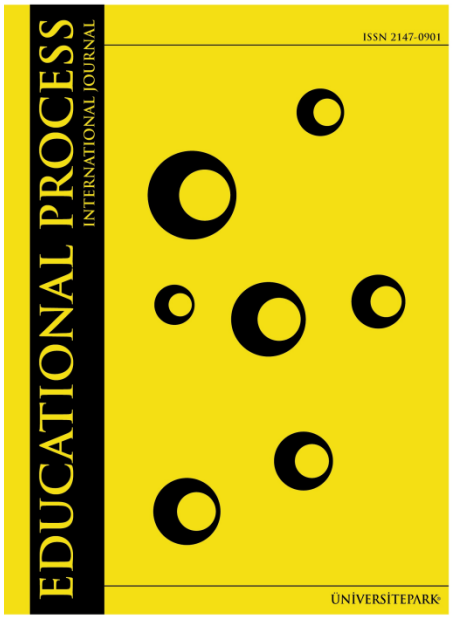

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Problem Posing of High School Mathematics Student's Based on Their Cognitive Style

ABDUL RAHMAN and ANSARI SALEH AHMAR

Abstract

Mathematical problem posing plays an important role in mathematics curriculum, since it encompasses the core of mathematics activities, among other things, with students' activities to construct their own problems as the preliminary step to actual problem solving steps. This study aims at revealing the profile of students' mathematical problem posing based on their cognitive styles in order to know and understand the learning of mathematics students. As a result of this study, students who have the cognitive style 'field independent' (FI) are able to propose a solvable mathematical problem and load new data, and also pose problems categorized as high-quality mathematical problems. Students who have the cognitive style of 'field dependent' (FD) are generally limited to solvable mathematical problems that do not contain new data, and mathematical problems of a moderate level. In this study, it is seen how student's work mathematical problem posing using their cognitive style, resulting in a breakthrough in the process of learning to use students' cognitive styles so as to increase the quality of learning outcomes.

Keywords: cognitive style, field dependent, field independent, problem posing, mathematical statement.

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Introduction

Implementation of the Indonesian Competency-Based-Curriculum is a forward step to improve the quality of the national education. The curriculum emphasizes developing students' ability to pose tasks within certain performance standards in order to perceive the learning outcome.

Romberg and Carpenter (1986) states that many studies related to teaching explicitly assume about students learning, but that they are inconsistent with the current cognitive learning theories. Therefore, it is suggested to undertake an integrated research and incorporate the required teaching and learning. Romagnano (1994) reveals three main dilemmas in mathematics teaching and learning activities as (1) "Ask Them or Tell Them" Dilemma, (2) "Good Problems" Dilemma, and (3) "Grading" Dilemma. Dilemma 1 regards the concept of delivery, Dilemma 2 concerns the difficulty of posing problems during the instructional process, whilst Dilemma 3 concerns evaluation, how to use measuring tool well. The focus of this study is Dilemma 2, posing mathematical problems.

One of the abilities necessary for students in terms of mathematical problem solving is the ability of posing mathematical problems. Research conducted by Hashimoto (1997) indicates that learning through problem posing elicits a positive influence on students' ability in problem solving.

Among the research reporting on problem posing approach in learning are Leung, Silver, and English, who propose that problem posing has a positive influence on students' ability to solve word problems, and provides an opportunity to gain insight into students' understanding of mathematical concepts and processes. Besides that, Kilpatrick (1969) argues a thesis that the quality of problems that students pose functions as an independent variable to predict how well students can solve problems. In addition, Mestre (2002) states that problem posing can be used to delve into the transferring of concept across context, and identifying knowledge, reasoning, and concept development of students.

Mathematical problem posing plays an important role in mathematics curriculum, since it encompasses the core of mathematics activities, among other things, with students' activities to construct their own problems as the preliminary step to actual problem solving steps. Performing problem posing in mathematics learning was strongly recommended by NCTM, because problem posing impacts on children's knowledge development and understanding to the important concept of school mathematics (English, 1998).

Mayer, Larkin, and Kadane (1984) found that students experience difficulties in solving mathematical problems due to difficulties understanding the language of problems. The authors further revealed that questions containing relation and subjunctive propositions are more difficult for students to solve than those containing assignment proposition. Thus, language structure in constructing questions is of great importance in order to avoid issues of unsolvable questions. In preliminary research administered to 7^{th} grade IPA 1 students of SMA Negeri 11 Makassar, Indonesia, it was found that students with the cognitive style of field-independent are more successful in posing solvable mathematics questions (53.21%) than those of the field-dependent style (19.23%) (Rahman, 2006). This differential is due to not all students having the same way of receiving and processing data within any given information.

Based on the researcher's survey results from 6th grade IPA students of SMA Negeri 3 Makassar, Indonesia early in the academic year of 2007-2008, it was found that 87 out of 240 students (36%) scored under 7.0, the Minimum Mastery Criteria established by the school for mathematics. Such low mathematics scores do not merely result from the mathematics content itself or the teacher's ability in managing learning in the classroom, but to students' characteristics in learning mathematics in the classroom, including their cognitive style and their ability to pose mathematical problems. The outline above indicates the significance of conducting research concerning mathematical problem posing on the basis of students cognitive style.

Methodology

There are several known definitions of problem solving. Problem solving is a problem receiving process taken as a challenge to be able to solve it. Besides, Cooney (1985) states that problem solving is a process of receiving a problem and the subsequent endeavor to solve it. In addition, Polya (2014) defines problem solving as an attempt to find a way out of a difficulty in order to attain a goal which cannot presently be solved. Problem solving is a psychological process rather than an application of theorems learned. Further, Bullock, Stallybrass, Trombley, and Eadie (1977) state that problem solving is a form of activity in which there is a goal to be reached, a gap in the route to the goal and a set of alternative means, none of which are immediately and obviously suitable. Furthermore, McGivney and DeFranco (1995) argue that problem solving comprises of two aspects, that is: problem to find and problem to prove. Henceforth, Santrock (2007) argue that problem solving means seeking an appropriate way to achieve a goal. Problem solving can also be defined as finding steps to overcome an existing gap, while Wilis Dahar (1996) reveals that problem solving activity itself is human activity in practicing concepts and rules previously acquired.

Some of the definitions of problem solving regard it as a process, as it is closely related to problem posing. This view is supported by Silver and Cai (1996) who stated that problem solving performance has a high correlation to problem posing performance, and furthermore asserted that problem posing can improve thinking, problem solving skill, attitude, and students' self-esteem to mathematics and mathematical problem solving, along with a contribution to a more extensive understanding of mathematics concepts.

Duncker and Lees (1945) proposed a definition for mathematical problem posing as an attempt to construct or formulate a problem for a given type of information or data. Alternatively, Dillon (1982) defined mathematical problem posing as problem finding, that is a thought process producing a mathematical question from certain information which is to be solved. Silver (1994) also proposed a definition for mathematical problem posing, as an endeavor to pose a new problem for information or experience possessed by students. Further, Stoyanova and Ellerton (1996) add their definition as, "Problem posing is defined as the process by which, on the basis of mathematical experience, students construct personal interpretation of concrete situation and formulate them as meaningful mathematical problems".

The problem situation of the current study is:

Tangent line of circle :

$$L_1 \equiv x^2 + y^2 = 13 \text{ at } Q(2,3) \quad (1)$$

is tangent to circle

$L_2 \equiv (x-7)^2 + (y-4)^2 = p^2$ (2)

Find *p!*

Problem posing:

(1) Draw the position of both Circles L_1 and L_2 in one Cartesian coordinate system?
Solution:

As shown in Figure 1.

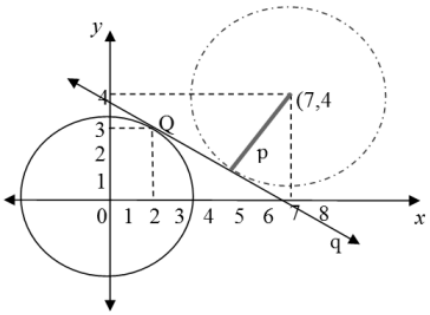

Figure 1. Position of both circles L_1 and L_2 in one Cartesian coordinate system

(2) What is the relationship between *p* and radius L_2?
Solution:

$p = r_2$ or $r_2 = p$, $r_2 > 0$ (3)

(3) How to find r_2?
Solution:

r_2 = the distance from the center point L_2 to the tangent line L_1 at Q(2,3)

(4) What is the tangent line equation L_1 at Q(2,3)?
Solution:

The tangent line equation L_1 at *Q* is:

$x_1x + y_1y = 13$ (4)

or

$q \equiv 2x + 3y = 13$ (5)

(5) What is the value of r_2?
Solution:

r_2 = the distance from the point (7, 4) to the line $2x + 3y = 13$ is:

$$r_2 = \left|\frac{2\times 7 + 3\times 4 - 13}{\sqrt{2^2+3^2}}\right| = \left|\frac{14 + 12 - 13}{\sqrt{4+9}}\right| = \left|\frac{13}{\sqrt{13}}\right| = \sqrt{13} \quad (6)$$

(6) What is the value of *p*?

Solution:

Value $p = r_2 = \sqrt{13}$

Thus, the solution is $p = \sqrt{13}$

In light of these solutions, there are six questions to the problem solution in order to obtain the result. From the result, it can be seen more as a posed problem to advance the existing problem solving:

(1) Find the tangent point of circle L_2 to the line :
$q \equiv 2x + 3y = 13$! (7)

(2) Find the distance from the tangent point of circle L_1 to the tangent point of circle L_2 by the line of equation (7).

These examples indicate that problem posing is not merely the posing of a problem/question from the given information, but also to provide a clue as to how to solve the problem/question properly. Besides, if students are accustomed to posing mathematical problems appropriately, it is expected that they will also be capable of developing their own mathematical thinking pattern.

Some definitions concerning cognitive style are stated by Witkin, Moore, Goodenough, and Cox (1975) in that characteristic modes of functioning revealed throughout our perceptual and intellectual activities are highly consistent and pervasive. Further, Messick (1984) defined cognitive style as a person's typical mode of perceiving, remembering, thinking and problem solving. Furthermore, Vernon (1973) defined cognitive style as a "superordinate construct which is involved in many cognitive operations, and which accounts for individual differences in a variety of cognitive, perceptual, and personality variables". This means that cognitive style constitutes the typical characteristics of functioning perceptual and intellectual activities. The characteristics are consistent and can "penetrate" behavior entirely, either in the cognitive aspect or affective aspect.

Several experts, such as Messick (1984), Zelniker (1989), and Waber (1989) restricted the meaning of similar cognitive styles as preference of someone relatively persistent in receiving, thinking, and problem solving, along with keeping information in mind. Further, Soedjadi (1996) proposes that:

> Cognitive style may be described by the following characteristics: (1) They are concerned with the forms rather than the content of cognitive activities, (2) They refer to individual differences concerning how people perceive, think, solve problems, learn and relate to others, (3) They are features of personality, the patterns of collective characters which include behavioral, temperamental, emotional and mental traits of an individual, (4) They are stable over time, and (5) They are distinguishable from intelligence and other ability dimensions.

Several cognitive style types that Sigel and Coop (1974) identify are: (a) to pay special attention to global versus detail (partly); (b) to distinguish a stimulus into larger categories versus numerous smaller ones; (c) to incline to classifying items on the basis of apparent characteristics such as similarity of function, time, or space versus selecting similarity of

some abstract attribute; (d) quick, impulsive versus slow, seriously problem solving behavior; (e) intuitive, inductive versus logical cognitive, deductive cognitive.

There are two cognitive styles that are particularly important in education, they are: 'field-independent' versus 'field-dependent' and 'impulsive versus reflexive'. Each of these are based on psychological and conceptual tempo differences. Implications of students' cognitive styles in learning of field-independent and field-dependent are as follows:

- Students with the cognitive style of field-independent learn mathematics individually, enabling them to provide better responses, and are more independent. Those with this cognitive style are more likely to learn mathematics by intrinsic motivation and are inclined to work to satisfy their own ambition.
- Students with the cognitive style of field-dependent learn mathematics in a group and frequently interact with their teacher, requiring extrinsic reinforcement. For those with this cognitive style, a teacher is required to design what should be undertaken and how to undertake it. Such students require guidance from the teacher and motivation is such reward and encouragement.

Henceforth, Witkin et al. (1975) proposed that:

> Someone having the cognitive style of field-independent inclines to separate parts of a number of patterns and analyses them on the basis of their components. Whereas, he or she having the cognitive style of field-dependent tended to view a pattern as a whole, not separating into parts.

Based on the thesis mentioned above, a student with the cognitive style of field-independent inclines to pose mathematical problem as:

(1) *Using his own perception*. This means that a student, in posing a mathematical problem, sees clearly the given information and is not influenced by the environment.
(2) *Analyzing patterns in light of their components*. This means that a student, in posing a problem, can involve numerous semantic and syntaxis elements.
(3) *Analytic*. This means that a problem a student poses on the basis of given information is systematic and is intertwined among its elements.

Meanwhile, a student with the cognitive style of field-dependent tends to pose mathematical problem as:

(1) *Responding a stimulus using the environment as the basis for his or her perception.* This means that in posing a mathematical problem in light of the given information, the student is only able to work within the apparent boundary of information in the environment. Or, in other words, a response that a student poses is highly influenced by the environment.
(2) *Viewing a pattern as a whole, not separating it into parts*. This means that a student is, in posing a mathematical problem, merely able to see the whole, and has in difficulty in posing a mathematical problem involving elements that exist in the given information, so that the problem posed poorly engages semantic and syntaxis elements.

The following is an example in the matter of inclination of both cognitive styles which may occur in mathematics learning.

A student is given geometric objects as follows (see Figure 2 and Figure 3). If a student is asked to find Figure 2 inside Figure 3, then students with the cognitive style of field-independent are quicker at finding it than those with the cognitive style of field-dependent. This is because they are not influenced by the figure existing around Figure b within Figure a, so that student FI easily finds Figure b form inside Figure a. Conversely, students with the cognitive style of FD find it difficult to locate Figure b inside Figure a due to being influenced by figures that exist around the Figure b environment within Figure a.

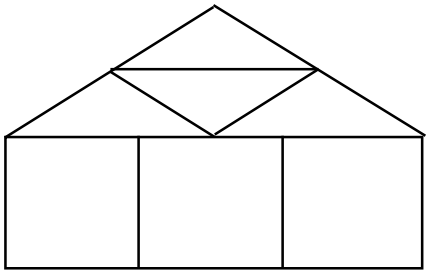

Figure 2. First geometric objects; *Figure 3.* Second geometric objects

Besides, in algebraic class, students are given a quadratic equation:

$$x^2 + 2\sqrt{2}x + 2 = 0. \quad (8)$$

If they are asked to find its roots, then FD students may apply the "abc formula"; whereas FI students find other ways such as factoring to understand that the quadratic equation (8) can be changed to:

$$\left(x + \sqrt{2}\right)^2 = 0 \quad (9)$$

This can be undertaken by the FI students since they are not influenced by the coefficient of x, $2\sqrt{2}$, and by the existing completion pattern. However, the FD students are influenced by the coefficient of x, which is not an integer $2\sqrt{2}$. Therefore, they cannot perform the equation using factorization and are influenced as well by the existing completion pattern, and utilize the abc formula as the only completion pattern for the quadratic equation. On the contrary for the quadratic equation:

$$x^2 + 2x + 4 = 0 \quad (10)$$

FD students tend to directly factorize in determining its roots, whereas FI students first probe into the discriminant of the quadratic equation. Since the value is less than zero, the FD students soon arrive at the conclusion that the quadratic equation does not have a real root.

Meanwhile, Silver and Cai (1996) found six elements of a semantic relationship in posing mathematical problems, which are: (1) there are no semantic relationships; (2) there is only one semantic relationship, that is restating; (3) there are two semantic relationships, which are restating and changing; (4) there are three semantic relationships, which are restating, changing, and grouping; (5) there are four semantic relationships, which are restating, changing, grouping, and comparing; and (6) there are five semantic relationships, which are restating, changing, grouping, comparing, and varying. Grouping Mathematical Problem Posing based on Students' Cognitive Style is shown in Table 1.

Table 1. Grouping of Mathematical Problem Posing by Students' Cognitive Style

Cognitive Style Types	Mathematical Problem Posing		
	Responses	Syntaxis Analysis	Semantic Analysis

FI	- Posed question can, in general, be solved.
	- Posed question is frequently difficult to solve.
	- Posed question contains new data.
		- Posed question contains:
		  - proposition
		  - relationship, or
		  - subjunctive
			Posed questions contain 3 or 4 semantic relationships:
			- changing
			- comparing
			- grouping
			- varying

FD	- Posed question, in general, does not contain new data. - Posed question is usually not difficult to solve. - Posed question frequently does not have a solution.	Posed question is dominated by 'assignment' semantic relationship.	Posed question, in general, has only 1 or 2 semantic relationships, such as: - restating, and - changing

This current study was conducted in SMA Negeri 3 Makassar, Indonesia with eight 6^{th} grade science students. The selection of SMA Negeri 3 Makassar as the research site was based on several considerations, namely: (1) SMA Negeri 3 Makassar was frequently chosen as the site for scientific activity by researchers; (2) students of SMA Negeri 3 Makassar are not dominated by certain social stratum or achievement (heterogen); and (3) the researcher has an established relationship with the school's staff.

The research subjects were 6^{th} grade science students, selected based on several considerations: (1) time allocated to mathematics in 6^{th} grade science was greater than for 6^{th} grade non-IPA; (2) they had adequately learning experiences in order to pose questions based on information given; and (3) they would be easier to interview to obtain accurate data for the study. The establishment of subjects for this study referred to the test results of students' cognitive style. Building on these test results, students were placed into one of two groups, as students with the field-independent (FI) cognitive style and those with the field-dependent (FD) cognitive style.

1) The student group with the cognitive style of field-independent (FI) was represented by four students; consisting of two students from the top-end and two from the bottom-end of the interval boundary for grouping the field-independent cognitive style.
2) The student group with the cognitive style of field-dependent (FD) was represented by four students; consisting of two students from the top-end and two from the bottom-end of the interval boundary for grouping the field-dependent cognitive style.

Data collection for this research employed one main instrument, that of the researcher, with supporting instruments as follows:

Instrument for Group Embedded Figures Test (GEFT)

Group Embedded Figures Test (GEFT) is a test adapted from the development by Witkin et al. (1975). This test was utilized to psychologically investigate cognitive style as either field-independent (FI) or field-dependent (FD). Material used for this GEFT were geometrical figures. The test consisted of three parts: (1) consisted of seven items; (2) consisted of nine items; and (3) consisted of nine items. The first part of the test was exercises prepared for the participants, whereas the second and the third parts were the core components of the test. Data obtained from this GEFT test was then utilized to group students on the basis of their cognitive styles, that is: (1) the cognitive style of field-independent (FI); and (2) the cognitive style of field-dependent (FD). Grouping according to the cognitive style of field-independent (FI) required that students acquired scores greater than nine (i.e., 50% of the maximum score); whereas those scoring less than or equal to nine were grouped as the cognitive style of field-dependent (FD) (Ratumanan, 2003).

Instrument for Mathematical Problem Posing

This mathematical problem posing test was constructed from various data associated with mathematical materials that students had learned rather than from material taught by the teacher. This approach was chosen in order to prevent students from constructing or posing questions in an imitation of their teacher's way of making or constructing questions. The test for mathematical problem posing utilized in this research displayed four different data items: graphics; verbal sentences; mathematical sentences; and figures. This test was aimed to reveal the profile of mathematical problem posing on the basis of students' cognitive style. The test was constructed by the researcher from studying instrumental examples of mathematical problem posing as developed by Silver and Cai (1996), Gonzales (1994), Siswono (2008), and Hamzah (2003).

Results and Discussion

Profile of Mathematical Problem Posing (MPP) Based on Cognitive Style for Graphics Data

The subjects involved in this study were eight students divided into two groups. One group consisted of four students representing the GK-FI group, and the other had four students representing the GK-FD group. The profile of students' mathematical problem posing based on their cognitive style (GK-FI and GK-FD) on graphics data was as follows: Figure 4 shows that the ability to pose mathematical problems of graphics was not that different to posing solvable mathematical problems; however, only students in the GK-FI group posed mathematical problems containing new data.

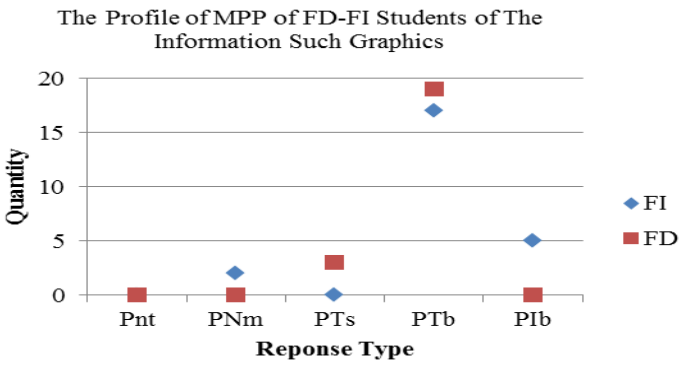

Figure 4. Profile of mathematical problem posing based on cognitive style for graphics data

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

The quality of mathematical problems with graphics posed by students of the GK-FI group were accomplished in the high category; whereas, those posed by students of the GK-FD group were accomplished only in the moderate category.

Profile of Mathematical Problems for GK-FI and GK-FD Groups Based on Verbal Sentences

The subjects involved in this study were eight students, consisting of four students representing the GK-FI group, and four students representing the GK-FD group. The profile of students' mathematical problem posing based on their cognitive style (GK-FI and GK-FD) on verbal sentences was as follows:

Figure 5 shows that not all verbal sentence mathematical problems posed by GK-FI students were indeed solvable mathematical problems. From the 17 mathematical problems that the GK-FI students posed, there was one unsolvable problem, and 16 other solvable mathematical problems, of which eight contained new data. The number of verbal sentence mathematical problems posed by the GK-FD students was 16, three of which were unsolvable problems and the other 13 were solvable, although none contained new information.

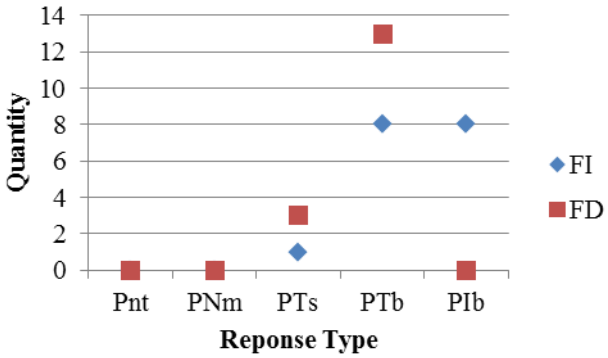

Figure 5. Profile of mathematical problem posing based on cognitive style for verbal sentences data

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

The quality of verbal sentence mathematical problems posed by students of the GK-FI group were accomplished in the high category; whereas, those posed by students of the GK-FD group were accomplished only in the moderate category.

Profile of Mathematical Problems Posing Based on Cognitive Style for Mathematical Sentences Data

The subjects involved in this study were eight students, consisting of four students representing the GK-FI group, and four students representing the GK-FD group. The profile of students' mathematical problem posing based on their cognitive style (GK-FI and GK-FD) on mathematical sentences was as follows:

Figure 6 shows that all mathematical problems with mathematical sentences posed by GK-FI students were indeed solvable mathematical problems; none were unsolvable, and two contained new data. However, of the 20 mathematical problems with mathematical sentences posed by the GK-FD students, 12 were unsolvable problems and the other eight were solvable, although none contained new information.

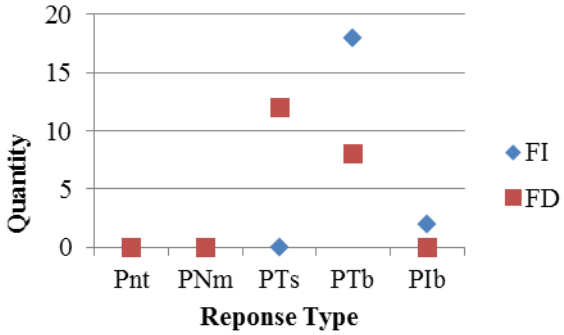

Figure 6. Profile of mathematical problem posing based on cognitive style for mathematical sentences data

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

The quality of mathematical problems with mathematical sentences posed by students of the GK-FI group were accomplished in the high category; whereas, those posed by students of the GK-FD group were accomplished only in the moderate category.

Profile of Mathematical Problem Posing Based on Cognitive Style for Figures Data

The subjects involved in this study were eight students, consisting of four students representing the GK-FI group, and four students representing the GK-FD group. The profile of students' mathematical problem posing based on their cognitive style (GK-FI and GK-FD) with figures data was as follows:

Figure 7 shows that not all mathematical problems with figures posed by GK-FI students were indeed solvable mathematical problems. From the 19 mathematical problems that the GK-FI students posed, there were two unsolvable problems and 17 solvable problems; among them there were eight problems containing new data. However, of the 22

mathematical problems with figures posed by the GK-FD students, 15 were unsolvable problems and the other seven were solvable, although none contained new information.

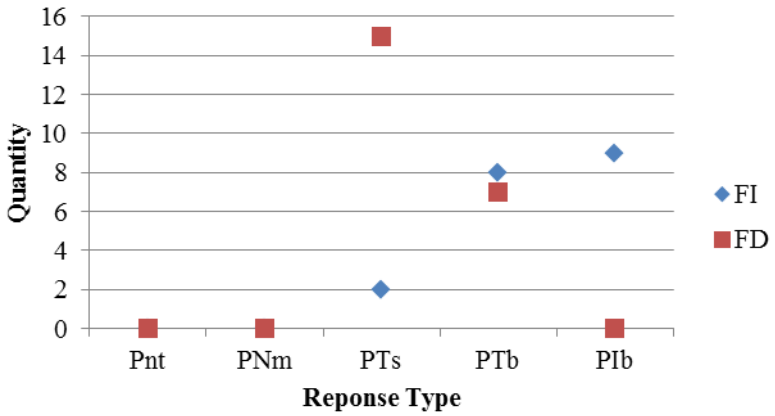

Figure 7. Profile of mathematical problem posing based on cognitive style for figures data

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

The quality of mathematical problems with figures posed by students of the GK-FI group were accomplished in the high category; whereas, those posed by students of the GK-FD group were accomplished only in the moderate category.

Profile of Students' Mathematical Problem Posing on the Basis of Cognitive Style

The subjects involved in this study were eight students, consisting of four students representing the GK-FI group, with two students representing the upper bound value of the GK-FI group, and two representing the lower bound value. Based on the test results of mathematical problem posing, it was seen that for the four data types given in this test, the students representing the GK-FI group posed 80 responses. The profile of students' mathematical problem posing based on the four data types was as follows:

Figure 8 shows that in posing mathematical problems for the four given data types, the GK-FI students posed more mathematical problems containing new data than those from the GK-FD group. In addition, the GK-FD students posed more unsolvable mathematical problem than those from the GK-FI group. Students from the GK-FI group were able to pose mathematical problems containing new data, whereas students from the GK-FD were not.

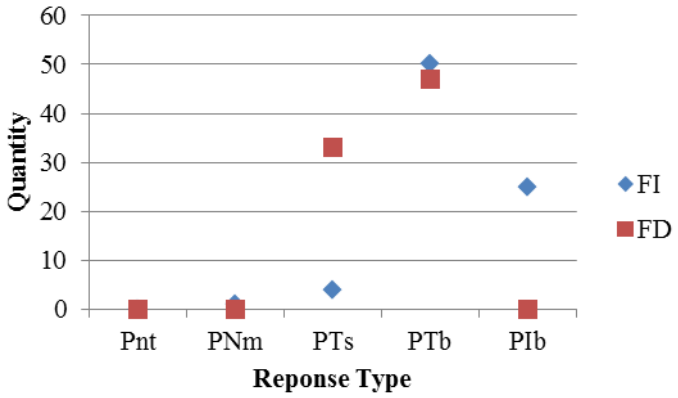

Figure 8. Profile of students' mathematical problem posing on the basis of cognitive style

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

Within this study, the cognitive styles of FI and FD are discussed. In establishing groups of students according to their cognitive style, the criteria employed was: "If students can only find simple figures from complex figures (0 to 9 figures), then they are grouped into the cognitive style of FD; whereas those who can find simple figures (in excess of 9 figures) are grouped into the cognitive style of FI". In this section, the researcher analyzed the profile of students' mathematical problem posing in the extreme point of each of cognitive style groups, and by doing so created two new groups, namely the 'end-group' (GK-FI-Ba and GK-FD-Bb) and the 'middle group' (GK-FI-Bb and GK-FD-Ba).

The research subjects representing the GK-FI-Ba group was comprised of two students, namely ANR and INT. Based on the data of mathematical problem posing for the four data types of given information, the profile of students' mathematical problem posing of the end-group (GK-FI-Ba and GK-FD-Bb) was as follows:

Figure 9 shows the problems/questions that students posed for the four given data types. It can be seen that students in the GK-FI-Ba group posed more solvable mathematical problems/questions containing new data, whereas the solvable mathematical problems not containing new data were posed more by students in the GK-FD-Bb group, but the difference was not significant.

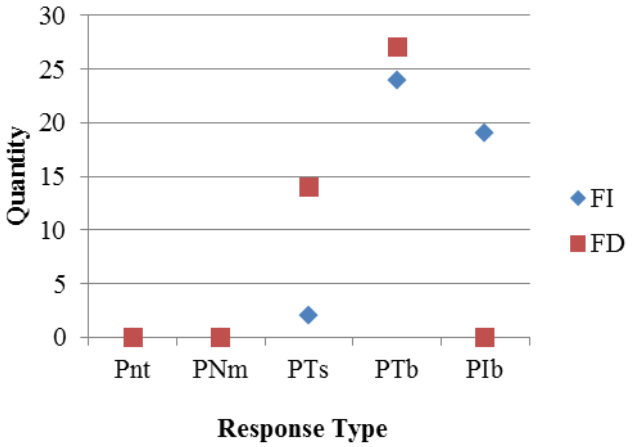

Figure 9. Profile of students' mathematical problem posing for the end-group for four information types

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

In light of the data of mathematical problem posing of both groups, it was seen that the profile of students' mathematical problem posing for the middle group (GK-FI-Bb and GK-FD-Ba) was as follows:

Figure 10 shows the problems/questions that students of both groups posed for the four given data types, and that the students in the GK-FI-Bb group posed more solvable mathematical problems/questions either containing new data or not, than those in the GK-FD-Bb group.

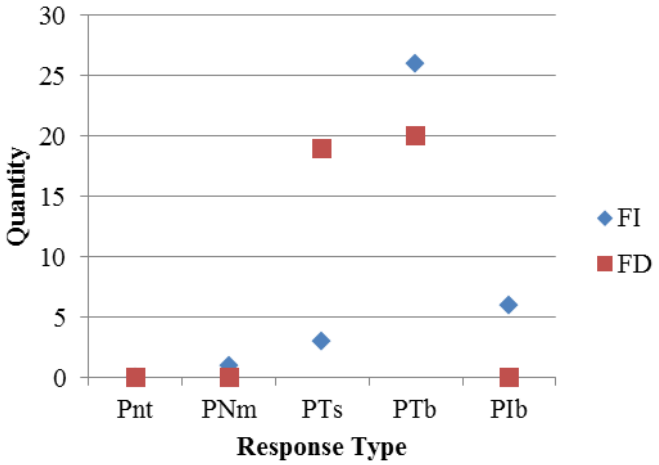

Figure 10. Profile of students' mathematical problem posing for the middle group for four information types

Description:

PNt = Statement
PNm = Non-mathematical statement
PTs = Unsolvable mathematical statement
PTb = Solvable mathematical statement not containing new data
Pib = Solvable mathematical statement containing new data

Figures 9 and 10 showed that students in the middle group of cognitive style had the profile of mathematical problem posing at the end-group of cognitive style. The difference was seen with mathematical problems that had a solution, but did not contain new data.

Conclusion

(1) The profile of students' mathematical problem posing with graphics. (a) The response type that students of GK-FI posed on graphics was dominated by 22 solvable mathematical problems/questions, and among them, there were five problems containing new data and two other responses that constituted unsolvable mathematical problems. However, for students of the GK-FD group, they posed 22 responses with graphics, with 19 solvable problems containing no new information, and three other unsolvable mathematical problems. This shows that the GK-FD students were focused on the available data when posing problems containing graphics, so much so that none of the problems posed contained new data. (b) The quality of problems that students from the GK-FI group posed on the basis of the result of semantic and syntaxis analysis, in general, were included in the moderate category, and there were three problems that students from the GK-FI group posed that were included in the high category. Whereas, the quality of mathematical problem that students of from the GK-FD group posed merely attained the category of moderate.

(2) The profile of students' mathematical problem posing with verbal sentences. (a) The response type that students posed from the GK-FI group totaled 16 solvable mathematical problems, and among them, there were eight problems containing new data. Whereas, the response type that students from the GK-FD group posed was also 13 solvable mathematical problems, but none contained new data. (b) Based on the quality of mathematical problems that students of the GK-FI group posed with verbal sentences, according to results of semantic and syntaxis analysis, it is seen that the sentence structure of the problems that students posed, in general, were included in the moderate category, and there were also six problems that students of the GK-FI group posed that were included in the high category. However, the quality of mathematical problems that students from the GK-FD group posed were included in the moderate category.

(3) The profile of students' mathematical problem posing with mathematical sentences. (a) The response type that students from the GK-FI group posed with mathematical sentences constituted 20 solvable mathematical problems, and among them, two problems contained new data. Whereas, students from the GK-FD group posed 20 responses, with 12 being unsolvable mathematical problems, and only eight solvable, although none contained new data. (b) The quality of mathematical problems that students from the GK-FI group posed with mathematical sentences, following semantic and syntaxis analysis, were included in the moderate category, as from 18 problems, only one was included in the high category. However, the quality of problems that students of the GK-FD group posed overall were included in the moderate category. This is because the mathematical problems posed

contained at most one semantic relationship and in general they used assignment proposition.

(4) The profile of students' mathematical problem posing with figures. (a) The responses from students in the GK-FI group posed with figures totaled 17 solvable mathematical problems, and among them, nine contained new data, whereas the students from the GK-FD group posed 15 unsolvable mathematical problems, and only seven solvable, but none contained new data. (b) The quality of mathematical problems that the students from the GK-FI group posed with figures, on the basis of semantic and syntaxis analysis, were included in the moderate category overall, with two mathematical problems in the high category; whereas, the mathematical problems that students from the GK-FD group posed were at most in the moderate category.

Notes

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