

## Analysis of Students' Learning Problem Solving Skills through the Application of Polya's Steps

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**Abstract.** The purpose of this study was to describe the ability to solve learning problems in the Islamic education learning system planning course (PSPP) through Polya's steps (understand the problem, devise a plan, carry out the plan, and looking back), using a quantitative descriptive approach. The results showed that the use of Polya's steps was quite effective in solving learning problems in PSPP subjects. From the skill test, 4 categories of scores were obtained, namely students who obtained a score of 100 and a score scale of A amounted to 6 people with a percentage of 13.04%. While students who obtained a score of 95 with a value scale of A were 13 people with a percentage of 28.26%. Students who scored 90 with a grade scale B were 20 people with a percentage of 43.48%. While students who scored 75 with a grade scale C were 7 people with a percentage of 15.22%.

**Keywords:** problem solving skills, learning tools, polya's steps

### Introduction

The current 21st century education has goals that focus on developing the 6C abilities in students, in the form of critical thinking, collaboration, communication, computational thinking, creativity, and compassion, (Puspawati et al., 2021). The abilities that are the goals of education are closely related to the needs of the industrial revolution 4.0 era and the society 5.0 era which characterize the development of the times in the 21st century.

Of the various abilities that must exist in students, as well as being a tough challenge for educators to foster is to educate students to have the ability to think critically (Dekker, 2020). It is a tough challenge, because critical thinking is needed by students to conduct in-depth analysis on learning to understand the material, and of course as a competency that students will need in preparing for their future (Seibert, 2021).

Various ways can be done by educators to develop critical thinking skills in students, starting from providing stimulus so that they can analyze the information obtained, being critical of the information obtained so that it can be accurate and reliable, to compiling procedures and mapping problem solving (Rodzalan & Saat, 2015). Therefore, critical thinking is the cognitive activity of students in analyzing, solving problems, evaluating and concluding problem solving (Sari et al., 2021).

Measurably, these cognitive activities must be able to make learners later explain what the problem at hand is, analyze whether there are other related problems, find facts on the problem, provide a relevant and representative description of the problem in order to validly solve the problem (Amrullah et al., 2022). So it can be understood that critical thinking skills are the ability to solve problems in learning through scientific processes and strategic planning (Yulian, 2021). In learning, the ability to solve problems also requires activities that involve the

Article info:

<https://doi.org/10.52760/ijerd.v4i1.53>

Received 24<sup>th</sup> December 2023; Received in revised form 20<sup>th</sup> January 2024; Accepted 20<sup>th</sup> February 2024

Published by Corolla Education Centre Foundation on behalf of International Journal of Education Research and Development. This is an open access article under the CC BY-SA license

psychological processes of students in solving various problems that are derived from a problem (Dörner & Funke, 2017). Especially if the problems that arise are complex problems, or problems that are derived from real problems.

In solving more complex problems, educators must be more dominant as learning facilitators, so that students can broadly develop understanding, can relate the information obtained as a problem-solving concept, explore problems, and formulate various knowledge as a tool to solve problems (Seibert, 2021).

Moreover, in learning carried out in higher education and the object of education is students, it means that problem solving must be truly measurable and go through stages that can be assessed. Because the needs in higher education go further, related to maintaining excellence, being able to compete competitively, and the need for employment in the global era (Rawashdeh et al., 2021). Especially if it is related to the concept of learning in higher education with the concept of lifelong learning, which is able to make the meaning of education in a different context according to its future needs. Because of lifelong learning, learning is a continuous activity for life, not bound to formal education, but also to informal and non-formal (Cendon, 2018).

Higher education must be able to be directed towards meeting the complexity of the problem so as to realize skills on various lines, including the demands of the 21st century (Chalkiadaki, 2018), which can be linked to the learning process (Lai & Viering, 2012). The weight of the role that universities must bear towards students as the object of their education, makes problem-solving-based learning a top priority so that students acquire these problem-solving skills and can be used in the context of lifelong learning.

## Material and Method

The current 21st century education has goals that focus on developing the 6C abilities in students, in the form of critical thinking, collaboration, communication, computational thinking, creativity, and compassion, (Puspawati et al., 2021). The abilities that are the goals of education are closely related to the needs of the industrial revolution 4.0 era and the society 5.0 era which characterize the development of the times in the 21st century.

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Various ways can be done by educators to develop critical thinking skills in students, starting from providing stimulus so that they can analyze the information obtained, being critical of the information obtained so that it can be accurate and reliable, to compiling procedures and mapping problem solving (Rodzalan & Saat, 2015). Therefore, critical thinking is the cognitive activity of students in analyzing, solving problems, evaluating and concluding problem solving (Sari et al., 2021).

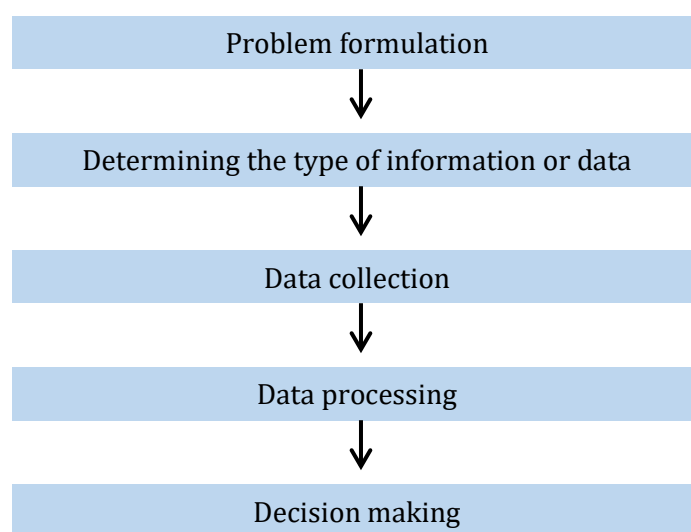
Measurably, these cognitive activities must be able to make learners later explain what the problem at hand is, analyze whether there are other related problems, find facts on the problem, provide a relevant and representative description of the problem in order to validly solve the problem (Amrullah et al., 2022). So it can be understood that critical thinking skills are the ability to solve problems in learning through scientific processes and strategic planning (Yulian, 2021). In learning, the ability to solve problems also requires activities that involve the psychological processes of students in solving various problems that are derived from a problem (Dörner & Funke, 2017). Especially if the problems that arise are complex problems, or problems that are derived from real problems.

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**Figure 1.**  
Research Stages

## Result and Discussion

### Result

Problem solving in learning is one of the thinking skills in solving problems contained in teaching and learning activities, accompanied by the skill of analyzing the problems that arise so that they can see whether the problem produces derivatives that are interrelated with one another, or also called dynamic thinking skills so that various complex problem-solving ideas are found (Riandi, 2016). In these thinking activities require cognitive activities that are able to distinguish whether the problem being faced is a general problem or a specific problem (Dörner & Funke, 2017). If the problem faced in learning is categorized as a special problem, of course, the solution cannot be in general form but requires deep thinking activities to the root.

In this research, the stages of problem solving in learning using Polya's stages are as follows:

**Table 1**  
**Polya's Step Problem Solving Stages**

No.	Process	Indicators
1.	<i>Understand the problem</i>	1. Ask a question 2. Develop an initial explanation of the problem 3. Linking one problem to another 4. Developing a model 5. Creating mind maps.
2.	<i>Devise a plan</i>	1. Predict the problem 2. Sketching and simplifying procedures

		3. Identify patterns and experiment
		4. Sequencing and testing possibilities
3.	<i>Carry out the plan</i>	1. Implementing what has been designed 2. Analyze the information provided 3. Implementing the strategy 4. Choosing another way or plan
4.	<i>Looking back</i>	1. Assess the information that has been identified 2. Check the steps that have been taken 3. Consider whether the solution is appropriate 4. Looking at alternative solution steps that are more effective 5. Ensure that the original problem question is answered.

To be able to measure students' problem solving skills in learning in the PSPP course, an assessment is carried out in the form of giving questions at the seventh meeting which discusses the material for preparing learning tools. The question sheet given to students is as in the table below:

**Table 2**  
Questions to assess Learning Problem Solving Skills

<b>MIDTERM EXAM QUESTIONS</b>		
Make learning tools according to the division of the education unit level and class that has been determined. Use assistive devices such as educational calendars, semester programs, annual programs and syllabi that have been compiled previously. Learning tools are only made for 1 KD (basic competency). Give your answers as stages in the table below!		
No.	Stages	Indicators
1.	<i>Understand the problem</i>	1. Understand the intent of the question 2. Organize the concepts needed in developing the learning toolkit 3. Write down the relationship between the education calendar, annual program and semester program and syllabus in the preparation of learning tools. 4. Create a mind map or draft of the toolkit.
2.	<i>Devise a plan</i>	1. Write down the predicted difficulties in creating the device 2. Review the mind map to simplify the procedure 3. Identify whether the supporting tools are correct
3.	<i>Carry out the plan</i>	1. Arrange the device according to the stages that have been developed 2. Use the strategy that has been designed 3. Write down any changes to the plan and strategy
4.	<i>Looking back</i>	1. Ensure that all steps have been performed 2. Check the completeness of the device 3. Consider whether the solution used is appropriate 4. Ensure that the question has been answered. 5. If it has been answered then make a statement that the answer has been checked correctly 5.

Furthermore, the students' ability to solve learning problems is measured from the students' answers to the questions that have been given. The measurement is done by giving a value or score according to an objective assessment. The following are the scoring guidelines used in this study:

**Table 3**  
Learning Problem Solving Skills Assessment Guidelines

No.	Tahapan	Indikator Penilaian	Skor
1.	<i>Understand the problem</i>	1. Students do not write down the known things	0
		2. Students write down the known things, but many are missing	15
		3. Students write the known things there is one that is incomplete	20
		4. Students write the known things completely and correctly	25
2.	<i>Devise a plan</i>	1. Students do not write predictions, simplification of procedures and mind mapping	0
		2. Students write predictions correctly, but simplification of procedures and mind mapping is less complete	15
		3. Students write predictions correctly, simplify procedures correctly but mind mapping is incomplete	20
		4. Students write predictions, simplification of procedures and mind mapping completely and correctly	25
3.	<i>Carry out the plan</i>	1. Students do not make devices according to stages and strategies	0
		2. Students make the device according to the stages but the strategy is less precise	15
		3. Students make devices according to stages and strategies and incomplete	20
		4. Students make devices according to stages and strategies completely and correctly	25
4.	<i>Looking back</i>	1. Students do not write an answer check statement	0
		2. Students write complete and correct answer check statements	25
<b>Maximum Score</b>			<b>100</b>

The results of the score on each step will be summed up so that the total score is obtained and the rating scale obtained by students can later be seen from the following score scale table:

**Table 3**  
Learning Problem Solving Skills Rating Scale

Score Value	Rating Scale
100 – 95	A
94 – 85	B
84 – 75	C
74 – 65	D
64 – 0	E

From the results of student answers, data on the assessment results of the preparation of learning devices from 46 students in classes IV C and IV D of the PAI study program for the 2021-2022 academic year are presented in the table below:

**Table 4**  
Assessment Data of Learning Problem Solving Skills

Student Name Code	Score Result				Score	Scale
	1	2	3	4		
S-1	25	20	20	25	90	B
S-2	25	20	20	25	90	B
S-3	25	25	25	25	100	A

S-4	25	25	20	25	95	A
S-5	20	15	15	25	75	C
S-6	25	25	25	25	100	A
S-7	25	20	20	25	90	B
S-8	25	20	20	25	90	B
S-9	25	25	20	25	95	A
S-10	25	20	20	25	90	B
S-11	25	25	25	25	100	A
S-12	25	20	20	25	90	B
S-13	25	25	20	25	95	A
S-14	25	20	20	25	90	B
S-15	20	15	15	25	75	C
S-16	20	15	15	25	75	C
S-17	25	20	20	25	90	B
S-18	20	15	15	25	75	C
S-19	25	25	20	25	95	A
S-20	25	20	20	25	90	B
S-21	25	20	20	25	90	B
S-22	25	20	20	25	90	B
S-23	25	20	20	25	90	B
S-24	25	20	20	25	90	B
S-25	20	15	15	25	75	C
S-26	25	25	20	25	95	A
S-27	25	25	20	25	95	A
S-28	25	25	20	25	95	A
S-29	20	15	15	25	75	C
S-30	25	25	25	25	100	A
S-31	25	25	25	25	100	A
S-32	25	25	20	25	95	A
S-33	20	15	15	25	75	C
S-34	25	25	20	25	95	A
S-35	25	25	20	25	95	A
S-36	25	25	20	25	95	A
S-37	25	25	20	25	95	A
S-38	25	20	20	25	90	B
S-39	25	20	20	25	90	B
S-40	25	25	25	25	100	A
S-41	25	20	20	25	90	B
S-42	25	20	20	25	90	B
S-43	25	20	20	25	90	B
S-44	25	20	20	25	90	B
S-45	25	20	20	25	90	B
S-46	25	25	20	25	95	A

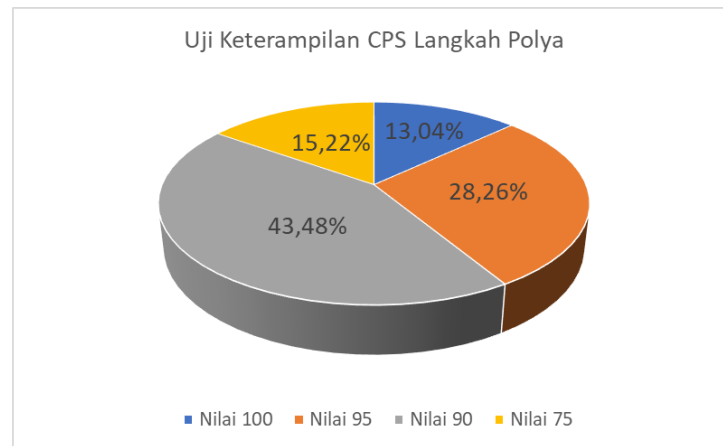
Furthermore, the grouping of the results of the student problem solving skills test in the PSPP course based on the achievement of using Polya's steps is presented in the following table:

**Table 5**  
Number of Students by Score and Scale

Score Value	Rating Scale	Total number of students
100	A	6

95	A	13
90	B	20
75	C	7

The following is a diagram of the overall percentage of the results of the problem solving skills test in learning in the PSPP course:



**Figure 2.**  
Percentage Diagram of Polya Step Achievement Test Results

## Discussion

Theoretically, in solving a specific problem in learning, a thinking process is needed that can implement the knowledge (knowledge) and experience (empirical) that has been obtained so that it can be used as a tool to solve problems (Rizky Ananda Setiyawan & Palupi Sri Wijayanti, 2020). In other words, to be able to solve complex problems requires higher-level thinking activities (Alchihabi et al., 2021), both personally and problem solving involving groups (Hagemann & Kluge, 2017) so that solutions or answers are obtained that can answer problems in learning.

Problem solving skills in education are an important goal in learning activities when viewed from the curriculum aspect (Cahyani & Setyawati, 2016), but from this learning, students will get used to being able to solve various problems they face in everyday life (Purnamasari & Setiawan, 2019). From the point of view of learning strategies, problem solving in learning is indicated by the existence of reasoning activities, so that students are encouraged to think critically and discuss it in class (Khalid et al., 2020). This means that problem solving in learning aims not only to have the ability to think critically and find answers in class, but also so that later it can be used in analyzing and critiquing life problems so as to get a way out and solve them in everyday life.

Problem solving, also requires psychological processes that support a person's cognitive activities, because it requires calmness, diligence and patience so that problem solving really finds the right solution (Dörner & Funke, 2017). This means that in teaching and learning activities, it requires the role of educators who function as facilitators who direct students to understand what problems are being faced, show conceptualizing from the information obtained, stimulate, and show procedural stages in problem solving (Seibert, 2021).

For learning carried out in higher education, problem solving ability leads to higher thinking, because higher education produces educational outputs that will later pursue careers in various places, including students who will later work as educators in an educational institution. As prospective teachers, of course, students must be equipped with various competencies in order to be able to plunge as educators. Some of these competencies are teaching skills, using learning methods, using learning media, professional attitudes, and having a good personality.

In relation to teaching ability (pedagogy), one of the skills that prospective teachers must have is to make a learning device plan. Lesson planning is considered a signpost that serves as a guide for educators before implementing the learning process (Ndihokubwayo et al., 2020). Because making lesson plans that describe annual learning programs and semester learning programs is not an easy matter (Fujii, 2016). Educators are required to map the fulfillment of competencies in one year and one semester as a whole, adjust learning to the national academic calendar and school academic calendar, which is then outlined in the elaboration of learning strategies (Nurtanto et al., 2021).

The quality of education is not just based on curriculum changes alone, but also on the readiness and understanding of educators in practicing the wishes of the curriculum (Tuncel, Ayvanaz, Z, 2019), so the first thing to do is to change the mindset of educators (Walker, C., 2019), especially in administrative planning, which is indicated by the ability of educators to plan learning programs and pour them into learning tools (Gunawan, 2017). Therefore, in the Islamic religious education learning system planning course (PSPP), it is necessary to design a lesson that is able to improve learning problem solving skills for students, especially in the preparation of learning tools.

To be able to measure whether students have been able to solve problems in the preparation of learning tools, it is necessary to use various approaches to steps in solving problems in learning. The benchmark of problem solving in learning if it meets the following conditions: (a) how many problems can be solved; (b) there is a reciprocal relationship between the problems solved; (c) being able to formulate the dynamics of the situation, if there will be changes in problem solving; (d) transparency of problem solving; and (e) conflict analysis (Dörner & Funke, 2017).

In order for these requirements to be met, it is necessary to apply the steps of problem solving in learning. There is an application of steps called IDEAL (Identify, Examine, Act, and Look) (Abazof, 2022). However, in this study, researchers used a step approach compiled by Polya (1973: 5) in the form of problem solving steps consisting of: understand the problem, devise a plan, carry out the plan, and look back.

In detail, the stages of problem solving in learning explained by Polya (1973: 5) are:

1. Understand the problem, the stage of asking questions about what is known and sought, then asked to explain the problem using their own language, followed by developing a model and compiling a mind map.
2. Devise a plan, the stage of identifying and making problem-solving strategies, in the form of predictions, determining solution techniques, compiling sketches, compiling procedures, identifying patterns, experimenting, and testing solutions.
3. Carry out the plan, the stage of implementing steps, analyzing strategies, and preparing other problem-solving solutions if what has been prepared is deemed unable to solve the problem.
4. Looking back, the stage of rechecking the steps that have been taken in the form of assessing the identification of information, checking the procedural stages, describing whether the solution is appropriate, whether alternative problem solving is used, to ensure the problem has been resolved.

From the data collection of problem solving skills in learning, the highest score achieved by students is 100, while the lowest score achieved is 75. Students who get a score of 100 carry out the Polya stages properly and correctly and are able to answer the questions completely. While students who scored 95 carried out stages 1, 2 and 4 completely and correctly but in step 3 the question was answered correctly but incompletely. Meanwhile, students who scored 90 performed step 4 correctly and completely, but in steps 1, 2 and 3 the answers were correct but incomplete. Meanwhile, students who scored 75 on the problem solving ability test carried out stage 4 correctly and completely, at step 1 it was correct but incomplete, but at steps 2 and 3 some stages were incomplete.

If the results from table 5 are percented to get an overview of the score, score scale and the number of students, the following percentage values are obtained: students who obtained a



score of 100 and an A grade scale amounted to 6 people with a percentage of 13.04% of the total population. While students who obtained a score of 95 with a value scale of A were 13 people with a percentage of 28.26% of the total population. Students who scored 90 with a grade scale of B were 20 people with a percentage of 43.48%. While students who obtained a score of 75 with a value scale of C were 7 people with a percentage of 15.22%.

In order to obtain answers that represent each score, random interviews were conducted with students who each achieved a score. For class IV C, 1 student who obtained a score of 100 was randomly taken and another student who obtained a score of 95 was taken. While in class IV D, 1 student who got a score of 90 was randomly taken and 1 student who got a score of 75 was also randomly taken. The interview asked each student who represented the value group, namely their response to the results obtained, and how their process in carrying out each Polya stage in order to obtain an overview of the ability of students in solving the problem of preparing devices in the PSPP course.

Students who received 100 points answered the interview question that before answering, they first ascertained the question indicators, then thought deeply, compiled concept maps, strategies and steps and then answered the question. While students who got 95 marks, answering interview questions had difficulty carrying out the stages according to the strategies prepared, because the plans prepared were too broad and lacked simplification. Then students who scored 90, answering interview questions, were incomplete in compiling strategies and mind maps so that at stage 3 they finally had difficulty in compiling the device properly and correctly. Meanwhile, students who received a score of 75 answered interview questions with a statement that it was difficult since the first stage, lack of knowledge and finally had difficulty compiling learning tools.

## Conclusion

The results showed that problem solving skills in learning in the PAI Learning System Planning course using Polya's steps tested on 46 students, obtained 4 categories of scores, namely 100, 95, 90 and 75, with a value scale of A to C. From the results of the data, it was found that students who obtained a score of 100 and a value scale of A amounted to 6 people with a percentage of 13.04%. While students who obtained a score of 95 with a value scale of A were 13 people with a percentage of 28.26% of the total population. Students who scored 90 with a grade scale B were 20 people with a percentage of 43.48%. While students who scored 75 with a value scale of C were 7 people with a percentage of 15.22%. of the total population. Students who get a score of 100 do the Polya stage perfectly, before answering, they first ascertain the question indicator, then think deeply, develop concept maps, strategies and steps and then answer the question. While students who get a score of 95, find it difficult to carry out the stages according to the strategies prepared, because the plan prepared is too broad and lacks simplification. Then students who scored 90 were incomplete in compiling strategies and mind maps so that there were stages that were ultimately difficult to compile the device properly and correctly. Meanwhile, students who get a score of 75 have difficulties since the first stage, due to lack of knowledge and finally have difficulty compiling learning tools.

## Acknowledgment

All contributors compiled this journal article based on research with the title Analysis of Students' Learning Problem Solving Skills through the Application of Polya's Steps. This work was independently funded in 2022. The opinions expressed here are those of the author and do not necessarily reflect the views of any other person or institution."

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