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Probabilistic Thinking Ability of Students Viewed from Their Field Independent and Field Dependent Cognitive Style

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Abstract. The aims of this research are to study: (1) probabilistic thinking ability of mathematics education students, (2) classification of the students' cognitive style, (3) levelling of the students' probabilistic thinking ability viewed from their cognitive styles. This research used thequalitative descriptive method and involved 74 subjects. The measured subjects were Group 1 with "fixed FD" classification consisted of 7 students, Group 2 with "mobile FD and mobile FI" classification consisted of 9 students, and Group 3 with "fixed FI" classification consisted of 5 students. The classification of cognitive styles into three groups revealed that there was suitability between cognitive style and probabilistic thinking ability from low to high level. These results could be analysed from theclassification of cognitive style and anaverage of their value of probabilistic thinking ability. The average of probabilistic thinking ability of Group 1 was 42.58; the average of probabilistic thinking ability of Group 2 was 54.44,and the average of probabilistic thinking ability of Group 3 was 68.6. Group 1 and 3 had small standard deviation for the value of probabilistic thinking ability, respectively are 11.36 and 12.30. Thus the data was relatively homogeneous. Meanwhile, Group 2 had a huge standard deviation for the value of probabilistic thinking ability, namely 19.36 which means that the data was relatively heterogeneous. Most of the probabilistic thinking ability level for Group 1 and 2 was Level 2, which is Transitional level, while the most of theprobabilistic thinking ability level for Group 3 was Level 4, which is Numeric level.

1. Introduction

Students' ability is influenced by several factors,namelythe external factors and the internal factors. Several studies have shown that the influence of the internal factor is predominant. One of the internal factors is the thinking ability, including the spatial thinking ability, mathematical rigourthinking ability [2] literacy thinking ability, probabilisticthinking ability, and statistical thinking skills [1, 3].

Studies related to probabilistic thinking is still progressing. Jones (1997, 1999, 2002), and Polaki (2002)suggest the levelling of probabilistic thinking and recommend further research to investigate the probabilistic thinking of students bytheir different backgrounds,languages, and cultures. Sharma (2006, 2012) indicates that many students use strategies based on the experience of culture (beliefs, everyday life, and school experiences) and intuitivestrategies [4-7]. Sujadi (2008) developed levels offered by Jones and add one level of probability thinking for junior high school students who have not been taught by probability material [14]. Maftuh (2014) suggests that probabilistic reasoning students in junior high school level in problem-solving associated with theprobability of occurrence is biased to respond to various situations within a context that include unsure- an element of uncertainty, while the reasoning in any problem-solving steps is useful decisionmaking [9].

The results of the studies are very interesting and need to be followed up at the college levelsince the results can be referred when the decision maker wants to determine the learning approach used, the lecture material, as well as the treatment in coaching and giving attention to the students.

The National Qualifications Framework of Indonesia (NQFI/KKNI) mentioned that the bachelor degree should possess Level 6. They have to master the theoretical area of knowledge in general and a special concept for the deeper theoretical part in science and be able to formulate settlement procedural problems. It leads to the idea that the students of bachelor degree need to possess the probabilistic thinking ability.

On the other hand, the trend of theindividual to receive, to process, and to organise information and then to present the information again, which is known as cognitive style, need the attention of the lecturer since the style will be associated with the cognitive process of students. Witkin (1976: 254) classifies cognitive style in several types, one of which is thecognitive style offieldindependent (FI) and field-dependent (FD) [15]. Classification of these cognitive styles regarding theindividual ability to distinguish relevant aspects in particular situation.This research is related to probabilistic thinking skills of students associated with cognitive styles of the students since it is important to improve the learning approach in mathematics education study program after learning our students' probabilistic thinking and their related cognitive style.

2. Study Theory

2.1. Probabilistic Thinking and Level

Probabilistic thinking processes of students is a higher order thinking processes, which is positionedon the stage of aformal operation process according to Piaget (Soeparno, 2001:25). Furthermore, Piaget explained that to understand the process of probability, a student needs to know two principal operations, namely system combination and proportion calculations. The materialsof probability the which are fundamental to measure the probabilisticthinking includesample space, theprobability of an event, conditional probability, and case of independence (Jones,1999).The probabilistic thinking level proposed by Jones (1997, 1999) consists of four levels, namely: (1) Level 1 Subjective, (2) Level 2 Transitional, (3) Level 3 Informal Quantitative, and (4) Level 4 Numerical. The details are shownin Table 1 below.

Table 1 Probabilistic Thinking Level

Level	Characteristics	Indicators
1. Subjective	Students continuously think bonded on thesubjectivebackground.	• Signed an incomplete set of experimental results one level. • Predict events that are most likely or least likely, based on a subjective opinion • Recognising the unlikely occurrence and certainly • Comparing the odds of an event in two different sample chamber, usually based on a subjective opinion • Unable to distinguish situations probabilistic "fair" from "unfair."
2. Transition	A transition period between thinking objectively and thinkingquantitatively characterised by students' thinking naive and often changed in quantifying probability	• Apply a complete set of experimental results one level • Sometimes a complete register with experimental results using two-level strategies is limited and not systematic. • Predict events that are most likely or least likely, based on the opinions quantitatively but back on a subjective opinion • Making comparisons based on the chances of quantitative statement (probably not quantitative, and may have limitations in which the events of the adjacent engaged) • Start to distinguish situations probabilistic "fair" from "unfair."

Level	Characteristics	Indicators
3. Quantitative informal	Thinking at this level is indicated through the use of generative strategies in registering the second stage of experimental results, and can align and quantifying their thinking about the sample space and opportunities	• Apply the experimental results consistently using a two-level portion of the generative strategy • Predict events that are most likely or least likely, based on the opinions of quantitative includes situations which contain results that are not adjacent (noncontiguous outcomes). • Use the numbers on an informal basis for comparing the probability. • Distinguish the events certain, impossible and possible, and justify the choice quantitatively. • Making comparisons based on the chances of consistent quantitative opinion. • Give reasons to quantitative reasoning is valid but limited to events that are not adjacent (noncontiguous events) • Distinguish generator opportunities "fair" from "unfair", based on the numeric reasoning is valid.
4. Numeric	Students can make the proper relationship of the sample chamber and opportunities and can use appropriately sized numerically to describe the probability of occurrence	• Implementing and using generative strategy that allows registering the complete results of experiment two or three levels • Predict the most likely or least likely to experiment one level or two levels. • State the opportunity an event numerically (either real or opportunities that are uniquely shaped) • Determine the size of the opportunities in numeric and compare the incidence • Combining the results of adjacent (contiguous outcomes) and the results are not adjacent (noncontiguous outcomes) in determining opportunities • Determine equality of opportunity in numeric for the events that are likely the same.

Sharma (2012) suggeststhat students use strategies based on the experience of culture (beliefs, everyday and school experiences) and intuitive strategy. While the results of the study confirm the findings of other researchers, the findings beyond those discussed in the literature. Use of beliefs, everyday and school experience was far more common than is discussed in the literature.

2.2. Cognitive Style

2.2.1. Understanding Cognitive Style

Cognitive styles according to Koheznikov (2007) refer to the individual characteristics of the environment toorganise conceptually. Furthermore, Witkin (1976) defines cognitive style as an approach to receive,to process, and to organise information and present the information returnedThere are individuals who receive such informati presented, while the other individual to reorganisethe information in his way [15].Witkin (1976) classify cognitive style in several types, one of which is cognitive style field-independent and field-dependent as shown in Table 2 [15].

Table 2 Different characteristics of the individualfield dependent and independent

Field Dependent	Field Independent
1. Oriented social.	1. Oriented impersonal
2. Stresses external motivation	2. Stresses internal motivation
3. More affected by external reinforcement	3. More affected by internal reinforcement
4. Object looked globally	4. Looking at objects composed of discrete parts and separate from the environment
5. Thinking globally	5. Thinking analytically
6. Tend to choose a profession that promotes social skills and humanities	6. Tend to choose a profession that promotes the ability to analyse.

3. Research Methodology

3.1. Type and Research Subjects

This research method is descriptive qualitative research which involved mathematics education students who take probability theory courses in the second semester of 2015/2016academic year.

3.2. Research Instruments

The instrument used was the test of probabilistic containing four problems.Question number 1 is to measure the ability of students to prove theorems of probability; Question number 2 is to measure the ability of students to determine sample space, probability of an event, random variables and their distribution; Question number 3 is to measure the ability of students to the conditional probability of an event; and the Question number 4 is to measure the ability of students to the problems associated with the probability of Bayes theorem.Identification of cognitive style subjects in this study carried out based on the test results cognitive style with instrument GEFT which consists of 25 items divided into three parts, of which 7 item in Part I of the exercise and 18 items in sections II and III are the core of GEFT. Each correct answer which means the subject can precisely shape thicken simple images which are hidden in the complex image, given a score of 1. In this study, subjects who score> 9 classed FI and subjects who score ≤9 classified FD.

4. Results and Discussion

4.1. Results

a. Classification of Cognitive Style

Group 1 is those who obtain the correct number of items in the test GEFT between "0" up to "3" with the classification "fixed FD" there are seven students.Group 2 are those who obtain the correct number of items in the test GEFT between "8" up to "11" with the classification "mobile mobile FD and FI" there are nine students. Group 3, namely those who obtain the correct number of items in the test GEFT between "16" up to "18" with the classification "fixed FI" there are five students. While the value of the measurement results of probabilistic thinking skills for each of the three groups of students is as follows. The average value of the Group 1is 42.86 with astandard deviation of 11.31. The average value of probabilistic tests of Group 2 is 54.44; with the standard deviation of 19.36.The average value of theprobabilistic test of Group 3 is 68.6; with astandard deviation of 12.30.

4.2. Discussion

From the results of research related to the classification of cognitive style, three groups of classification showed that there is a match between three groups with the probabili stic thinking ability. It can be seen from the classification of cognitive style,and the acquisition value of the probabilistic thinking ability.It is the one with the classification of fixed FD, the average value of probabilistic thinking ability is 42.58; group 2 with mobile classification FD and FI mobile has anaverage value of probabilistic thinking ability is 54.44, and group 3 with the classification of fixed FI has anaverage value of probabilistic thinking ability is 68.6. (1) Group 1, in this group there is an interesting fact that a student become an outlier among others, with the value of the probabilistic thinking ability is 67, this indicates that he does not belong to fixed FD group, but the probabilistic thinking ability is high enough, we concerned that in question 1 is at level 4, question 2 is at level 4, question 3 is at level 3, and question 4 is at level 2.Likewise, for group 1 is not located at level 1, it

draws attention to exploring further. The largest percentage of the level of probabilistic thinking skills are at level 2 by 71.43%, and the lowest percentage in the level 1 is 10.71%. These results indicate that the majority of this group at the level of probabilitythinking: transitional. The standard deviation of 11.31 These groups are the one most small compared with other groups, have demonstrated the ability to think of groups one is homogeneous. (2) Group 2 with a mobile classification FD and FI mobile, the number of subjects at most compared with other groups are 9 subject, which draws attention to the value range of probabilistic thinking ability is large enough that the smallest value and the greatest value 30 85, and the standard deviation 19.36; This demonstrates the ability to think of this group is very heterogeneous, this is in accordance with the mobile classification to their cognitive style. Probabilistic ability level for this group represented all for 4 existing level. The largest percentage of the level of probabilistic thinking skills are at level 2 is 44.44%, and the lowest percentage was at level 1 by 5.56%., These results indicate that the majority of this group at the level of probability thinking: transitional. (3) Group 3 with fixed FI classification, in this group the number of subjects at least compared to the other two groups that are 5. The largest percentage of the subject's level probabilistic thinking skills are at level 4 by 40%, while the lowest percentage at level 1 by 0%. It shows that the majority of these groups are at a numerical level, which is the highest level of thelevel that existed at the level of probabilistic thinking skills. The standard deviation is 12.30 these three groups are relatively small; this also shows the probabilistic thinking ability is arelatively homogeneous group. The findings are suitable with the finding of Fitriyani (2013) and Witkin (1976) that explained that the cognitive style influences how the students solve mathematics problems. The mathematics problem in this research is the probabilistic problem which is influenced by the FI and FD of the students' cognitive style [2,15].

5. Conclusion

In this section will be presented the conclusions of results and discussion in this study. (1) Classification of cognitive style into 3 groups showed match between level of compliance with probabilistic thinking ability of low level to high level, it can be seen from the classification of cognitive style and the average acquisition value of their probabilistic capabilities, namely the one with the classification of fixed FD average value of ability probabilistic is 42.58; group 2 with mobile classification FD and FI mobile average value of ability probabilistic is 54.44; and group 3 with the classification of fixed FI average value was 68.6 probabilistic capabilities. (2) Group 1 and Group 3 had a small standard deviation for the value of probabilistic thinking skills, respectively by 11, 36 and 12,30, suggesting that the ability to think probabilistic both groups are relatively homogeneous, while group 2 had a fairly large standard deviation for the value of probabilistic thinking skills in the amount of 19.36, this suggests that the probabilistic thinking ability is relatively heterogeneous group. (3) Level probabilistic thinking skills to groups 1 and 2 majority on level 2, with percentages respectively 71.89% and 44.44%, so both groups tended to be on level 2: transitional; while the majority of the group 3 level 4 with percentage by 40% so that these groups tend to be at level 4: Numerical.

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