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THE IMPLEMENTATION OF SCAFFOLDING IN PROJECT BASED LEARNING TO IMPROVE STUDENTS' SCIENCE PROCESS SKILLS IN BUFFER CONCEPT

Tri Haryati[1*], Diah Riski Gusti[2], Muhammad Haris Effendi Hasibuan[2], and Muhammad Rusdi[2]

[1]Master Program of Chemistry Education, Universitas Jambi
Jl. Jambi - Muara Bulian Km. 15, Jambi 36122, Indonesia
[2]Faculty of Education and Teacher Training, Universitas Jambi
Jl. Jambi - Muara Bulian Km. 15, Jambi 36122, Indonesia

*Correspondance: tel/fax : 081377528358, email: triharyati1109@gmail.com

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ABSTRACT

Dynamic assessment, which is supported by scaffolding, consists of questioning, prompting, cueing, and explaining. Scaffolding is considered as an effort to overcome learning problems which present in the concept of buffer solution as well as in the Project-based Learning, which aims to improve students' science process skills. This study aims to investigate the implementation of scaffolding to enhance students' science process skills about the concept of buffer solution. Data were collected using in-depth interviews and analyzed using the Delphi technique. Based on the results of the analysis, it can be seen that the ideal scaffolding widely used was the questioning and the prompting. This was because the students only needed to be guided to solve the problems using the most appropriate assistance to overcome the issues. Therefore, it can be concluded that the implementation of the scaffolding was able to help the students to overcome the problems that occur during the learning process. The implementation was also able to improve the students' understanding and skills of the science process about the concept of buffer solution.

Keywords: *Scaffolding, Project Based Learning, Science Process Skills, Buffer Solution*

INTRODUCTION

The project-based learning model has the advantage that students can be motivated in learning, increase creativity in producing products from projects that are done, can improve the ability to think critically [1][2]. Project-based learning is also useful for developing science process skills and science attitudes of students [3]. The development of science process skills and science attitudes of students can occur because project-based learning focuses on concepts that involve students in project activities [4].

This design has advantages in implementing the PjBL model, but still experiences difficulties; this happens because of the large amount of equipment that must be available. Students who have weaknesses in the experiment and information gathering will experience problems. Students may be less active in group work. According to Nawawi caused by various factors, including lack of time when students want to solve existing problems. 5. Shortage of costs [1].

As a result of the optimization of the use of the PjBL model, the impact of students' scientific process skills is low. According to Jack, that causes the soft science process skills can be caused by two factors, namely the lack of background / initial ability of science and the lack of laboratory infrastructure in schools [5]. But in reality, educators find that students have difficulty when solving problems, usually caused by a lack of knowledge about the subject matter. It can be caused by mis-understanding or misconceptions related to symbols and formulas and difficulty under-standing the context in the buffer solution followed by generalizing concepts and using incorrect problem-solving strategies [6-7]. If the knowledge and understanding of chemistry are interpreted, then there are three aspects, namely macroscopic, submicroscopic, and symbolic. Macroscopic aspects include pheno-mena that can be directly observed and described, submicroscopic aspects include depictions of particulate matter, and symbolic aspects include chemical symbols and equations used to communicate chemical concepts [8].

Buffer is a chemical material that can cause students to experience concept percep-tions that are not easy or difficult; that is, students think that buffer material is a concept that is difficult to understand. Difficult concepts possessed by students have the opportunity to cause misconceptions if they occur repeatedly[9-10]. Besides, the previous research found that the misconception of buffer solutions occurs because educators do not emphasize conceptual material. Especially in the indicator of buffer solutions in everyday life, the language of chemistry textbooks is too tricky. Another problem is that students themselves are less focused during the learning process [11].

As a result of students' problems during the learning process, the assessment cannot equate for all students, for that assessment is done dynamically. The dynamic assessment has an interactive nature; in this case, the educator responds, observes, and concludes about the student and serves to express the learning process and to facilitate change [12]. Besides, the dynamic assessment also serves to help educators in identifying barriers to learning get more effective performance [13], and be used for scaffolding adjustments that have been provided [14].

To support the dynamic implementation of the assessment, gradual assistance is carried out by educators to reduce problems resulting from students' lack of understanding of the lesson, and this assistance is called scaffolding. Scaffolding is the right aid to reduce student problems based on the difficulty level of the material, concepts, and learning. This assistance is provided by educators in stages, starting from maximum mentoring to minimal mentoring. Previous research related to scaffolding has resulted in a workflow that has been created based on the Goldilocks Help (GH) workflow in helping the chemistry learning process in the classroom [6].

Other studies have also shown that scaffolding has proven to help overcome learning difficulties experienced by students by using three stages, namely supportive, strategic, and interrogative guidance, which is named Systematic Scaffolding Guidance.

(SSG). SSG can be applied to all learning models, and this result has been patented [15]. Belland & Evidence also states that ultimately the goal of scaffolding is that learners not only acquire the skills needed to perform the task independently but also take responsibility for the task itself [14].

Assistance in the form of scaffolding will be very effective if used in the potential development zone Zone of Proximal Development (ZPD). This zone is a zone that can be assisted by adults who are better able to overcome material problems, projects as well as task presented without reducing the level of difficulty of the task. ZPD is also a zone where interactions occur between students and educators [16].

Based on this background, scaffolding is considered as an effort and solution to overcome problems that occur during the learning process. So that researchers will implement the use of scaffolding based on the 2013 curriculum on the buffer solution material, which will be combined with the Project-Based Learning model with the aim to improve students' science process skills. Eventually, every syntax that is in the Project-Based Learning model will be given scaffolding assistance that is ideal for helping to overcome problems that occur precisely and effectively.

METHODS

Qualitative data are sourced from the opinions of experts, practitioners, and students regarding their assessment of the usability and use of scaffolding products. The test was carried out at the SMK Keluarga Bunda in class XI Pharmacy, with 17 students divided into five groups in 2020 January. The instrument used in this study is an interview protocol that can be developed following the needs of researchers when collecting data.

Data were collected using in-depth interviews with experts and practitioners. Data collection techniques using the Delphi technique, which is then analyzed by following the pattern on the spiral model that has been modified and the data analysis results will be interpreted with the following stages [16]. (1) Expand findings data, (2) Linking findings data with personal findings and group development, (3) Ask for input from parties who are critical of the findings of this study, (4) Linking research data with literature, (5) Discuss the results of research with existing theories.

RESULTS AND DISCUSSION

The selection of research sites is also based on the opinion of Jack that two factors cause the low science process skills, namely the low science background and the lack of laboratory infrastructure in schools. Therefore, this school was chosen because of adequate laboratory facilities and time allocation of the material selected following the buffer solution material that the researchers made as objects of scaffolding products developed in the form of plot and student worksheets [5].

The researcher focused on the six syntaxes PjBL model from The George Lucas Educational Foundation to looked at problems encountered in the classroom and found the right assistance to help solve the problems encountered. This research was conducted four times, in this case, each meeting discussing each syntax. The first meeting focused more on discussing syntax 1 of the determination of the fundamental questions followed by the explanation of the buffer solution material and explaining the tasks for the next meeting. The second meeting focused on syntax two designing project planning and syntax 3 related to schedule setting. The third meeting focused on Syntax 4 on monitoring students and project progress. The fourth meeting is focused on the syntax of five results, this is testing, and the syntax of six evaluates the experience [17].

For syntax (1) determination of basic questions, there are three questions in student worksheet page 19. Question and answer assistance was chosen to be an effective aid as much as 60% because it was used the most. Because students do not understand and have not been able to link previously studied material with buffer solutions, this option is the most widely chosen. Students have just entered the buffer solution material, therefore, for the role of educators more in this activity to help students understand the buffer solution material as well as assisting students in recalling pre-written material to study buffer solutions.

Based on the results of the study, students are able to answer the questions asked. Because this question is an open type of question that students can find information from books, the internet, and other sources. This question is also to train to improve students' science process skills, namely to observe where students gather as much related information as possible. Then students interpret and relate the results of their observations and answer the questions provided. Furthermore, students are able to ask questions again or ask for further explanation for educators.

Fisher & Frey argues that students' responses give educators insight into what students know and don't know at the time. An educator who has content knowledge and an in-depth understanding of how novice students approach new concepts - quickly hypothesizes the learner's current condition and responds with encouragement, cues, or direct explanation and modeling when needed. The ability to expose learners' understanding or partial understanding requires anticipating misunderstandings and asking substantial questions [18].

The help of scaffolding by giving this question is called the verbal scaffolding technique. This technique focuses on the use of language used by educators in conveying information or giving questions aimed at making students easily understand every learning process that takes place. Pucangan et al., in his article, stated that the impact of verbal difficulties experienced by students, one of them caused by the low conceptual learners [19].

At the stage of asking questions back by the students, the next assistance educators are prompting as much as 20%. This is because the questions asked have definite answers that students can definitely answer them. Like how the ionization of the compound HNO_2 with $NaNO_2$? Or How to make buffer acid and base?.

While cueing and explaining aids are used by at least 10% each. Because help such as cues are often posted with prompts to ensure that students understand the material. Whereas on the other hand, the cues are sufficient to ensure the success of the students. In other words, cueing is just additional assistance for further scaffolding assistance. Educators will provide explanations without any feedback from students who do not understand the concept at all during the learning process. Below is the work of students.

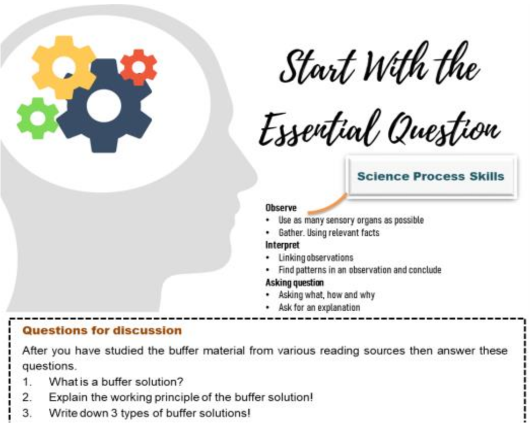


Figure 1. Syntax 1 start with the essential question

At the second meeting discussed syntax 2 and 3 on the project-based learning model. Previously students were asked to gather information related to the experiment of buffer solutions at home, which is in school educators, and students lived to discuss the findings. At stage (2), design the project planning, which starts from determining the objectives of the experiment. At this stage, students make the purpose of the investigation that will be conducted. Educators use practical scaffolding assistance that is 60% prompting because it is based on knowledge from literature studies conducted by previous students. And then, educators directly provide questions that are directly giving the right answers or students themselves who initiative to ask questions about the problems found. Support encouragement that students must go hand in hand with 20% cue assistance to direct students' attention to the title of the experiment to be carried out.

Other scaffolding assistance consists of questioning 10% and explaining 10%. The percentage of these two assistance is low because, at this stage, students are asked to be able to determine the tools/materials/ sources used, determine what will be observed, and determine the ways and steps of work. These three things are useful for enhancing the science process skills in which students work more actively, both individually and in groups, to plan experiments. It is for questioning and explaining aids for some seldom used aids, even for students who have difficulty understanding the assigned assignment.

The percentage of scaffolding assistance is obtained based on observations of educators and students. At this stage, Titu [1] explains that the activities carried out are: designing the entire project, the activities in this step are: preparing the project, in more detail including providing information on learning objectives, the teacher conveys a real phenomenon as a source of problems. This is following the science process skills aspects that must be achieved by students, namely planning an experiment consisting of, determining the tools, materials, and sources used in research, determining what will be observed, measured and written, and determine the ways and steps of work [20]

An essential element in the scaffolding circuit used during guided instruction. Suggestions can be cognitive or metacognitive examples, cognitive impulses, including those that activate and build background knowledge, and which support the use of processes or procedures. Background knowledge drives a focus on core concepts, which can be considered based on long-term representation, transferability, transmission, and quality. Procedural guidance focuses on applying a sequence or process that results in the successful completion of an academic task. These procedures may be strung forward or backward to give students scaffolding support because they gain more cognitive control over a complex set of tasks [18].

Educators could use several cues to focus students' attention, including visual, verbal, gestural, physical, and environmental cues. Often, cues are paired with a prompt to ensure that students have the scaffolding they need to succeed. At other times, cues are enough to ensure success [18].

Then the other problems found are when making a workflow in the form of drawings, sketches, or others. This stage has its own difficulties because they will combine their understanding of the concept of a buffer solution with the tools and materials provided by educators to plan their experiments and determine the appropriate work steps for determining a buffer solution with a certain pH. Creating a workflow can use algorithm flow as stated by that making flow can use symbol meanings that are commonly used in compiling standard operational procedures or in algorithm flow charts [16].

Scaffolding assistance that is used is prompting and cueing. These two aids are chosen because of the lack of experience of students in making workflows by combining the concepts they have received. Educators can use a number of cues to focus students' attention, including visual, verbal, gestural, physical, and environmental cues. Often, cues are paired with a prompt to ensure that students have the scaffolding they need to succeed. At other times, cues are sufficient to ensure success [18].

Figure 2. Syntax 2 design a plan for the project

In an attempt to create a workflow in this experiment, there are still students who do not understand that I assist students in creating a workflow mechanism to be used. To determine the amount of NaOH used or dilution of HCl and NaCl, educators provide instructions by giving formulas on the board and helping them during the process. The reason is that students do not have experience in preparing the molarity material and the dangers of the existing material. This finding is consistent with the opinion of Jack, which states that one of the factors that cause the low science process skills is the low science background. However, this assistance will be more readily understood by students after they do the practicum. The workflow is made after the student's experiment, not before the practicum [5].

The activity in the third stage is to compile a schedule based on the timeline and deadlines. Students make a plan of activities contained in the worksheets, which are divided into three, namely the project planning design schedule, the schedule for implementing practicum tasks, and the schedule for reporting the results of project assignments. At this stage, the expected aspect of science process skills is that students can plan research that consists of determining the timeline and deadline for project completion, planning the project, and making project completion and selection.

At the stage of arranging the schedule, [1] activities carried out by students namely organizing work, activities in this step are: planning the project, in more detail includes: organizing cooperation, choosing topics, choosing information related to the project make predictions and design investigations. In practice, students have difficulty in making activity plans that adjust the deadlines and timelines provided. Educators can provide cueing assistance in the form of filling instructions, for example, in designing project planning; there are activities to review concepts and make completion rules. Then students are asked to describe their opinions in the table that has been provided, likewise, for the implementation and reporting schedule. Therefore, a useful aid option lies in cueing as much as 40%.

As educators, we use verbal cues regularly. But we must be aware of the difference between cues and feedback. Although we can combine verbal cues and feedback, they serve different purposes for students. Cues focus the attention of students, while feedback provides information about their success.

Signs are important because they combine visual information with verbal information. Evidence shows that cues enter the visual system, our main way of getting information. In addition to gesture cues, students pay attention to environmental cues and physical cues, both of which help in getting attention [18]

In some cases, prompts are also used as much as 40% to help resolve problems that occur, and the cue to resolve errors or misunderstandings and direct explanations are not needed. When questions and cues do not match the desired results, scaffolding is linked to direct explanation, modeling, and motivation to students. Scaffolding provides insight into the next stage and support to persevere when the task is difficult. We use another scaffold aid with a percentage of 10% each questioning and explaining 10%.

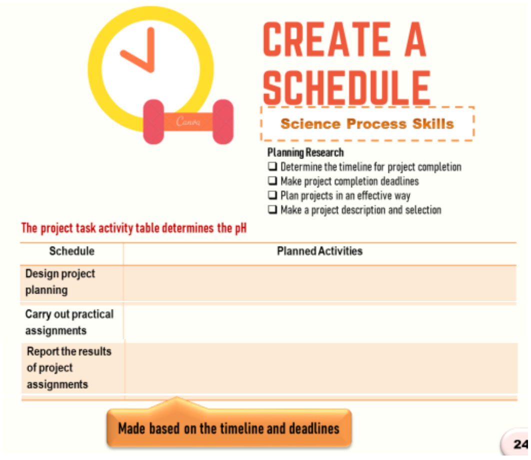


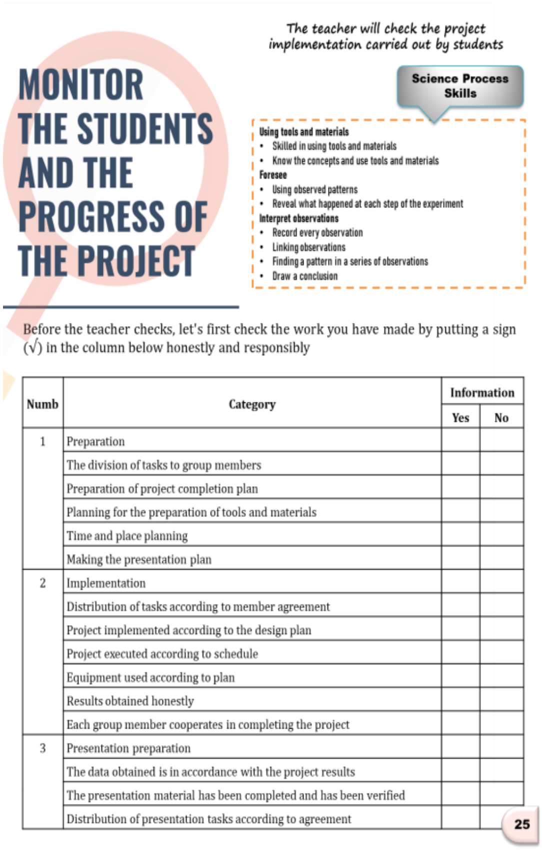
Figure 3. Syntax 3 create a schedule

The third meeting to carry out stage (4) monitors the progress of the project. The role of educators here as monitoring of the activities carried out. This stage has a variety of problems encountered because this section has three science process skills that students must apply to use tools and materials, predict and interpret observations. Therefore each group has different problems such as changes that occur in litmus paper for acids and bases and determine the pH, to solve the problem, educators assist in the form of prompt 50% and 30% cueing which is more dominant. This was chosen because students already understood the previous material only need to remind them again. At the same time, for the predicting section, the educator only gave questions related to the concept of buffer solution, which then students explored how much amount of acid, base, or equates solution to prove the concept.

Educators can use some cues to focus students' attention, including visual, verbal, gestural, physical, and environmental cues. Often, cues are paired with a prompt to ensure that students have the scaffolding they need to succeed. At other times, cues are enough to ensure success [18].

While questioning assistance is 10% and explaining 10%. This happens because children's knowledge is increased due to experience and group discussion. The questions usually come from the students themselves regarding stoichiometric solutions. For explain-ning assistance, it is used for students who have low comprehension abilities, so the educator helps students to continue to the same level of understanding as other students.

Another problem is connecting theory with practical results. Educators assist in the form of promoting by giving questions related to the concept of buffer solution. Prompt is an essential element in the scaffolding circuit that is used during guided instruction. Suggestions can be cognitive or metacognitive examples, cognitive impulses, including those that activate and build background know-ledge, and which support the use of processes or procedures. Background knowledge drives a focus on core concepts, which can be considered based on long-term represent-tation, transferability, transmission, and quality. Procedural guidance focuses on applying a sequence or process that results in the successful completion of an academic task. These procedures may be strung forward or backward to give students scaffolding support because they gain more cognitive control over a complex set of tasks [18].


The teacher will check the project implementation carried out by students

MONITOR THE STUDENTS AND THE PROGRESS OF THE PROJECT

Science Process Skills

Using tools and materials
- Skilled in using tools and materials
- Know the concepts and use tools and materials

Foresee
- Using observed patterns
- Reveal what happened at each step of the experiment

Interpret observations
- Record every observation
- Linking observations
- Finding a pattern in a series of observations
- Draw a conclusion

Before the teacher checks, let's first check the work you have made by putting a sign (√) in the column below honestly and responsibly

Numb	Category	Information	
		Yes	No
1	Preparation		
	The division of tasks to group members		
	Preparation of project completion plan		
	Planning for the preparation of tools and materials		
	Time and place planning		
	Making the presentation plan		
2	Implementation		
	Distribution of tasks according to member agreement		
	Project implemented according to the design plan		
	Project executed according to schedule		
	Equipment used according to plan		
	Results obtained honestly		
	Each group member cooperates in completing the project		
3	Presentation preparation		
	The data obtained is in accordance with the project results		
	The presentation material has been completed and has been verified		
	Distribution of presentation tasks according to agreement		

25

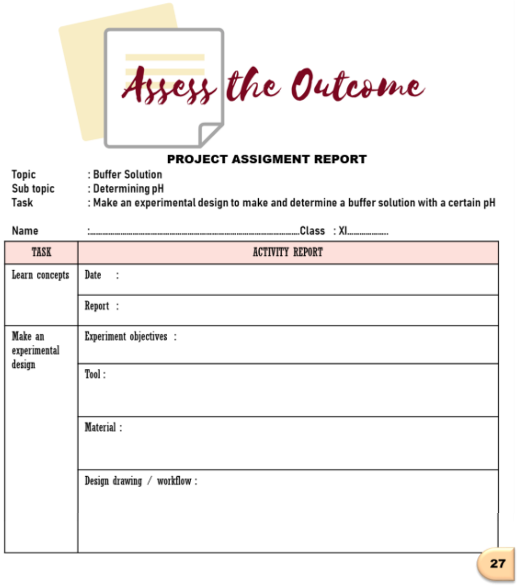
Figure 4. Syntax 4 monitor the student and the progress of the project

The fourth meeting discussed the 5th syntax and the 6th syntax in the project-based learning model. Stage (5) tests the results, and students are given three tasks, namely, to make a project assignment report, make a practice report determining the pH and research report. The science process skills that must be achieved at this stage are; learners can group, apply concepts, and communicate with groups of the three tasks that have various problems.

In making project reports, students find it difficult to produce design drawings following the research conducted. Therefore, the help that educators provide in the form of cueing is like helping to make patterns or sketches of images that students then develop. If there are other problems, the student will ask questions to the students, and the educator will give a question back whose answer is more directed. This is the stage of prompting assistance that aims for students to understand the problems experienced.

In making practice reports, students find it difficult to write the stages of activities and reports on observations. This is because they are making a practice report for the first time, it is natural that they have difficulty making it for that educators provide cueing assistance followed by prompting to provide assistance in the form of instructions to be done. They can explain by including pictures or directly to their treatment and making contact reciprocity in the form of a question whose answer is specific.

Another difficulty encountered to fill out a practice report on pH determination at the activity stage, and the results report lies in its writing format. The assistance is in the form of filling instructions, such as asking them to make a reaction equation, seeing the results of the pH change. Educators can use some cues to focus students' attention, including visual, verbal, gestural, physical, and environmental cues. Often, cues are paired with a prompt to ensure that students have the scaffolding they need to succeed [18].



Assess the Outcome

PROJECT ASSIGMENT REPORT

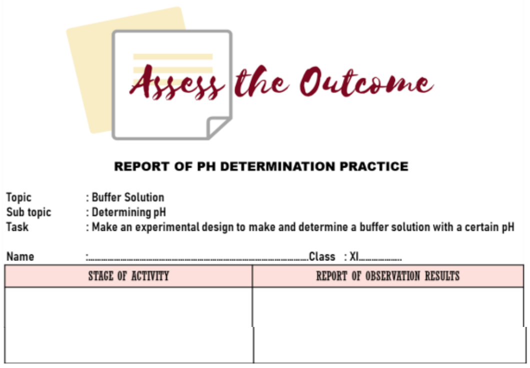
Topic : Buffer Solution
Sub topic : Determining pH
Task : Make an experimental design to make and determine a buffer solution with a certain pH

Name :........................Class : XI..........

TASK	ACTIVITY REPORT
Learn concepts	Date :
	Report :
Make an experimental design	Experiment objectives :
	Tool :
	Material :
	Design drawing / workflow :

27

Figure 5. Syntax 5 examines the results of the practical assignment report section



Assess the Outcome

REPORT OF PH DETERMINATION PRACTICE

Topic : Buffer Solution
Sub topic : Determining pH
Task : Make an experimental design to make and determine a buffer solution with a certain pH

Name :........................Class : XI..........

STAGE OF ACTIVITY	REPORT OF OBSERVATION RESULTS

Figure 6. Syntax 5 examines the results of the practice report section

Making research reports has difficulty because students are required to classify, classify, and relate them to paragraphs. In the process, educators provide prompting assistance in this case; the students first ask questions and then proceed to the students to explain which then students conclude the explanations given. In addition to promoting other assistance that has a high percentage of cueing, educators provide cues or clues that lead to the process of making practice reports. Such as look at the observation table, then conclude, and connect with the theory.

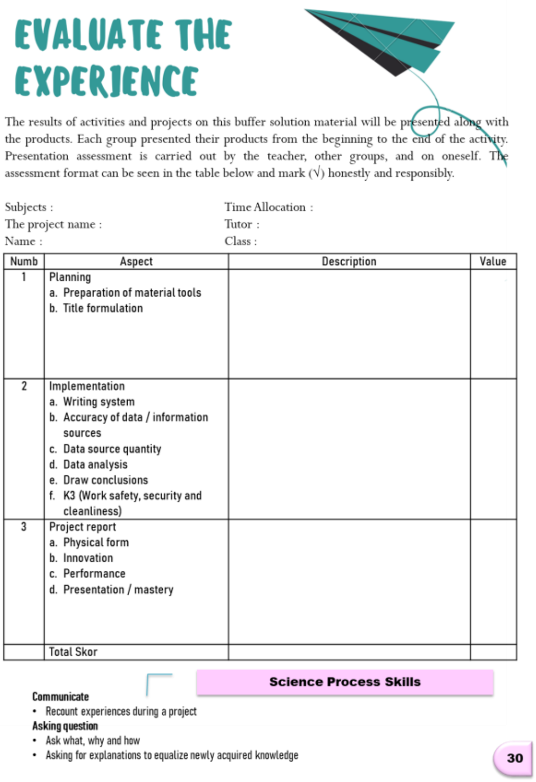
If there are still problems, educators can provide questioning assistance, namely questions such as "what is not understood?" Followed by feedback on students' answers such as, "why, how, why." This question helps students to make the right conclusions. If differences are found based on the concepts and literature found, it means that there was a mistake during the experiment.

Students' responses give educators insight into what students know and don't know at the time. An educator who has content knowledge and an in-depth understanding of how novice students approach new concepts -quickly hypothesizes the learner's current condition and responds with encouragement, cues, or direct explanation and modeling when needed. The ability to expose learners' understanding or partial understanding requires anticipating misunderstandings and asking strong questions [18].

Based on the information above, effective assistance at this stage is 50% prompting and 30% cueing assistance. In addition to these two aids, researchers also gave questioning assistance of 20% to initiate opening questions in connecting between the concepts used, because this assistance helps check understanding related experiments, students are usually able to explain with their language style. Therefore the use of questioning assistance is not too much. While explaining assistance is not used because at this stage, students already have an understanding related to the experiment and the material being taught because from stages 1 to 4, educators try to make students who have delays in understanding with other students treated more. So students have almost the same understanding related to the experiment and the material being taught.

Stage (6) evaluates experience, this stage provides information related to difficulties experienced by students and can see an increase in the science process skills possessed during the project and namely communication skills and asking questions. The most appropriate scaffolding aid at this stage is 70% questioning. Because by giving questions, educators can examine students' understanding of what is known and not known. Another advantage is that by giving questions, educators can find out and assess the extent to which students can find experience and skills and concepts that are appropriate in planning, implementing, and reporting projects that are contained in the description.

As for each scaffolding assistance for prompting 20% and cueing 10%, this is because prompting assistance is used to do further questions that if students are confused, then educators do cue assistance using cues. The assistance that is not used is explaining because it is reviewed from the discussion process, and the implementation of activities the ability of students to understand can be equalized [20].



EVALUATE THE EXPERIENCE

The results of activities and projects on this buffer solution material will be presented along with the products. Each group presented their products from the beginning to the end of the activity. Presentation assessment is carried out by the teacher, other groups, and on oneself. The assessment format can be seen in the table below and mark (√) honestly and responsibly.

Subjects : Time Allocation :
The project name : Tutor :
Name : Class :

Numb	Aspect	Description	Value
1	Planning a. Preparation of material tools b. Title formulation		
2	Implementation a. Writing system b. Accuracy of data / information sources c. Data source quantity d. Data analysis e. Draw conclusions f. K3 (Work safety, security and cleanliness)		
3	Project report a. Physical form b. Innovation c. Performance d. Presentation / mastery		
	Total Skor		

Science Process Skills

Communicate
- Recount experiences during a project

Asking question
- Ask what, why and how
- Asking for explanations to equalize newly acquired knowledge

30

Figure 7. Syntax 6 Evaluate the experience

The percentage of scaffolding assistance provided [1] that this stage includes project presentations and evaluations. At the project presentation, there will be actual communication of creations or findings from group investigations, while the evaluation stage will reflect reflections on project results, analysis, and evaluation.

Based on the overall PjBL syntax, we got the result that there is further assistance in every syntax performed from frequently used to rarely used. This happens because each syntax in the PjBL model has different difficulties, resulting in another scaffold aid, as shown in Figure 6. Based on these images, it can be seen that during the treatment, researchers used more questioning and prompting assistance. This is based on because children only need to be guided to solve the problems provided by providing appropriate and appropriate assistance to overcome these problems. That educators have the task of becoming facilitators to help students to improve their science process skills. Also, this learning system will have an impact on the learning atmosphere of students.

The application of scaffolding that occurs varies from the frequently used form of questioning to the rarely used in the form of explaining. Scaffolding is often used in the form of questioning and prompting while for the form of cueing and explaining used when the ability of the subject is outside the Zone Proximal Development (ZPD) [19]. This is obtained because of the level of education of students and age that have entered the formal operations stage; in this case, [21] that students at this stage can think in abstract and symbolic terms. Problems can be solved through the use of systematic experimentation. This stage is also referred to as the hypothetical-deductive operation stage, which is the highest stage of intellectual development [22].

Suppose illustrated in diagram form, the resulting diagram Figure 9. Percentages were obtained based on researchers' estimates and interpretations of the many and the least assistance from each of the scaffolding stages. However, researchers realize that this assessment is not standard. This is based because the results found are only valid for students who are currently in the XI class of SMKS Keluarga Bunda Jambi in Pharmacy. At the same time, the use of different subjects and materials will result in other assistance. And then, this assistance can be adjusted to the conditions being experienced by educators and students by changing the ideal assistance in the flow. At the same time, student worksheets cannot be changed because it is developed following the concept of learning design to develop teaching materials. This makes student worksheets can be used for all school units.

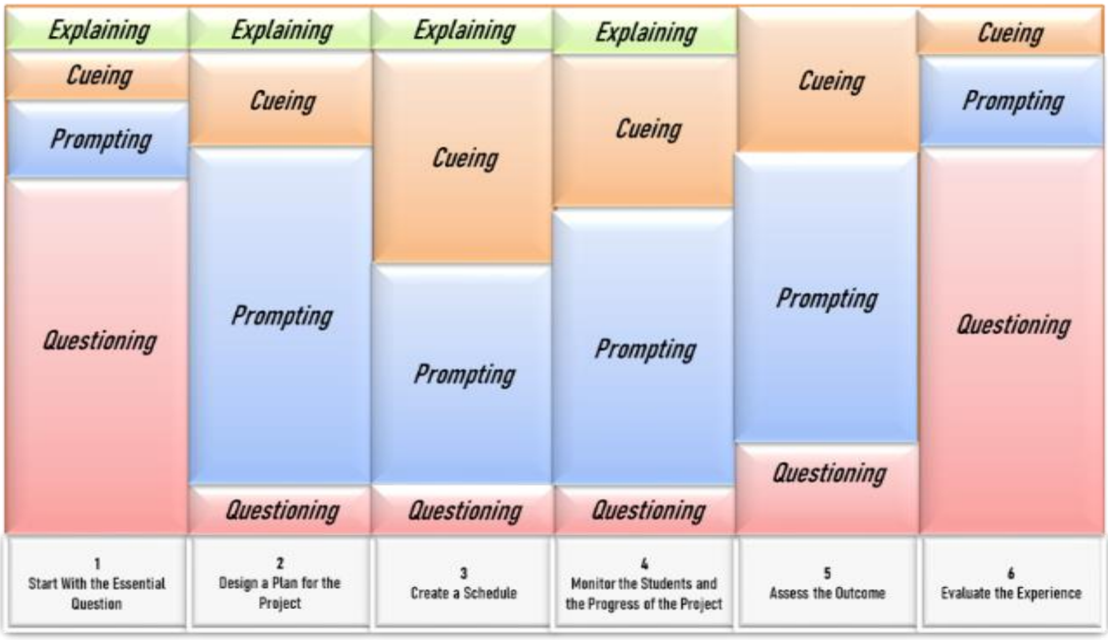


Figure 8. Schematic scaffolding in the PjBL model

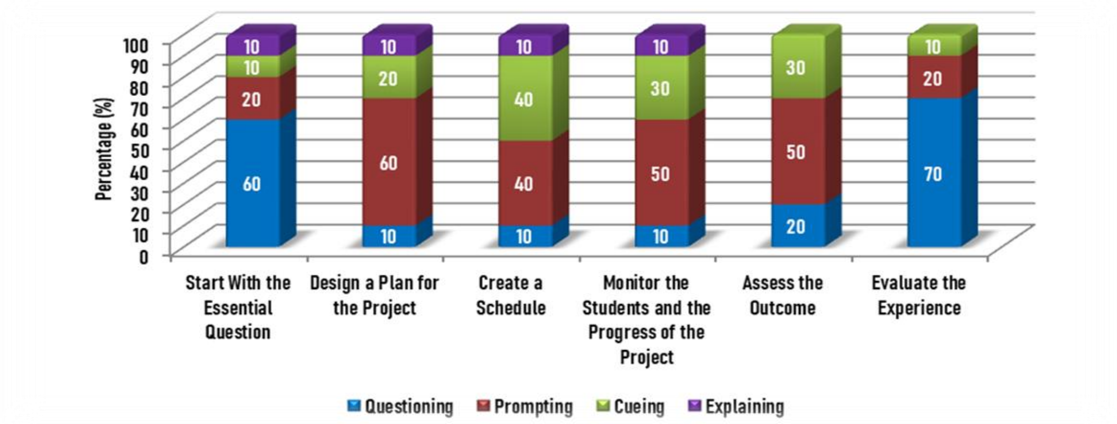


Figure 9. Percentage diagram of scaffolding assistance in each PjBL syntax

CONCLUSION

From the results of the study, it can be concluded that the implementation of the use of scaffolding provided to students can help overcome problems that occur during the learning process, as well as being able to improve students' understanding and skills of science processes for buffer solution material. In the application of the PjBL model, ideal scaffolding and more widely used are questioning and prompting. This is based on because children only need to be guided to solve the problems provided by providing appropriate and appropriate assistance to overcome these problems. However, scaffolding assistance given to students is not standard, because, for the use of different subjects, models and materials will produce different scaffolding.

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