.66, it can be concluded that the learning outcomes of students who use audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning are higher than the learning outcomes of students who do not use media. Summary of hypothesis testing can be seen in Table 9 below:

Table 9 Summary of Hypothesis Test Calculations

Average Posttest Value		T_{count}	t_{table}	Conclusion
Using audio visual media with the help of Adobe Flash CS4 based on Project Based Learning	Not using audio visual media with the help of Adobe Flash CS4 based on Project Based Learning	2,14	1,66	There is a significant difference
72,60%	65,33%			

From the results of hypothesis testing, empirical evidence is obtained that student learning outcomes using audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning are higher than student learning outcomes using conventional learning models.

The effectiveness of the inolyn learning model based on blended learning in the basics of beauty and SPA subjects is as follows:
x = (Total score obtained)/(Total ideal score) x 100%
x = 2396/3300 x 100% = 71.58%

While the effectiveness of learning by using conventional learning models.

x = (Total score obtained)/(Total ideal score) x 100%
x = 2156/3300 x 100% = 66.35%

Thus the value of the effectiveness of audio-visual media with the help of Adobe Flash CS4 based on Project Based Learning in the basics of beauty and SPA subjects is higher than not using learning media

3.2 DISCUSSION
The results of the study show that learning media play an important role in supporting the quality of the teaching and learning process. Media can also make learning more interesting and fun. The learning medium that is currently being developed is audiovisual media. According to Ambuko Benson and Florence Odera [35], The media is expected to play a critical role in enhancing academic performance. Media is expected to play an important role in increasing academic achievement. Suranto [36] states that the media is a means used to convey messages from a communicator to a communicant. Gagne [37] argued that the media are various types of components in the student's environment that can stimulate them to learn.

In line with the media functions developed for chemistry learning videos supported by the benefits and functions of Learning media, according to Kemp and Dayton in Prasetyo [38], the benefits of using media in learning are: (1) the delivery of material can be uniform; (2) The learning process becomes clearer and more interesting; (3) the learning process becomes more interactive; (4) time and energy efficiency; (5) the quality of student learning outcomes; and (6) the media allows the learning process to be carried out anywhere and anytime. (7) The media can foster students' positive attitudes towards the material and the learning process; (8) The teacher's role can be changed in a more positive and productive direction.

The chemical audio-visual media developed is said to be feasible and has met several stages of expert validation as well as trials on students, with several things declared feasible because they are supported by the advantages of the Audio-visual media. According to Atoel [39], audio-visual media has several advantages or uses, including: (1) clarifying the presentation of the message so that it is not too verbalistic (in the form of words, written or spoken). (2) overcoming the limitations of space, time, and sensory power, such as objects that are too large being replaced with reality, images, film frames, films, or models. (3) Audio-visual media can play a role in tutorial learning. Arsyad [40] says that using learning media will attract more students' attention so that it can foster learning motivation. In learning activities, motivation can be said to be the overall driving force within students that creates, guarantees continuity, and provides direction for learning activities so that learning objectives can be achieved.

Supported by the same research by Raum Syahputri with the research title Quality of PjBL-based chemical teaching materials on the subject matter of electrolyte and non-electrolyte solutions. The results of the research were obtained from 126 due diligence interviews with media experts, material experts, PjBL experts, and students' responses to teaching materials. After the feasibility test was carried out by the expert validator and the responses of the students obtained an average value of 84.05% in the very feasible category, it can be continued to the large class implementation stage. The results of the project assessment, which include process aspects, product aspects, and students' attitude aspects, obtained an average of 80.74. The results of students' assessments of teaching materials obtained a percentage of 82.32% in the proper category.

The same thing was explained about the results of research by Muliaman [41] with the research title The Effectiveness of the Project-Based Learning Model Oriented on eXe Learning and Motivation on Learning Outcomes in Reaction Rate Material. The results showed that there were differences in improving learning outcomes through the eXe-Learning-oriented PjBL model and Macromedia Flash-oriented Direct Instruction at high and low motivation levels. Learning in the experimental

class using the eXe-Learning oriented PjBL model obtained better results with an average N-gain of 0.73, while the average N-gain of the control class was 0.63, so a more effective eXe-Learning oriented PjBL model was obtained. used in learning Reaction Rate.

4. CONCLUSION

Based on the results of the analysis and discussion of the data, it can be concluded, namely:

1. Project-based learning-based audio-visual media assisted by the Adobe Flash CS4 application has been tested to obtain a percentage value of 85.95% with the criteria of "very feasible" to be used in the material for electrolyte solutions and non-electrolyte solutions for class X IPA SMA Bina Bersaudara.

2. Audio-visual media based on project-based learning assisted by the Adobe Flash CS4 application that has been tested has obtained a score of 95% with the criteria of "effective" and obtained tcount = 2.14 > ttable = 1.66 so that Ho is rejected and Ha is accepted, it is concluded that there is a difference in the results of student learning using learning media with those that do not use media used in the material for electrolyte solutions and non-electrolyte solutions for class X IPA SMA Bina Bersaudara

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