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STUDENTS' PROBABILISTIC THINKING LEVEL IN SOLVING PROBABILITY PROBLEMS REVIEWED FROM HONEY MUMFORD'S LEARNING STYLE

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ABSTRACT

Students' difficulties in solving probabilistic problems occur due to their lack of knowledge and understanding of probability concepts. Probabilistic thinking skills are essential to enhance students' ability to solve probabilistic problems in everyday life. This qualitative research aims to describe student's levels of probabilistic thinking in solving probability problems reviewed from Honey Mumford's learning style. The research subjects consisted of eight ninth-grade students from a State Tsanawiyah Madrasah of Batu City. The primary instrument in this study was the researcher, supported by additional instruments such as probabilistic thinking test and a task-based interview guide. Data were collected through written tests, task-based interviews, and documentation. Data analysis was carried out using the constant comparative method which includes the stages of reduction, categorization, synthesis, and substantive theory preparation. The results showed that students with activist and pragmatist learning styles met all indicators at level 1 of subjective thinking, while reflector and theorist students showed wider variations up to level 3 if informal quantitative thinking and some at level 4 of numerical thinking. This finding implies that differences in learning styles contribute to student's probabilistic thinking abilities at each level.

Keywords: probabilistic thinking, Honey Mumford's learning style, probability.

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INTRODUCTION

Probability is a branch of mathematics that focuses on analyzing the chances or likelihood of events taking place (Wijaya, et al., 2021). The concept of probability is also associated with concepts such as possibility, opportunity, hope, or prediction involving uncertainty (Qomaria, 2016; Sari et al., 2017; Sujadi, 2008). Probability provides a mathematical

framework for estimating outcomes in situations involving uncertainty (Kurniasih & Sujadi, 2017). Probabilistic problems are those that involve random activities or experiments with multiple possible outcomes, where the results are uncertain or cannot be predicted in advance (Rohman, 2022). Within the educational context, it is noted that students frequently encounter difficulties in solving probabilistic problems because they lack adequate knowledge and comprehension of probability concepts (Muyasaroh et al., 2023; Sari et al., 2022). In educational practice, a key question arises how students can effectively understand the material presented without considering their individual characteristics and learning experiences (Ahmad, 2022). Students' learning experiences play a significant role in shaping their thinking skills (Sari et al., 2023). The development of students' cognitive and thinking abilities is influenced by their inherent potential as well the learning experiences they acquire at each stage of their cognitive development (Nainggolan & Daeli, 2021). Therefore, probabilistic thinking skills are essential to enhance students' ability to solve probabilistic problems effectively.

Probabilistic thinking refers to a cognitive process that incorporates uncertainty when making decisions (Khoirunnisa et al., 2021; Sari, 2015). Probabilistic thinking skills are crucial in situations where students are faced with events that may occur, even though the outcomes are uncertain or unpredictable (Sujadi, 2008). Probabilistic thinking skills are one of the thinking processes categorized as high-level thinking processes (Taram, 2016; Taram, 2017). Probabilistic thinking skills are students' capital in the future to make better decisions about uncertain problems or probabilistic problems (Rohman, 2022).

When solving probabilistic problems, students' responses vary greatly according to their abilities. To categorize students' abilities to solve probabilistic problems, a systematic probabilistic thinking framework is needed (Fa'ani et al., 2022). Tarr & Jones (1997) classify probabilistic thinking into four levels: level 1 (subjective thinking), level 2 (transitional thinking), level 3 (informal quantitative thinking), and level 4 (numerical thinking). In addition, Sujadi (2008) introduced an additional level, level 0 (pre-subjective thinking), to better align with the abilities of Indonesian students. The categorization aims to recognize and track the progression of students' probabilistic thinking skills from the earliest stage to more advanced stages. The following are the indicators for each level of probabilistic thinking as outlined by to Tarr & Jones (1997).

Table 1. Probabilistic Thinking Level Indicator

Level To-	Level of Thinking	Characteristics	Indicator	Code
1	Subjective	Student thinking that is consistently tied to subjektive reasons.	1. Students cannot write the sample space of an event completely.	[Sa]
			2. Students predict the outcome of an event based on subjective opinions.	[Sb]
			3. Students compare the likelihood of an event across two different sample spaces using subjective judgment.	[Sc]

Level To-	Level of Thinking	Characteristics	Indicator	Code
2	Transition	Students' frequently changing thinking in quantifying opportunities shows a transition between subjective thinking and quantitative thinking.	1. Students can write the sample space of an event completely.	[Ta]
			2. Students predict the outcome of an event based on quantitative opinions, but again use subjective opinions.	[Tb]
			3. Students are able to compare the probability of an event across two different sample spaces using quantitative reasoning, though their judgment is still affected by subjective considerations.	[Tc]
3	Informal Quantitative	Students' thingking in aligning and quantifying thoughts about sample space and probability	1. Students can quantify their thoughts about the sample space of an event.	[Ka]
			2. Students use numbers informally to express the probability of an event.	[Kb]
			3. Students are able to compare the probability of an event in two distinct sample spaces and express their views using informal quantitative reasoning.	[Kc]
4	Numeric	Students are able to make appropriate relationships between sample spaces and their probabilities, and are able to use numerical measurements appropriately to describe the probability of an event.	1. Students can make the right relationship between sample space and its probability, and can state with certainty the probability of an event numerically.	[Na]
			2. Students are able to calculate the probability by comparing the number of favorable events with the total number of possible outcomes.	[Nb]
			3. Students can numerically identify the equality of probability for events that share the same likelihood.	[Nc]

(Tarr & Jones, 1997)

Based on a pre-survey conducted by the researchers with students of State Tsnawiyah Madrasah of Batu City who have not received probability material by providing probability

material questions that are used as information to help researchers analyze students' probabilistic thinking abilities, it resulted in findings that their level of probabilistic thinking is at level 1 (subjective thinking). Students still rely on subjective assessments to predict an event and are influenced by environmental conditions and personal experiences. Because students do not yet understand the concept of probability, such as determining sample space and probability values of events and comparing probabilities, students face difficulties when working on probability problems. Interviews with mathematics teachers indicated that probability is among the topics students find most challenging, as it demands a strong conceptual understanding. In addition, in solving probabilistic problems, students only use informal probabilistic experience and knowledge because they have not studied probability material formally. Lack of probabilistic experience and knowledge will have an impact on the development of students' mindsets when facing probabilistic or probability problems (Mahyudi, 2017).

Honey & Mumford (2006) describe the criteria for learning styles based on the tendency of students' thinking patterns and how students absorb, process, and convey the knowledge given. Honey & Mumford (2006) categorize learning styles into four types: activist, reflector, theorist, and pragmatist. Students with an activist learning style enjoy engaging in new experiences, students with a reflector learning style prefer to think carefully before taking acting, students with a theorist learning style like to work based on theoreis and concepts, while students with a pragmatist learning style dislike discussions and debates, favoring practical action instead. According to Honey & Mumford (2006), each learning style has different characteristics depending on the situation and level of experience. Experience is the most dominant factor that forms the basis of students' thinking patterns in solving probabilistic problems (Mahyudi, 2017).

Every year, many studies are conducted related to students' probabilistic thinking levels. Previous research on the probabilistic thinking levels of junior high school students revealed that 28 students were at level 1 (subjective thinking), 30 students were at level 2 (transitional thinking), 8 students were at level 3 (informal quantitative thinking), and none were at level 4 (numerical thinking) (Fa'ani et al., 2022). The probabilistic thinking levels of high school students are distributed across three levels: 28% at level 1 (subjective thinking), 45% at level 2 (transitional thinking), and 27% at level 3 (informal quantitative thinking) (Muyasaroh et al., 2023). It was also found that of class X MA students, 16 students were at level 1 of probabilistic thinking and 5 students were at level 2 of probabilistic thinking (Fa'ani et al., 2016). In contrast to previous research that merely mapped probabilistic thinking levels, this study examines learning style tendencies as factors influencing students' attainment of those levels. This study also revealed the relationship between learning styles (activists, reflectors, theorists, and pragmatists) with students' probabilistic thinking levels that have not been widely studied in previous studies.

Research conducted by Mala & Setyaningsih (2023) indicates that high school students generally exhibit low probabilistic thinking abilities, which calls for attention in the field of education. These findings are particularly noteworthy and should be extended to the Junior High School level by first identifying students' probabilistic thinking levels. This provides an opportunity for educators to design learning to develop students' probabilistic thinking skills

when responding to probabilistic situations. Based on suggestions from previous studies to conduct further research related to students' probabilistic thinking levels and the results of the pre-survey that has been conducted, the researcher is interested in studying more deeply the level of probabilistic thinking of students at State Tsanawiyah Madrasah of Batu City in solving probability problems reviewed from Honey Mumford's learning style: activist, reflector, theorist, and pragmatist.

METHODS

This qualitative research employing a single case study approach, aimed to describe the probabilistic thinking levels of students at State Tsanawiyah Madrasah Batu City in solving probability problems reviewed from the Honey Mumford learning style based on observed facts. The subjects were ninth-grade students from State Tsanawiyah Madrasah of Batu City who represented each Honey Mumford learning style. Subjects' selection was conducted using the Honey Mumford learning style questionnaire, which was administered to 62 ninth-grade students of State Tsanawiyah Madrasah of Batu City. Based on the questionnaire results, students were classified into the four learning styles: activist, reflector, theorist, and pragmatist. From each category, two students were selected by purposive sampling to represent the characteristics of the learning style. The selection of two students per category was carried out to obtain in-depth data and strengthen the validity of the findings through internal triangulation, as recommended in case study research (Creswell, 2016). Furthermore, students were given a probabilistic thinking test and conducted task-based interviews.

The data for this study consisted of students' probabilistic thinking levels obtained from the results of a probabilistic thinking test and task-based interviews. All data were collected from the students who served as the research subjects. The primary instrument of this study was the researcher, supported by additional instruments such as the probabilistic thinking test and task-based interview guidelines. The probabilistic thinking test was used to assess students' levels of probabilistic thinking, while the task-based interview guidelines provided supplementary information regarding these levels. Interviews were conducted by asking again about the completion of tasks that had been done by the subjects. Before being used, the probabilistic thinking test sheets and interview guidelines have been validated by two expert validators, namely lecturers of the Mathematics Education Study Program, Maulana Malik Ibrahim State Islamic University of Malang to test the feasibility of the instruments used in the study. Data collection was conducted through written tests, task-based interviews, and documentation.

The probabilistic thinking test questions used in this study are shown in Figure 1.

Dalam suatu kelas akan dilakukan pemilihan ketua kelas. Terdapat lima siswa yang akan mencalonkan diri sebagai ketua kelas, yaitu sebagai berikut.

Roni Ayu Sarah Bagas Anda

Dari kelima calon tersebut akan dipilih satu orang yang akan menjadi ketua kelas.

1. Siapakah yang memiliki peluang untuk menjadi ketua kelas? Mengapa? Berikan Alasan Anda!
2. Menurut pendapat Anda, yang memiliki peluang lebih besar untuk menjadi ketua kelas adalah laki-laki atau perempuan? Mengapa? Berikan alasan Anda!
3. Apakah Anda memiliki peluang lebih besar untuk menjadi ketua kelas daripada calon yang lain? Mengapa? Berikan alasan Anda!

Figure 1. Probabilistic Thinking Test Questions

Data analysis was conducted continuously until the students' probabilistic thinking levels were determined. The analysis employed the Constant Comparative Method which consists of data reduction, data categorization, synthesis, and substantive theory development (Glaser & Strauss, 2006). During the data reduction stage, data from the probabilistic thinking tests and task-based interviews were selected and coded, then linked to the indicators of probabilistic thinking levels as defined by Tarr & Jones (1997). Coding was done by providing codes for each indicator of probabilistic thinking levels to make it easier for researchers to analyze and interpret the data. The data categorization stage was carried out by grouping pieces of data that had similar characteristics into categories of probabilistic thinking levels, and comparing data and categories to find correspondence or differences. The synthesis stage was carried out by connecting the categories formed to build student thinking patterns and the relationship between learning styles and probabilistic thinking levels. The substantive theory development stage was carried out by compiling a comprehensive description of the probabilistic thinking levels of each subject based on the patterns found and their correspondence with the theory indicators.

The validity of the data was ensured through technical triangulation and increasing perseverance. Technical triangulation was implemented by integrating data from the probabilistic thinking test results with the task-based interview results for each subject. Increasing perseverance was carried out by carefully observing the data to ensure the suitability of the data found. The final stage is the preparation of a substantive theory that answers the research question, namely describing the level of probabilistic thinking of students from a State Tsanawiyah Madrasah of Batu City in solving probability problems viewed from the Honey Mumford's learning style.

RESULT AND DISCUSSION

Based on the Honey Mumford learning style questionnaire administered to 62 ninth-grade students of State Tsanawiyah Madrasah of Batu City, the results indicated that 6 students had an activist style, 44 students had a reflector learning style, 5 students had a theoreis learning style, and 7 students had a pragmatist learning style. Furthermore, 2 students were selected from each learning style who were considered to represent the characteristics of each category to be used as research subjects. The students selected as research subjects are presented in Table 2.

Table 2. Research Subject

Learning Style	Selected Subjects
Activist	MT, KS
Reflector	KR, FG
Theorist	AD, HM
Pragmatist	FA, BD

The researcher gave a probabilistic thinking test to the research subjects. Furthermore, the subjects were interviewed to gain a deeper understanding of their probabilistic thinking levels. The classification of probabilistic thinking levels was conducted by the researcher and validated by the supervising lecturer and mathematics teacher.

The following section presents an analysis of the probabilistic thinking level of MT subject, who exhibits an activist learning style.

Figure 2. MT Test Results Number 1

The researcher gave a probabilistic thinking test to the research subjects. The subjects were then interviewed to provide a deeper clarification of their probabilistic thinking level. The following is an analysis of the probabilistic thinking level of the MT subjects, who demonstrates an activist learning style.

Table 3. MT Task Based Interview Number 1

P	:	Based on question number 1, who do you think has the opportunity to become class president?
MT	:	Bagas [Sa]
P	:	Why can Bagas become class president?
MT	:	Eee... seen from those who have responsibility and are firm, Bagas (while looking down at the picture) [Sa]

The interview results showed that when answering question number 1, MT only mentioned one member of the sample space by giving subjective reasons based on the assumptions in the picture, namely that only Bagas has the opportunity to become class president because he has responsibility and is firm.

Based on the data presented from the probabilistic thinking test and supported by the results of the task-based interview on question number 1, credible data was obtained that MT could only mention one member of the sample space from an event using subjective opinions based on the assumptions in the picture. The data obtained refers to the first indicator of level 1 subjective thinking, namely MT cannot write the sample space of an event completely [Sa].

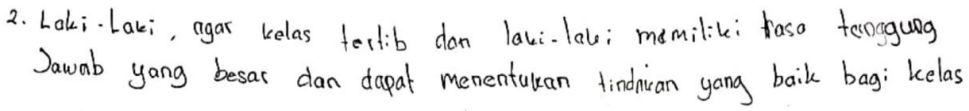

Figure 3. MT Test Result Number 2

In question number 2, it shows that MT can compare the chances of an event based on subjective opinion, namely that men have a greater chance of becoming class president than women because men are more responsible and act well. This is further supported by the following excerpt from MT's task-based interview results.

Table 4. MT Task Based Interview Number 2

P	:	Based on the answer to number 2, you answered that men have a greater chance of becoming class president, why?
MT	:	Because men have a great sense of responsibility [Sc]
P	:	Don't women have responsibilities?
MT	:	Men have greater responsibilities and can do (think) mmm... more assertive work [Sc]
P	:	What do you base your answer on?
MT	:	From the experience I have seen

The interview results show that MT can only compare the chances of an event using subjective opinions based on personal experience. This can be seen when MT answered that men have a greater chance of becoming class president than women because men have greater responsibilities and are more assertive. MT's answer is based on experience that has been experienced.

Based on the data from the probabilistic thinking test and supported by the task-based interview for question number 2, credible data was obtained, namely showing that MT can only compare the chances of an event using subjective opinions based on personal experience. The data obtained refers to the third indicator of level 1 subjective thinking, namely MT compare the likelihood of an event across two different sample spaces using subjektive judgment [Sc].

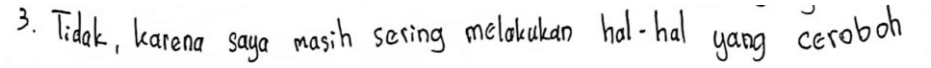

Figure 4. MT Test Result Number 3

In question number 3, it shows that MT can predict the outcome of an event based on subjective opinion, namely MT has no chance of becoming class president because he is still careless. This is further supported by the following excerpt from MT's task-based interview results.

Table 5. MT Task Based Interview Number 3

P	:	Based on question number 3, are you sure you have the opportunity to become class president?
MT	:	No, because I'm still careless [Sb]
P	:	If I disqualify Rony and Bagas, then the only candidates are Ayu, Sarah, and you. Do you still not have a chance to become class president?
MT	:	No, sis
P	:	Why?
MT	:	Because I'm still careless

The interview results showed that MT predicted the outcome of an event using subjective opinions based on what he experienced. This can be seen when MT answered that he did not have the opportunity to become class president because MT felt that he was still often careless. The researcher gave additional questions by reducing the members of the sample space of an event. However, MT's answers were still consistent in using subjective opinions.

Based on the data from the probabilistic thinking test and supported by the task-based interview for question number 3, credible data was obtained, namely showing that MT could only predict the outcome of an event based on subjective opinions and was consistent with subjective thinking. The data obtained refers to the second indicator of level 1 subjective thinking, namely MT predict the outcome of an event based on subjektive opinions [Sb].

The following is a summary of the probabilistic thinking levels of all research subjects as shown in Table 6. This level of probabilistic thinking was obtained based on the learning styles identified in each research subject.

Table 6. Subject's Probabilistic Thinking Level

Learning Style	Selected Subjects	Probabilistic Level of Thinking
Activist	MT	Level 1
	KS	Level 1
Reflector	KR	Level 1
		Level 3
	FG	Level 1
		Level 3
Theorist	AD	Level 1
		Level 4
	HM	Level 1

Learning Style	Selected Subjects	Probabilistic Level of Thinking
		Level 3
Pragmatist	FA	Level 1
	BD	Level 1

Based on the analysis of the eight research subjects, several key findings emerged regarding the probabilistic thinking levels of students at State Tsanawiyah Madrasah in Batu City when solving probability problems viewed from the Honey Mumford's learning style.

Subjects with Activist Learning Style

The probabilistic thinking levels of subjects MT and KS are at level 1 (subjective thinking). Students with an activist learning style demonstrate indicators of level 1 probabilistic thinking as described by Tarr & Jones (1997), namely students cannot mention the sample space of an event completely, predict the probability of an event based on subjective opinion, and compare the probability of an event across two different sample spaces using subjective reasoning. These students rely on subjective judgments rooted is assumptions and personal experiences when estimating event probabilities. Research by Hidayati & Afifah (2020), students at the subjective level tend to solve mathematical problems based on personal assumptions and experiences. This aligns with the characteristics of activist learning style who prefer engaging with experiences and exploring new situations (Honey & Mumford, 1986).

Students with an activist learning style cannot fully identify the sample space of an event. Activist students tend to focus only one element of the sample space that they consider appropriate based on subjective reasoning. According to Honey & Mumford (1986), students with an activist learning style are more inclined to prioritize new experiences rather than conducting in-depth analysis. Additionally, students with an activist learning style often lack patience when performing repeated checks (Kuncoro & Ruli, 2022). This tendency leads activist students to hastily identify the sample space of an event without verifying all possible outcomes.

Students with an activist learning style are also capable of comparing the likelihood of an event in two different sample spaces using subjective opinions. Such students usually act first based on prior experiences without considering all available information (Honey & Mumford, 1986). As a result, activist students tend to estimate probabilities using intuition or experience rather than objective calculations. It can be concluded that students with an activist learning style align with the characteristics of level 1 (subjective thinking) because they prioritize direct experience over analytical reasoning.

Subjects with Reflector Learning Style

The probabilistic thinking levels of subjects KR and FG are at level 1 (subjective thinking) and level 3 (informal quantitative thinking). At level 1 (subjective thinking), students with reflector learning style are characterized by an inability to fully state the sample space of an event and by predicting the probability of an event based on subjective opinions. Reflector students tend to be cautions in making decisions and their thinking may be limited to personal experience when determining probabilities. This finding aligns with Ahmad (2022), who states

that students' thinking at the subjective level focuses on irrelevant aspects and is largely influenced by subjective reasons. At level 3 (informal quantitative thinking), students with a reflector learning style are capable of quantifying their understanding of the sample space of an event. Students with a reflector learning style prefer to make decisions carefully and thoughtfully (Honey & Mumford, 1986; Kuncoro & Ruli, 2022). Therefore, reflector students can accurately determine the sample space of an event and begin incorporating numerical information to support their reasoning. These students can also compare the probability of an event and express their opinions using informal quantitative reasoning, typically in their own words. This behavior is consistent with the tendency of reflector learners to seek accuracy without rushing to make decisions (Budiyanto, 2018). Reflector students exhibit caution and take time before forming an opinion when comparing the chances of an event. Reflector students to base their conclusions on reliable information and then articulate decisions in language they find clear and understandable. Moreover, students with a reflector learning style tend to pursue truth systematically when making decisions (Budiyanto, 2018).

Subjects with Theorist Learning Style

The probabilistic thinking level of subject AD is at level 1 (subjective thinking) and level 4 (numerical thinking), but does not meet all the indicators at level 4 (numerical thinking). Meanwhile, subject HM's probabilistic thinking level is at level 1 (subjective thinking) and level 3 (informal quantitative thinking) but does not met all the indicators at level 3 (informal quantitative thinking).

At level 1 (subjective thinking), students with a theorist learning style are characterized by an inability to completely state the sample space of an event, predicting outcomes based on subjective opinions and comparing the probability of events across two different sample spaces using subjective reasoning. Students with a theorist learning style cannot fully identify the sample space of an event. Theoretical students only focus on one member of the sample space that is considered appropriate based on subjective thinking. This is because theoretical students most likely do not have a strong analytical approach in understanding the sample space so that they cannot mention the sample space completely.

Students with a theoretical learning style prefer an approach based on facts and theory rather than subjective opinions (Kuncoro & Ruli, 2022). However, it was found that students with a theorist learning style still relied on subjective opinions when predicting and comparing the likelihood of events. This indicates that theorist students have not yet developed the analytical skills required to predict and compare event probabilities objectively. The thinking remains dependent on prior assumptions and personal experiences.

At level 3 of (informal quantitative thinking), students with a theorist learning style demonstrate the ability to compare event probabilities in two different sample spaces and express their opinions using informal quantitative reasoning in their own words. According to Honey & Mumford (2006) students with a theorist learning style tend to be analytical, detailed, and perfectionist. Therefore, theorist students can compare probabilities systematically but still rely on their own wording.

At level 4 of (numerical thinking), students with a theorist learning style are characterized by their ability to determine probability values by comparing the number of

favorable events with the total number of possible outcomes. This aligns with the theorist learning style, which emphasizes logical and systematic thinking (Honey & Mumford, 2006). Theorist students apply probability principles systematically and logically and are capable of connecting these principles to more formal calculations.

Subjects with Pragmatist Learning Style

The probabilistic thinking levels of subjects FA and BD are at level 1 (subjective thinking). Students with pragmatist learning style demonstrate the indicators of level 1 probabilistic thinking as defined by Tarr & Jones (1997), namely students unable to completely identify the sample space of an event, predict the probability of an event based on subjective opinions, and compare the probability of an event across two different sample spaces using subjective reasoning.

Students with pragmatist learning style prefer a practical and fast approach to solving problems (Kuncoro & Ruli, 2022). Pragmatic students tend to ignore detailed analysis steps such as compiling a complete sample space, because the most important thing is that pragmatist students get practical answers that are considered sufficient (Kuncoro & Ruli, 2022). So students with pragmatist learning style cannot mention members of the sample space of an event. Students only focus on one member of the sample space that is considered appropriate based on subjective thinking.

Students with pragmatist learning style predict the probability of an event using subjective opinions based on real experience. This occurs because pragmatist students tend to trust ideas that are engaging and rooted in experience (Honey & Mumford, 1986). They often make subjective predictions about the likelihood of an event without applying probability concepts in a systematic way. Pragmatist students rely more on actual experiences rather than structured calculations. When comparing the probability of an event across two different sample spaces, pragmatist students also depend on subjective opinions. This finding aligns with previous research by Khoirunnisa et al. (2021) which states that students who are at the subjective level tend to use subjective reasoning when comparing probabilities in two different sample spaces. Pragmatist students are more interested in the end result than the in-depth analysis process (Honey & Mumford, 1986). Therefore, in comparing the probabilities of two different sample spaces, pragmatist students may immediately draw conclusions based on subjective experience or opinions without doing systematic calculations. It can be concluded that students with a pragmatist learning style align with the characteristics of level 1 (subjective thinking) because they rely on practicality based on direct experience when understanding probability rather than using mathematical analysis or abstract theory.

CONCLUSION

The study results indicate that learning styles influence students' probabilistic thinking levels. Students with activist and pragmatic learning styles are generally at level 1 subjective thinking. Meanwhile students with reflector and theorist learning style demonstrate broader variations, reaching up to level 3 informal quantitative thinking and some at level 4 numerical thinking, although they have not fully met all the indicators at those levels. This finding shows that differences in learning styles contribute to students' ability to understand probability more quantitatively and formally. The implication is that teachers need to design learning plans that

consider students' learning styles and provide varied, non-routine probability problems to strengthen students' probabilistic thinking skills. Further research is recommended to explore other mathematical topics in order to map the levels of probabilistic thinking more comprehensively.

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