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Using Macromedia Flash-Assisted PBL and PjBL Learning Model to Improve Acid Base Leraning Outcomes

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Abstract: Learning science provides a challenge for students who have lost interest in learning science, especially chemistry lessons. Resulting in low student learning outcomes, because apart from being abstract in nature, it is influenced by the positive attitudes of students and teacher readiness in managing innovative learning so that the skills that students must have are lacking in dealing with the advancement of 21st century education. The purpose of this study was to determine differences in learning outcomes (cognitive, affective and psychomotor aspects) using the PBL and PjBL learning models in Acid-Base material assisted by macromedia flash which was implemented at SMA Negeri 1 Delitua.Technique The selection of the sample used was purposive sampling with the research design Two Group Pretest – Posttest Design. Data collection techniques used tests for cognitive learning achievement and non tests for affective and psychomotor achievements. Data analysis used the normality test with the Chi Square test, homogeneity through the F-test and two-party hypothesis testing to analyze whether or not there was a difference between the two experimental classes. The results showed that there were differences in cognitive and psychomotor learning outcomes and there were no differences in students' affective aspects between PBL and PjBL models assisted by macromedia flash.

Keywords: problem based learning model, project based learning model, macromedia flash, learning outcomes.

Abstrak: *Pembelajaran sains memberikan tantangan bagi siswa yang kehilangan minat belajar sains terkhusus pelajaran kimia. Mengakibatkan rendahnya hasil belajar peserta didik, karena selain kimia bersifat abstrak, dipengaruhi sikap positif siswa dan kesiapan guru dalam mengelola pembelajaran inovatif sehingga keterampilan yang harus dimiliki peserta didik kurang dalam menghadapi kemajuan pendidikan abad ke-21. Tujuan penelitian ini untuk mengetahui perbedaan hasil belajar (Aspek kognitif, afektif dan psikomotorik) menggunakan model pembelajaran PBL dan PjBL pada materi Asam Basa berbantuan Macromedia Flash yang diimplementasikan di SMA Negeri 1 Delitua. Teknik pemilihan sampel yang digunakan adalah Purposive Sampling dengan desain penelitian Two-Group Pretest- Posttets Design. Teknik pengumpulan data menggunakan tes untuk prestasi belajar kognitif dan non tes untuk prestasi afektif dan psikomotorik. Analisis data menggunakan uji normalitas dengan uji Chi Square, homogenitas melalui uji-F dan uji hipotesis dua pihak untuk menganalisis ada atau tidaknya perbedaan antara dua kelas eksperimen. Hasil penelitian menunjukkan adanya perbedaan hasil belajar kognitif dan psikomotorik dan tidak ada perbedaan hasil belajar afektif antara model PBL dan PjBL berbantuan Macromedia Flash.*

Kata kunci: *model pembelajaran problem based learning, model pembelajaran project base learning, macromedia flash, hasil belajar.*

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▪ INTRODUCTION

Quality education is able to support future development through the potential of students. To achieve quality education, a learning system is needed that is able to help students develop their potential. The teacher's ability to develop effective learning models and improve student learning outcomes is very important for the success of the learning process. However, sometimes the learning model that is applied becomes monotonous due to the fact that most teachers rely on rote memorization in chemistry, the inability of teachers to deliver good material and practicum, learning media are not used, thus creating a negative attitude of students towards science which results in decreased student activity and motivation during the learning process. . This then can lead to problems of low student achievement, especially in the field of chemistry (Montes, Ferreira, & Rodríguez, 2018; Nuha, Febriana, & Merdekawati, 2020).

Chemistry subjects are often considered difficult for students. During the learning process, many students experience difficulties in solving problems and connecting chemistry concepts properly because they are influenced by several factors including a lack of understanding of students' basic concepts, lack of motivation and student attitudes, learning built on teachers and inadequate teaching and learning resources. Many students only memorize formulas without understanding concepts, such as the concept of acids and bases with a fixed ionic strength and pH calculations. Chemistry consists of concepts that are related and layered, making it difficult for students to understand. Therefore, many students experience difficulties in achieving good academic achievement in chemistry subjects so that there are still many students who need help to develop a positive attitude in learning chemistry (Lutviana et al., 2019; SUSWATI, 2021).

In accordance with the implementation of the 2013 curriculum , a learning model is needed that not only helps improve student learning outcomes, but also encourages students' active participation in the learning process. One of the recommended learning models is PBL (Problem Based Learning) and PjBL (Project Based Learning), which are proven to improve learning outcomes and student activities in following the 2013 curriculum (Aritonang & Zubir, 2022). The problem-based learning model provides equal opportunities for all students to participate in the learning process. Therefore, the PBL learning model is considered as an alternative to improve learning outcomes because it is proven to increase collaboration, creativity, positive action, exchange of information, express opinions, ask questions, discuss, and debate, so as to improve student learning outcomes . The application of the PBL model can also improve creative thinking and critical thinking skills in chemistry learning which can train students' problem-solving skills (Antara, 2022; Dakabesi & Luoise, 2019; Ernawati et al., 2022; Rudibyani, 2019). Problem-based learning can also improve students' cognitive, psychomotor and scientific attitude learning outcomes (Tohadi, Samani, & Susila, 2020). In addition to the PBL model, the PjBL learning model can also be used to improve student learning outcomes, abilities in solving problems, critical thinking skills, actively involved in learning, good teamwork and demonstrating skills from the learning process (Kipfer, 2021; Qholby & Lazulva, 2020; Syukriah, Nurmaliah, & Abdullah, 2020; Wayan Santyasa, Agustini, & Eka Pratiwi, 2021). The PjBL model can provide science learning innovation in stimulating knowledge, participation in scientific practicums, and curiosity (Schneider et al., 2022).

In addition to learning models, another effort needed to overcome boredom and student inactivity is the use of interactive learning media support the chemistry learning process. One of the learning media that can be utilized is Macromedia Flash, or what is now known as Adobe Flash. Macromedia flash is an interactive animated medium that can improve students' conceptual understanding skills (Tsany, Septian, & Komala, 2020). Macromedia Flash can facilitate teaching materials, especially in chemistry lessons, because teaching materials are presented visually with interesting animations and are good for use in the learning process. Understanding chemical concepts is difficult because they are abstract in nature such as acids and bases, so learning media are needed that are able to solve these concepts so that they are easily understood by students (Manurung & Simaremare, 2022; Nurdin, 2021).

Based on several relevant studies, a theory was found namely (Amini, Setiawan, Fitria, & Ningsih, 2019) that the learning outcomes of students with the PjBL model were higher than the PBL model and found differences in the effect of PJBL and PBL learning on students' creativity and critical thinking. Furthermore, in research (Inayah, Buchori, & Pramasdyahsari, 2021) which discusses the effectiveness of the PBL model and the Kahoot Media-assisted PjBL model on learning outcomes. The results show that there are differences in student learning outcomes between the PBL and PjBL models assisted by Kahoot media in Vocational High Schools. But student learning outcomes in this studyonly includes only cognitive aspects, which are shown through the Mathematics learning material test instrument. Then research by (Irwanto & Santoso, 2022) discusses the effect of the PBL and PjBL models on learning outcomes in Elementary School Mathematics. The results stated that the learning outcomes of the PBL model were higher than the learning outcomes of the PjBL model. As for research by (Nasir, Fakhrunnisa, & Nastiti, 2019) regarding the application of the PBL and Guided Inquiry models to improve Science Process Skills and Cognitive learning outcomes of students concluded that there is a static difference between the PjBL model and Guided Inquiry in which the PjBL model is more effective than the Guided Inquiry model in improving science process skills and cognitive learning outcomes student. Not many studies have analyzed the differences in cognitive, psychomotor and affective learning outcomes of students using the PBL and PjBL learning models, especially in Chemistry learning. In addition, the use of learning media that is in accordance with the characteristics of chemical material has not been widely used in research, even though learning media is one of the learning tools that supports the achievement of learning objectives. So the researchers conducted a study that compared the cognitive, affective and psychomotor learning outcomes of Chemistry with the help of Macromedia Flash as a learning medium that could simplify the concepts of chemistry theory so as to overcome students' learning difficulties.

▪ METHOD

The population in this study were all class XI students of SMA N 1 Delitua for the 2022-2023 academic year, consisting of six science classes and five social studies classes. The number of samples in this study were 70 participants. The sampling technique used purposive sampling, namely class XI MIPA 2, namely the experimental class I which was taught by the PBL model and class XI MIPA 3, namely the experimental class II which was taught by the PjBL model. The reason for using this data collection technique is because based on the learning outcomes of the two classes which are not much different so that the sample can be used as a research sample for a two-party t test. In this study, researchers used the Two Group Pretest – Posttest Design, namely experiments conducted in two different groups that received different treatments (Silitonga, 2014). The stages of this research started with the Pre-Test and ended with the Post-Test, the research lasted for 3 meetings apart from the pre-test and post-test activities. The research instrument consists of tests and non-tests. The validity of the test instrument was first measured using the Product Moment Correlation formula and the KR-20 reliability formula was used. The valid test instrument consists of 20 questions which are arranged based on indicators of achievement of competence, namely "Determining the Concept of Acid and Base Solutions", "Understanding the pH of Acid-Base Solutions", "Calculating the pH of Strong and Weak Acids", "Acid-Base Indicators", "Determining the Degree of Acidity", "Determining the concentration and amount by weight of the substance formake acid and base solutions. For the validity of the non-test instruments in this study, it is sufficient to carry out qualitatively with expert judgment or expert judgment in the field (expert validator) which considers and analyzes the suitability of the criteria for the assessment observation sheets measured against the attitude indicators and descriptors made. by researchers. A valid test instrument was used to obtain data on cognitive aspects of learning outcomes through pretest and posttest multiple choice questions, then affective and psychomotor observation sheets As a guideline for assessing students' affective and psychomotor assessments during the learning process. Affective observation sheets to measure student activity and psychomotor observation sheets to measure student practicum performance during learning takes place. Observation guidelines in the form of indicators and scoring. Each affective and psychomotor has an indicator, and each indicator has a test score, a maximum score of three for students if it matches the indicators set and a minimum score of zero if it doesn't match the indicators.

Data analysis in this study was carried out using statistical analysis. After all the data is collected, the data is tabulated and then tested for normalitycarried out using the Chi Square testand data homogeneity testdone through Test F, then tested the hypothesis.namely the two-party t test with the presence or absence of differences in student learning outcomes which applied to different models with the criteria: if t count $< -t\ 1/2\ \alpha$ and $t > t\ 1/2\ \alpha$ then Ho is rejected. The stages of implementing this research in the two experimental classes can be seen in Table 1

Table 1. Differences in the syntax for implementing the pbl and pjbl models

PBL Stages	Teacher Action	PjBL Stages	Teacher Action
1. Orient students to issues	Explain the learning objectives, materials needed and encourage students to participate in solving the selected problem	Determination of fundamental questions	Learning topics to be discussed are communicated by the teacher. After that, the teacher shows the problem to the students and asks them questions about how to solve it.
2. I fix students to study	Play a role in guiding students to identify and organize learning tasks related to issues.	Preparation of project design	The teacher groups students into several groups to discuss plans for the process of making projects that will be used to solve problems. Project design, how to

			divide work, how to prepare tools and materials, and problems that must be reported after the project is completed
3. Guide individual or group investigations	Students need to be motivated to gather relevant information, conduct experiments , obtain explanations and solve issues independently .	Schedule Arrangement	Teachers and students agree on a project schedule from completion to project withdrawal
4. Develop and present the work	Assign tasks to students in compiling and completing appropriate assignments such as reports.	Project Completion Monitoring	in completing projects according to agreed designs, make detailed notes, and discuss problems related to project completion .
5. Analyze and evaluate the problem solving process	Assess the learning reporting of the learning topic and, ask the group to present it	Testing of Project Results	The teacher assesses the projects that have been completed, measures targets, and assesses the progress of each student after implementing the effort-based learning model.
		Project Evaluation	While other students answered, the teacher and students discussed learning activities and project results. Each group shows a project

▪ RESULT AND DISSCUSSION

Cognitive, affective and psychomotor learning outcomes from the application of two different learning models are the results in this study. Cognitive learning outcomes of students were measured using a multiple choice test instrument. Before starting learning, a pretest was carried out and after learning, a posttest was carried out. Analysis of cognitive learning outcomes data is summarized in Table 2.

Table 2. Student cognitive learning outcome data

Experiment Class	Average value		Standard Deviation		Variant	
	Pre-Test	**Post-Test**	**Pre-test**	**Post-Test**	**Pre-Test**	**Post-Test**
I	41.43	74.57	13.605	5.65	185.102	31.95
II	43.57	82.29	6.6008	5.64	105.102	31.918

Students' cognitive learning results were obtained after being given a pretest and posttest in the experimental class. Then the pretest and posttest data were tested for normality and homogeneity variants, so that hypothesis testing could be carried out. Cognitive learning outcomes data obtained in this study are normally distributed and have a homogeneous variant. Through data on student learning outcomes, the project-based learning model is proven to be more effective in influencing student learning outcomes compared to the problem-based learning model. Project-based learning is more appropriate for use in authentic assessments which have a positive effect on student learning outcomes (Parwati, Suarni, Suastra, & Adnyana, 2019). This is due to the factor that the project-based learning model can provide opportunities for students to direct learning activities in class by including projects, so that they not only solve problems but also encourage innovation. This learning model puts forward values such as:cooperation, tolerance, discipline, integrity, and self-confidence among students, resulting in active participation in learning activities (Anggriani, Wijayati, Susatyo, & Kharomah, 2019). Apart from that, every activity carried out by students in the PjBL learning model will provide direct experience that can improve their learning outcomes. Through this model, students can find new concepts and new experiences that can improve their learning outcomes and creativity in solving problems and producing new products (Gultom & Muchtar, 2022). This is in line with the opinion (Tabieh & Hamzeh, 2022) that this PjBL model is student-oriented, emphasizing problem solving and project completion through collaboration and higher order thinking skills. This research is in line with relevant research by (Amini et al., 2019) showing that the PjBL model is superior to the PBL model this is because the pattern of problem-based learning is learning with directions. Meanwhile, the project-based learning model can create a fun learning atmosphere and develop problem-solving skills.

The affective learning outcomes of students from the two experimental classes were measured through non-test instruments through observation and scoring. Data on student affective learning outcomes is summarized in Table 3. Data analysis on differences in students' affective values for each assessment indicator is listed in Table 4.

Table 3. Student affective learning outcome data

Experiment Class	Average value	Standard Deviation	Variant
I	60.428	13.195	174.13
II	64.724	11.779	138.76

Table 4. Data on differences in student affective learning outcomes

Assessment Indicator	Experiment I	Experiment II
Paying Attention to Teacher Explanations During Learning	69%	68%
Pay attention to learning media	67%	62%
Join discussion groups	64%	69%
Respect the opinion of the group of friends	54%	59%
Express opinions and ask questions	46%	44%
Like learning activities with responsibility	57%	82%

The results of the assessment of affective learning used an observation sheet which was filled in by observers based on indicators and scoring. Indicators of student affective assessment related to the attitudes and responses of students when participating in learning. For affective instruments, a maximum score of three is used for students if they match the predetermined indicators and a minimum score of zero if they do not match the indicators. Affective learning outcome data from the two experimental classes obtained an average value of affective learning outcomes for experimental class I of 60.428. The average value of affective learning in the experimental class II is 64.742. After testing the hypothesis, both parties concluded that there was no significant difference in the learning outcomes of the affective aspect in the application of the PBL and PjBL models, this was because based on the findings (Fitriani, Zubaidah, Susilo, & Al Muhdhar, 2020) stated the problem-based learning model and Project-based learning basically emphasizes a scientific problem-solving attitude. The PBL model does not only require students to passively listen, take notes, and memorize learning material, but through this model it can help students store information obtained through questions. Solving activities so that they become a deep part of the student's long-term memory which gives birth to scientific attitudes and thoughts. students' critical thinking can increase (Dakabesi & Luoise, 2019). Likewise, the project-based learning model helps decision-making and frameworks, designs student processes to achieve the desired results, trains students in the responsibility of managing information in the projects they are working on, and encourages students to produce real products that are the result of themselves. Work. which is then presented in class. This is supported by research (Widyasari, Indriyanti, & Mulyani, 2018) which states that there is no difference between the PBL and PjBL models on learning achievement and student attitudes because both models both emphasize problem solving andnot focused on rote learning methods so that students are active in finding and building their knowledge and stored in their memory in the long term. It can be interpreted that both the PBL and PjBL learning models can create a more active and effective or affective student attitude. Affective learning outcome data in this study contradict research (Chiang & Lee, 2016) which states that the PjBL model can increase student learning motivation, students enjoy learning activities, share experiences and help peers besides that the PjBL model can improve student problem solving. ability, in which students try to explore findings.However, student achievement is not entirelyachieved with the successful implementation of PBL learningPjBL models and models. The two learning models are the samegood if applied to improve student learning outcomes.Student affective learning outcomes for each indicator of affective learning outcome assessment are presented in Figure 1. From Figure 1 it can be seen the differences in learning outcomes for each student affective assessment indicator

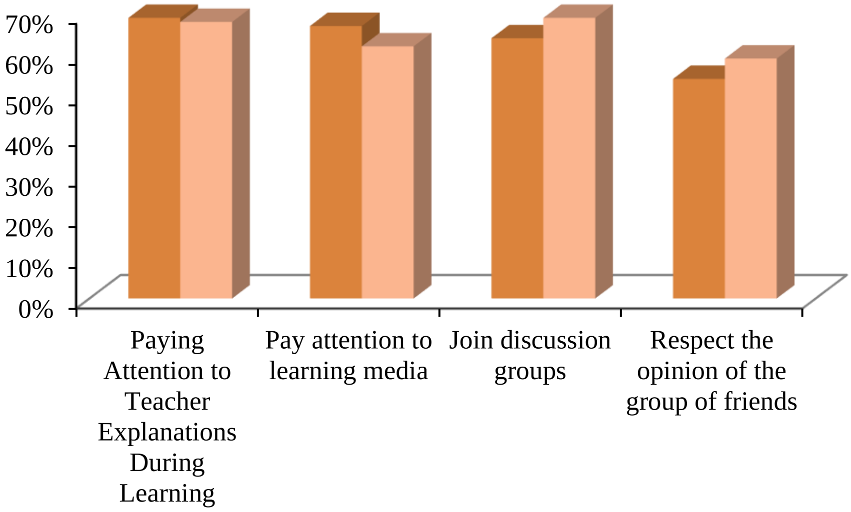

Figure 1. Differences in affective learning outcomes in each indicator

Students' psychomotor learning outcomes are measured through non-test instruments, namely scoring observation sheets where the aspects assessed include moving, manipulating, communicating, and creating. Differences in students' psychomotor learning outcomes for each indicator of students' psychomotor assessment during practicum are summarized in Table 5. Data analysis of students' psychomotor learning outcomes is summarized in Table 6.

Table 5. Data on differences in student psychomotor learning outcomes

Assessment Indicator	Experiment I	Experiment II
Bring study supplies	100%	100%
and study supplies	99%	99%
Using practical tools	83%	83%
Observe experiment	97%	99%
Clean tools and practical materials	79%	78%
Asking question	75%	75%
Describe data	70%	72%
record data	72%	72%
Design procedures	77%	76%
Analyze the problem	75%	74%
Synthesize problems	62%	65%

Table 6. Student psychomotor learning outcome data

Experiment Class	Average value	Standard Deviation	Variant
I	73.171	5.26	27.74
II	81257	5.60	31.44

The results of the psychomotor learning assessment used an observation sheet filled in by the observer. Criteria for student psychomotor indicators related to practicum activities. The psychomotor assessment instrument is a tool used to obtain information on learning outcomes, especially in skills. The assessment is carried out during the practicum process. In the experimental class I, the average number of psychomotor learning outcomes was 73,171, while in the experimental class II, the average number of psychomotor learning outcomes was 81,257. Figure 2 shows the significant differences between the two class groupsexperiment. This difference in psychomotor learning outcomes is due to project-based learning enabling students to use knowledge and integrate the theory and practice they have learned. The material for the Acid-Base project that has been implemented is Identification of Acid-Base Solutions Using Litmus Paper, Identification of Acid-Base Solutions through Electrolyte Properties, and Design of Natural Indicator Projects. The PBL learning model emphasizes giving real problems in life that must be done by students through independent investigation, so that it is judged that from the psychomotor aspect PjBL is superior to PjBL learning (Widyasari et al., 2018). This is in line with research that has been conducted by (Agustini, 2021) that the implementation of the PjBL model is effective in extraction practicums where students create their own projects so that students feel challenged, more creative, have an increased sense of knowing, connect chemistry with everyday life, increase knowledge and insights and strengthen concepts and learn to solve problems. This is because the experience of students in conducting experiments will enterinto long-term memory so students will remember it.

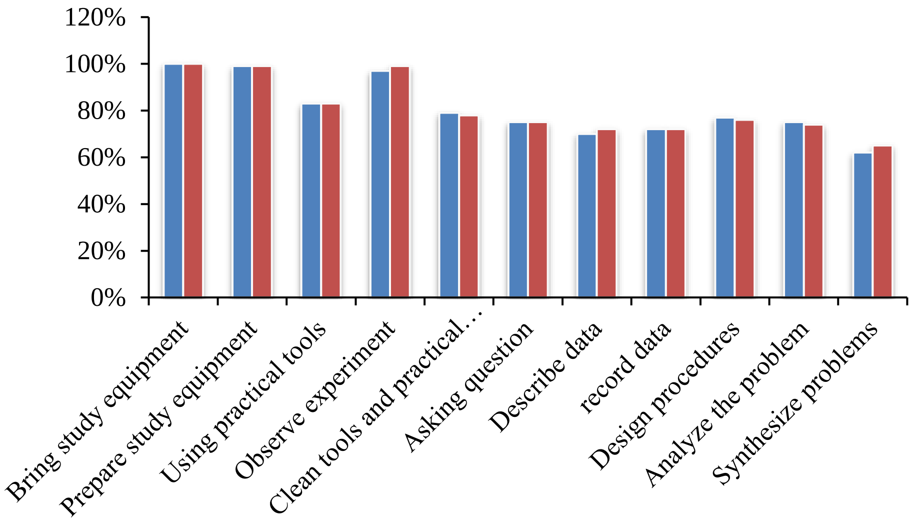

Figure 2. differences in student psychomotor learning outcomes in each indicator

Through Figure 2 the difference in the difference in values in each psychomotor assessment indicator from the two small experimental classes but the experimental class II showed several indicator values that were higher than the experimental class I. So it can be concluded that PjBL learning is superior to students in psychomotor aspects compared to PBL learning. This is in line with research (Amini et al., 2019) that the learning outcomes of students using the PjBL model are higher than using the PBL model because in the application of the PjBL model superior activity, enthusiasm, cooperation and problem solving are seen in the learning process. Data on student learning outcomes in each aspect of learning in experimental classes I and II are presented in Figure 3.

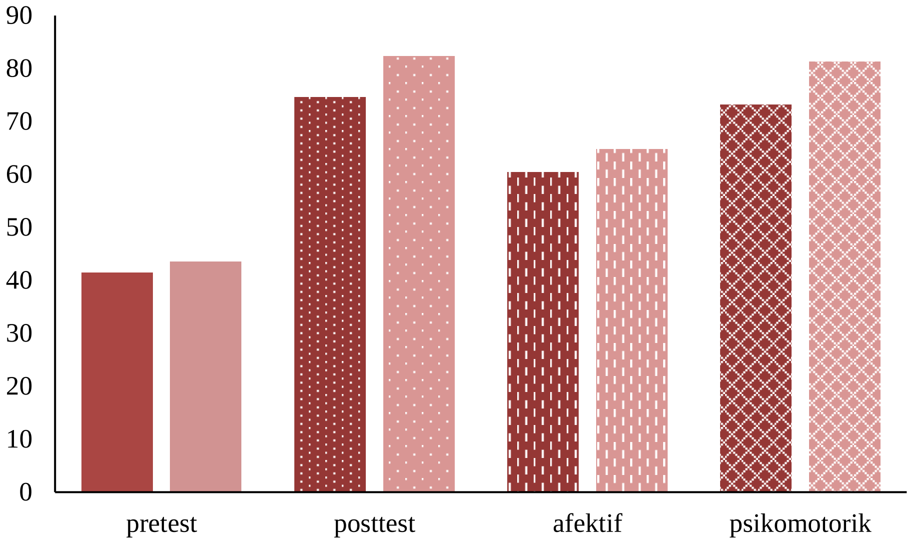

Figure 3. Differences in experimental class i and ii learning outcomes

The implementation of the PBL and PjBL model learning processes is assisted by macromedia flash learning media which aims to increase motivation and minimize boredom during the learning process. The macromedia flash used was designed by the researcher as a tool to help convey the content of Acid-Base learning material through writing, pictures and sound. Macromedia flash media can be seen in Figure 4.

Figure 4. Display macromedia flash

Through this research it was found that the PjBL model and the PBL model had differences in improving students' cognitive, psychomotor and affective learning outcomes. This is in line with research (Nugroho, Irianto, & Herwanto, 2019) where the learning outcome data after the two-party test showed that there were differences between PBL and PjBL models assisted by Mobile applications to results student learning. This difference is caused by the factor where PBL encourages students to be creative in solving problems and the PjBL model focuses on determining solutions to projects. Other factors that influence include the ability of each student in class, motivation to learn and the condition of students in each class. In line with findings obtained during research at SMA Negeri 1 Delitua. Learning can take place well if it is supported by good facilities and infrastructure, teacher readiness, student and situational readiness. The facilities and infrastructure at the research location are adequate so that the project implementation can take place properly. Teacher readiness or pedagogic teacher competence also influences student learning outcomes. A teacher must be able to understand existing theories so that he can easily decide what actions to take in learning both in terms of learning methods, learning models, use of media, worksheets and lesson plans so as to create active and educative learning (Sudargini & Purwanto, 2020). In addition, the teacher must also be able to detect student characteristics. The characteristics possessed by students are related to the environmental situation of the students themselves. During the research, the researcher tried to understand the characteristics possessed by the research sample, where some students because of their difficult circumstances involved students to work, some other students focused on helping their parents' business, and some students were addicted to gadgets. Through these obstacles, researchers are trying to overcome them through the application of active learning models so that students can focus on work, both designing and completing projects as well as formulating and solving problems. In addition to active learning, students' thinking and opinion skills are honed through presentations and questions and answers. For students' motivation and interest in learning, researchers overcome them through macromedia flash learning media which are designed to be as attractive as possible through pictures, writing and sound. This is proven to help overcome the obstacles that researchers found. So that the teacher's ability and teacher's accuracy in determining and selecting learning methods and devices can affect the improvement of student learning outcomes.

▪ CONCLUSION

The conclusion obtained is that the cognitive and psychomotor learning outcomes of students who are taught with the problem-based learning model and the Macromedia Flash-assisted project-based learning model on acid-base material have significant differences. The cognitive learning outcomes of experimental class II students were 82.29, while the cognitive learning outcomes of experimental class I (PBL) students were 74.57. The average psychomotor score of the experimental class I students was 73.171, while the average psychomotor learning score of the experimental class II students was 81.25. The affective aspect of learning outcomes between the problem-based learning model and the Macromedia Flash-assisted project-based learning model on Acid-Bas\e material does not have a significant difference. Experimental class I students achieved an average of 60 affective learning outcomes, while experimental class II students achieved an average of 64.74 affective learning outcomes.

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