Student's Learning Independence Profiles in Solving HOTS Questions Related to Numeracy

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Learning independence is one factor in learning outcomes. The ability to solve HOTS questions related to numeracy is also a learning outcome. This paper examines the profile of student learning independence in solving HOTS questions related to numeracy. Researchers conducted qualitative research. Researchers took data from student work, observations, and interviews. This study describes three learning independence profiles of students in solving HOTS questions related to numeracy. Low independence learning students tend not to use Polya's theory in working on the given questions; meanwhile, moderate and high learning independence students tend to use Polya's idea in solving the given problem.

Keywords: independent learning, HOTS, numeracy

INTRODUCTION

Independent learning is not formed in a short time. This independent learning is developed through a very long process. Students who have high learning independence are usually successful in their academic fields. University students are around 18 years old and above. At this age, they should be mature enough to determine what is good and what is not. They are mature enough to be independent in life, including learning. In preparation for students to work in modern environments, higher education should enable students to learn independently*(Shah et al., 2020)*. Many universities worldwide teach online during the COVID-19 pandemic((Tomislava Vidić, Irena Klasnić, 2022; Yaseen et al., 2021). Universitas Negeri Semarang using online learning approach too. Learning independence is very important for students in online learning(Palaniappan et al., 2022). Learning independence is essential for students to learn(Tanti et al., 2020). Graduates must have activity planning, goal setting, and decision-making skills, but these cannot be mastered without the development of self-organization and independent learning *(Red et al., 2015)*. Students, including PSTE UNNES students, need learning independence.

The Primary School Teacher Education (PSTE) Study Program, Universitas Negeri Semarang (UNNES), is a study program that prepares prospective elementary school teachers to become qualified teachers. The ability of high-order thinking skills associated with numeracy is useful for PSTE UNNES students personally and academically. They use it to implement their daily life. It also plays a vital role in preparing themselves later when they become elementary school teachers who will become government collaborators in teaching numeracy in schools.

High-order thinking skills (HOTS) are always the subject of discussion by educational researchers. Many studies have highlighted this. The 2013 Indonesian curriculum directs learning to develop students' HOTS (Hidayah et al., 2021). Higher-order thinking is the top end of Bloom's cognitive taxonomy (Sole & Anggraeni, 2020). Questions that command to analyze, evaluate, or create creativity in problem-solving steps are categorized as higher-order thinking problems (Meryansumayeka et al., 2019). Students' potential will increase if they are often faced with practicing HOTS questions(Setiawan et al., 2021). If students are familiarized with high-order thinking skill questions, their potential will also develop(Wardono & Mariani, 2020). However, the reality is that the development of mathematical HOTS is currently not optimal (Payadnya & Atmaja, 2020). Indonesian students are weak in HOTS, as indicated by the results of the 2018 National Examination (Setiawati et al., 2018).

Numeration is seen as the ability to handle daily life quantitative aspects appropriately, while the ability to read and write, which aims to overcome life demands, is called literacy (Westwood, 2008). PIAAC Cycle 1 defines numeracy as the ability to access, use, interpret, and communicate mathematical information and ideas to engage in and manage the mathematical demands of various situations in adult life (OECD, 2012). In PIAAC Cycle 2, numeracy is accessing, using, and critically reasoning with mathematical content, information, and ideas represented in various ways to engage in and manage the mathematical demands of various situations in adult life(OECD, 2021). Numeracy is implemented in everyday life. Numeracy is a part of mathematics. Mathematical problems are good if they activate human cognition in exploring various mathematical ideas, strengthening reasoning regarding the relationship between various mathematical concepts, and exercising creativity in finding appropriate problem-solving strategies (Tyas & Pangesti, 2018). Such a problem can be found in the matter of HOTS. However, sometimes the problem of HOTS is not in line with real-life makes sense; for example, rounding 0.5 down should be rounded to the number below, but in everyday life, for example, we need 2.2 m of cloth to make clothes, if we round it, it should be 2 m of fabric, but if we buy only 2 meters of cloth then our clothes cannot be perfect. High-order thinking skills also need to be linked with numeracy so that their usefulness is wider. The purpose of mathematics education is not only related to the academic field but also to prepare students to face social life in society(Agoestanto et al., 2020).

Knowledge, procedures, ideas, arguments, and decisions result from thinking activities (Abdullah, 2016). Researchers see the students thinking process from the problem-solving steps that they do. There are several theories about how to solve the problem, among which the famous one is John Dewey (1933), Stephen Krulik and Jesse Rudnick (1980), IDEAL by Bransford, Sherwood, & Tom Sturdevant (1984), George Polya (1988), Wankat and Oreovics (1992), Carlson and Bloom (2005), and Yimer and Ellerton (2010). John Dewey (Carson, 2007), Krulik & Rudnick (Carson, 2007), Bransford, Sherwood, & Tom Sturdevant (Bransford & Stein, 1993) mention five stages of problem-solving. The three problem-solving stages are almost the same as each other. Then what is famous in mathematics is the problem-solving stage of Polya, namely understanding problems, making plans, implementing plans, and retesting (Carson, 2007). Wankat and Oreovics (1992) complete the problem-solving stage in Engineering into seven steps (Wankat & Oreovicz, 1993). In 2005, Carlson and Bloom suggested that the problem-solving steps be made into four, almost identical to Polya's math problem-solving steps. In 2010, Yimer and Ellerton told the stages of solving mathematical problems into five phases (Yimer & Ellerton, 2010). The theories' complete math problem-solving steps are the Wankat & Oreovics'. However, this theory is used in the field of Engineering. We have to check whether this idea aligns with the field of mathematics in everyday life. This study aims to see how the learning independence profiles of PSTE UNNES students in solving HOTS questions related to numeracy.

METHODS

Research Design

The researchers implemented a qualitative research method. The researcher conducted an in-depth study of high-order thinking skills, numeracy, and how to solve mathematical problems to design steps for solving high-order thinking skills problems related to numeracy for PSTE UNNES students. In this qualitative study, subjects were selected according to purposive sampling. The recommendations found in the deepening of the theory are then proven through the chosen subjects.

Participant

This research was conducted in one class containing 25 students of PSTE UNNES who took the subject of deepening mathematics material. The student also joined groups with regular online discussions outside of class via WhatsApp. Subjects were selected based on the level of learning independence that had been known beforehand through the questionnaire results. Subject considerations also look at the results of work and activity in the discussion group. The result of the previous questionnaire on learning independence was given to 25 students. One student identified with low learning independence, 21 students were recognized with moderate learning independence, and the rest were identified as students with high learning independence. One subject with low learning (LLI) independence, Three subjects were chosen with moderate learning independence (MLI), and three subjects with high learning independence (HLI).

Data Collection Technique

Researchers conducted interviews and observations when students worked on HOTS questions related to numeracy. In pandemic Covid-19, interviews and observations were carried out through the Zoom and Google meet applications. This data is also equipped with data documentation of student answers and student learning independence questionnaire results. Documents of student work are also collected.

Data Analysis

Data analysis in this study is qualitative. The data validity testing used triangulation, namely a combination of interviews, observation, and documentation. By reducing the selection of supporting data, data that comes out of the problem is annulled. The repetition process is stopped until it finds a saturation point. First, the researcher conducted a material deepening to find recommendations for high-order thinking skill problem-solving steps related to numeracy. Second, the researcher conducted interviews and observations to find out students' thinking process in solving the given problem based on learning independence. Student's answers as part of the document data.

RESULT AND DISCUSSION

In 1933, John Dewey defined the problem-solving step as facing a problem, diagnosing a problem, finding several solutions, implementing a solution, and testing again (Carson, 2007). Stephen Krulik and Jesse Rudnick, 1980, defined the problem-solving steps as reading, exploring, choosing strategies, solving, and reviewing (Carson, 2007). In 1988, Polya represented four problem-solving steps: understanding the problem, making plans, executing plans, and testing again (Carson, 2007). The three theories are not too different. Apart from these three theories, in 1984, there was also the IDEAL theory (Bransford & Stein, 1993). This theory states that problem-solving steps are problem identification, defining goals, exploring possible strategies, anticipating results and acting, and seeing and learning (Bransford & Stein, 1993). If we look at this theory, the contents of the IDEAL idea are not much different from the previous three theories. Similarly, Carlson and Bloom's view in 2005, whose opinion is almost identical to Polya's approach, namely orienting, planning, executing, and checking. What is different is the Wankat theory

(Wankat & Oreovicz, 1993) and Yimer and Ellerton(Yimer & Ellerton, 2010). Wankat's solving steps are the motivation step, the defining step, the exploring step, the planning step, doing it, checking the result, and generalizing (Wankat & Oreovicz, 1993). Yimer's problem-solving steps are engagement, transformation-formulation, implementation, evaluation, internalisation (Yimer & Ellerton, 2010). Yimer's theory states that there is an evaluation step that tests the real-life makes sense answer to the problem before a retest step that tests the whole calculation. In comparison, Wankat's theory is the most complete, perhaps because it is applied to the field of Engineering.

The problem-solving steps from various theories steps are almost the same, the most different only in (1) according to Wankat & Oreovics, step 0 is a motivational step, (2) steps to understand the problem in Polya are only one temporary step in other theory, it passes two steps, (3) according to Wankat & Oreovics, step six is a generalization. Polya is well-known for math-based problem solving, while Wankat & Oreovics is in engineering. What motivational steps are needed in problem-solving steps? According to Woods (Woods et al., 1997), solving problems is mental work, so this motivational step is necessary for 0 steps. Why 0 steps? This step is not an operational step but a pre-step that focuses on motivation. So we called it 0 steps. Then what do students take the steps with the three levels of learning independence in solving HOTS questions related to numeracy? The following table 1 shows the results of observations made by researchers for the three levels of learning independence.

TABLE 1
STUDENT OBSERVATION RESULTS IN SOLVING HOTS QUESTIONS RELATED TO NUMERACY

Low Learning Independence	Moderate Learning Independence	High Learning Independence
The student has no motivation in mathematics	All of them have motivation in mathematics	1 has motivation in mathematics, and two have not
The student read the problem twice or more	All of the students read the problem more than twice	All of the students read the problem twice minimally
The student has difficulty defining the problem	all students write down the definition of the problem even though it is not perfect	all students write down the definition of the problem even though it is not perfect
The student is used to only having one plan	All students are used to having only one solution plan	All students are used to having only one solution plan
Unable to solve the problem	all students carry out incomplete completion plans, process skill errors	all students carry out incomplete completion plans, process skill errors
students do not check their suitability in the real life	All students do not confirm their suitability in the real life	All students do not verify their suitability in the real life
Students immediately collect the answers	All students re-check their work steps	All students re-check their work steps

From these observations, PSTE students with low learning independence tend to have not applied Polya's theory. Meanwhile, those with moderate and high learning independence tend to use Polya's view. The difference between the two categories is how to check the processing steps. Students with low learning independence immediately collect answers, while students with moderate and high independence always check the process steps. Students with independent learning are no longer reading the questions when checking the answer steps. Students with high independence always read the questions as the first step in checking the answers. The following is an excerpt of an interview with YR, who was identified with low learning independence.

Researcher: When you first read the question, what did you think about it?

Subject YR: Confused because the question is long. I was confused about analyzing one by one, what is being asked, what is known?

Researcher: How often do you need to read to understand the question?

Subject YR: over and over but don't know the point

Researcher: Do you always write down what you know?

Subject YR: Always written for ease of completion.

From the interview, YR reads repeatedly but still has difficulty understanding the essence of the question. Her ability to define problems determines the next step in solving the problem. Learning irregularities and misconceptions are interrelated and affect the failure of students' final solutions (Ansari et al., 2021).

Researcher: Are you sure about the answer?

Subject YR: No

Researcher: Why?

Subject YR: Because from the beginning the work was wrong, ma'am

Researcher: Do you often check your answers?

Subject YR: if you have time, ma'am, but often not because doing math takes a long time, you are afraid that your time will run out, ma'am.

From this, it can be seen that YR does not have self-confidence in doing mathematics. From the beginning before working, he always doubted whether he could solve the problems given. And this was revealed several times in the interview process. YR is not used to checking the answer or the steps to rework it. This is because he is afraid of running out of time and not having time to do anything else. From these observations and interviews, the types of errors made in the results of their work can be viewed in table 2.

TABLE 2
TYPES OF ERRORS MADE BY STUDENTS IN WORKING ON HOTS QUESTIONS RELATED TO NUMERACY

LLI student	MLI students	HLI students
Read less carefully so that there is information missing	Read less carefully so that there is information missing	Read less carefully so that there is information missing
Transformation error	Error calculation process skills	Error calculation process skills
Errors in inference due to not checking conformity to the real world and also not checking completion steps	Errors in inference due to not checking conformity to the real world	Errors in inference due to not checking conformity to the real world

YR usually submit their answer sheet. YR no longer looks at the problem because she believes that the problem defined by her was correct. Meanwhile, F, A, D, YW, NU, and EY are accustomed to examining the steps of their calculations but have not yet examined the real-life makes sense of the answers. F, D, A, always look at the problem identification to cross-check what they did without rereading the problems. YW, NU, and EY always read the problem again and checked the process of what they did. Learning independence plays an essential role in the lives of individuals to achieve high results on the tasks they perform, as well as in acquiring knowledge, social skills, and decision-making abilities(Hashem, 2021). Learning independence positively affects student achievement in academics (Kayacan & Ektem, 2019). Learning independence is essential to academic success (Raković et al., 2022). The learning independence of students level affects their learning performance(Hong et al., 2021), Students with high learning independence can assess what is needed and the obstacles faced in carrying out learning tasks, set goals, and create plans on how to achieve them, carry out learning strategies that can help them achieve goals, and evaluate the effectiveness of those strategies (Raković et al., 2022). High learning independence students tend to use appropriate study skills such as exercises immediately compared to others(Chen & Li, 2021). Table 3 shows their steps in working on the HOTS questions related to numeracy.

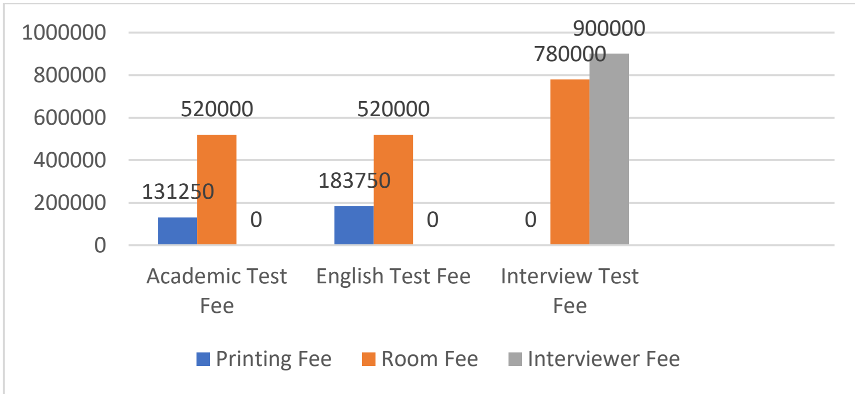
TABLE 3
STUDENT STEPS IN DOING HOTS QUESTIONS RELATED TO NUMERACY

Low learning independence student	Medium learning independence students	High learning independence students
Read	Read	Read
Problem Identification	Problem Identification	Problem Identification
Applying	Applying	Applying
	Re-checking (from problem identification)	Re-checking (From reading)

However, all research subject students have not checked the suitability of the answers with real life. It is necessary to emphasize this so that it is not only checking steps but also conformity with real life. So re-checking needs to be modified to make sense in real life and re-checking.

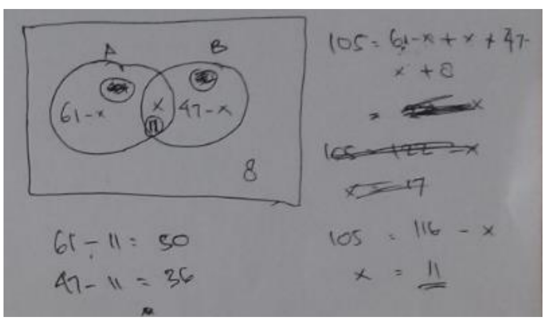
The following is a given C5 question: A company in the food sector opens job vacancies in marketing. The requirements given are bachelor’s graduate in all fields of study, fluent in communicating in English, and having a motor or car driving license. There were 105 applications received. To be accepted as marketing, applicants must previously pass an academic test and an English test to become a candidate for an interview test. The academic test takes 45 minutes, breaks take 15 minutes, and the English test takes 60 minutes. It takes IDR 1,250.00/person for the cost of printing questions and answering academic tests and IDR 1,750.00/person for the cost of printing questions and answering English tests, as well as room rental fees of IDR 130,000 / hour for each room with a capacity of 30 people. Sixty-one applicants passed the academic test, 47 passed the English test, and eight withdrew. The committee predicts that more than a third of all applicants become candidates on the interview test. The company appointed three interviewers to interview the candidates and rented a place to interview for IDR 130,000/hour for each interviewer’s room. Each candidate is interviewed by one interviewer with a maximum interview time of 10 minutes per candidate. Interviewer fees are IDR 150,000/hour for each interviewer. The committee makes a cost report, as Figure 1.

FIGURE 1
FEES OF MARKETING TEST

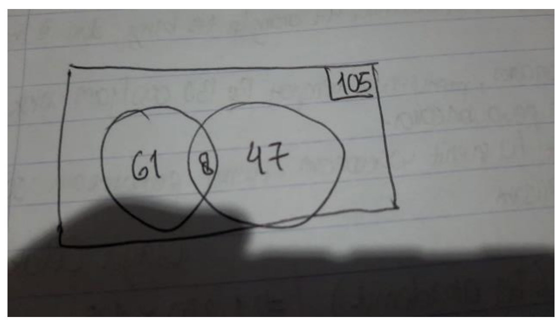


Is the committee’s report true? The director wants to hire the committee for returning employee recruitment if their job is satisfactory. What decision will the director make, in your opinion? Give your reasons!

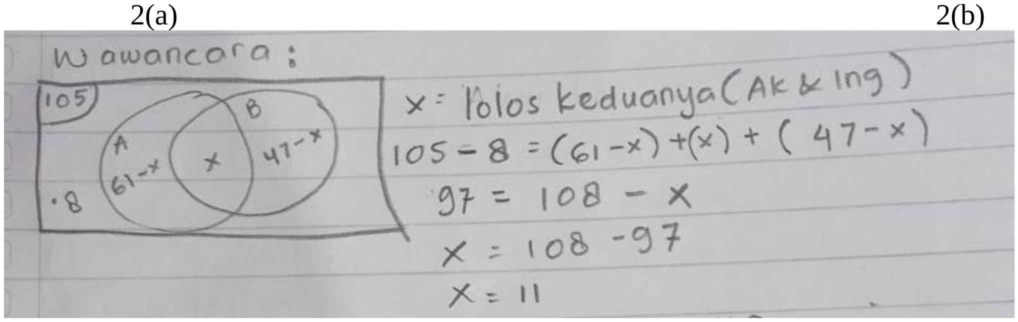
FIGURE 2
(A) FIRST SCRIBBLE OF YR (LLI), (B) FIRST SCRIBBLE OF F(MLI), (C) FIRST SCRIBBLE OF YW (HLI)



2(a)



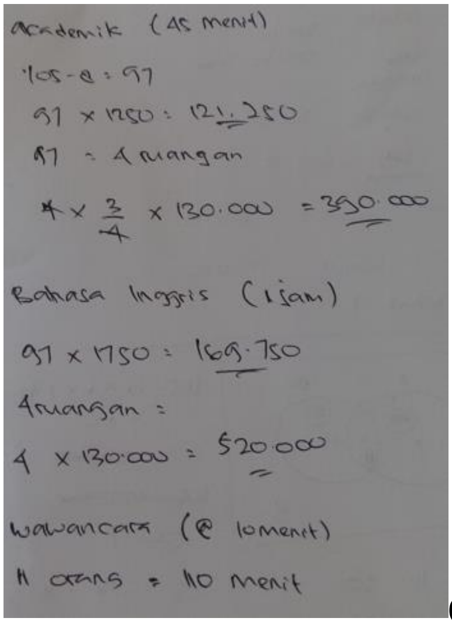
2(b)



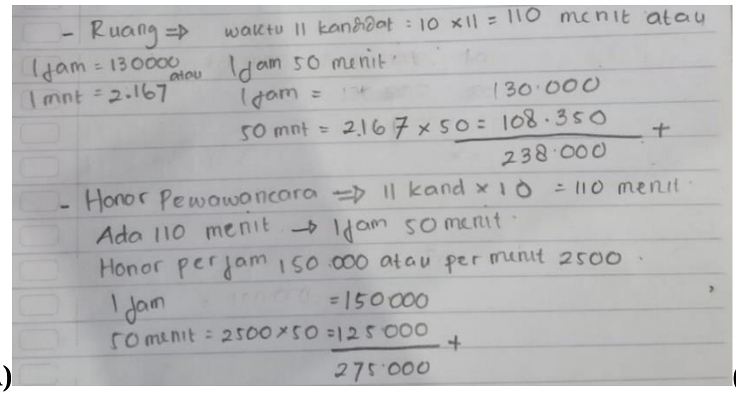
2(c)

The thinking of students with different levels of learning independence can be seen in Figures 2(a), 2(b), and 2(c). From the scribbles in Figures 2(a), 2(b), and 2(c), we know why YR couldn’t complete the calculation. YR is not yet adept at transforming problems into mathematical models. He has not been able to describe the problem in the Venn diagram adequately. It affects the calculations in the next step.

FIGURE 3
(A) SUBJECT F'S (MLI) ANSWER, (B) SUBJECT YW'S (HLI) ANSWER



(A)



(B)

Figure 3 shows that F and YW did not check real-life make sense. This calculation is mathematically true, but it is not common in real situations. If we rent a room for 1 hour and only use it for 40 minutes, our money is usually not returned. The real-life makes sense answer plays a role here. Thus, revising the evaluation step by emphasizing conformity with the real life is necessary.

CONCLUSION

There are three profiles of student learning independence in solving HOTS questions related to numeracy. Students need to read more carefully so that no information is missed. Students with low independence tend not to use Polya's theory in working on the given questions. Meanwhile, students with moderate and high learning independence tend to use Polya's ideas in solving the given problem. However, both of them made mistakes in their conclusions due to not checking the suitability of the answers with the implications in the real world. So there needs to be a revision in the steps of Polya's theory carried out by students. The modification is in the re-check stage. In this step, in addition to checking the steps taken, it is necessary to add emphasis to checking conformity with real life so that the conclusions are correct.

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