Profile of Students' Strategy in Senior High School with Cognitive Reflective and Impulsive Style in Solving the Combinatorial Questions

by Nurul Aini

Submission date: 29-Dec-2021 10:20AM (UTC+0700)
Submission ID: 1736194612
File name: Profile_of_Students_Strategy_in_Senior_High_Schoo.pdf (927.18K)
Word count: 3856
Character count: 20246

Profile of Students' Strategy in Senior High School with Cognitive Reflective and Impulsive Style in Solving the Combinatorial Questions

Profile of Students' Strategy in Senior High School with Cognitive Reflective and Impulsive Style in Solving the Combinatorial Questions

N Aini*[12], D Juniati[3], T Y E Siswono[3]
[1]Doctoral Program of Mathematic Education Departement, Universitas Negeri Surabaya,
[2]Mathematic Education Departement, Sekolah Tinggi Keguruan dan Ilmu Pendidikan Jombang
[3]Mathematic Departement, Universitas Negeri Surabaya,

E-mail: nurulaini10@mhs.unesa.ac.id

Abstract. The goal of this research is to describe the strategies used by the Senior High students with the reflective and impulsive cognitive style in solving combinatorial questions. The strategy is seen from three aspects, namely: formulating, representing, and solving aspect. The subject of the research is the eleventh grade students based on the test of MFFT (*The Matching Familiar Figures Test),* to determine the reflective and impulsive cognitive style and also the communicative of research subject. The data is collected by giving the combinatorial questions and identifying the subject's strategy in solving the questions through interview. The validation used is time triangulation. The data analysis used is data reduction, data representation, and conclusion. The result shows that the students with reflective type are different from the students with impulsive type. When it is in the formulation stage, student with reflective cognitive style (RCS) reads the question slowly with strong intonation and gives the information by using his own words. In the representation, RCS draws four parallel boxes as many as the representation of the digits. In solving the question, RCS chooses the strategy based on the question rule, by memorizing and using strategy, RCS ways checks each step. While, in the formulation, ICS reads the question first, then makes parts of the questions by not using his own words. In the representation, student with impulsive cognitive style (ICS) uses the mathematics symbol. In solving the questions, ICS chooses a strategy fast without seeing the question rules overall and uses the strategy spontaneously without rechecking so that there are many mistakes found.

1. Introduction

Solving the problem in the form of question is a part of mathematical process. Standard process of mathematics at school includes problem solving, reasoning and proof, connections, communication, and representation [1]. Problem solving is the way of thinking, analyzing, and reasoning by using the experience and knowledge related with the problem [2]. When the students answer the questions, it will be influenced by the students' cognitive style. The impulsive cognitive style and reflective cognitive style are important variables which influence students' response in the class, behaviour in doing the test, and the result of the test.The students with impulsive cognitive style respond fast and

dare to take the risk, while the reflective one tends to more slowly in responding, more slowly, and more carefully [3].

The question in this research is related with the combinatorial lesson. The combinatorial lesson is the branch of mathematics discrete focuses on countable discrete structures [4]. There are many advantages of learning combinatorial, such as: 1) it can train the students in enumeration concept, making assumption, optimization, and systematic thinking; 2) it can be applied in the branch of other field such as physics, chemistry, probability, and many others; 3) it can make the students more creative; [5]. However, there are many researches state that the students find difficulties in solving combinatorial questions because there are many dangerous traps when answering the questions so that the students do not understand the questions [6,7,8].

Therefore, there must be a way to solve combinatorial questions by using appropriate strategy [9]. Strategy is important point in solving the problem because it can ease to answer the questions precisely. There are three kinds of strategies in solving the combinatorial questions by listing, combinatorial operating and counting principle [9]. Combinatorial operation includes pattern/combinatorial formula or permutation. Counting principle is the principle in multiplication or addition [9]. Listing has four ways, namely: 1) it can be trial and error; 2) start strategy, where the students use certain pattern but it is not used overall; 3) cyclical pattern, where the students use all opposite patterns; 4) mistaken odometter where the students determine one constant variable but they fail in doing enumeration overall and it is too many mistakes; 5) perfect odometer, where the students determine one constant variable and find enumeration overall [10].To use the strategy above, the students must have competence in using a strategy. Strategic competence is mental activity in using the strategy of formulating, representing, and solving [11]. Fomulating sub aspect seen is the strategy used in understanding the problem to formulate the information known and strategy in formulating the information used to question. Representation of sub aspect seen is strategy used in representing problem situation. Solving the sub aspect is the strategy used to solve it [11]. While the representation meant is the model used by the students as the effort in looking for the solution and interpret the problem [12]. The form of representation is the real object representation, mathematics symbol representation, oral or verbal representation and picture or graphic representation [13,14].

The strategy in this research is development of Sukriyani's sub aspects, where the first aspect in formulating is two sub aspects seen, namely formulating in what kind of strategy used in understanding, formulating the information known and formulating the question and how to use the strategy. The second aspect is representing where there are two sub aspects seen, namely what kind of strategy used to represent the problem and how the process in using the strategy. The third aspect is solving, sub aspects seen, namely the strategy used and the reason why they use the strategy and how to use the strategy. Therefore, the researcher is interested in describing the strategy used by the Senior High School students with reflective cognitive style and impulsive cognitive style in solving the combinatorial questions.

2. Methods

This study is qualitative research. There are 140 students as the respondents. The researcher uses the instrument of *Matching Familiar Figure Test* to get the information between the students who use reflective cognitive style and impulsive one. There are 35% students with reflective cognitive style, 32% students with impulsive cognitive style, 10% students with fast and accurate cognitive style and 23% with slow and inaccurate cognitive style. The combinatorial questions are given to the student who has reflective cognitive style and the student who has impulsive one that has the same mathematical and communicative ability. The combinatorial questions are used after va lidated by the experts.

The combinatorial question is:

Reno and Tomi are students of SMA Negeri 2 Jombang who won the creativity competition in national level. They create a vacuum cleaner robot. To avoid the blame of other people, they designed

the robot carefully where the robot would obey its master after he pressed the password button in the robot chess. Reno and Tomi use numbers with the date and the month when the robot is used to ease them to remember. The robot was created in July, 12 2016. The password consists of four digits and does not repeat the same numbers. In your opinion, how many numbers in the password made by Reno and Tomi? Explain how you determine it!

The research subjects with reflective and impulsive cognitive style are given the combinatorial question and they are identified for the strategies used when they solve the combinatorial questions through interview. The validity uses the time triangulation. The analysis technique uses three steps, namely: data reduction, data representation, and conclusion.

3. Results

The researcher will explain the data which inform about the strategy used in solving combinatorial question. The data is got through test and deep interview. The data is presented in two parts namely the strategy of students in Senior High School with reflective cognitive style and students with impulsive cognitive style in solving combinatorial questions.

3.1 *Student's strategy in Senior High School with reflective cognitive style* (RCS) *in solving combinatorial question*.

RCS in the beginning understands the question first by reading the question slowly and stressing intonation by using their own words. RCS gets the information that there are four digits with different numbers, which are arranged of the number 1,2,0,7 from the date when the robot reated. RCSdraw patterns the information questioned that the passwords are searched from the number 1,2,0,7 while pointing the numbers with a pen. The beginning strategy used by RCS to solve the question is drawing. RCS draws the first box, then goes to the next second box, third and fourth box in a parallel line to represent the numbers of the digits in the password as shown in the following Picture 1:

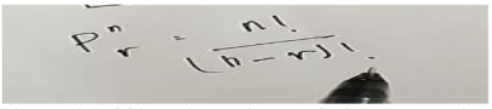
Picture 1. Representation of the beginning strategy of RCS

Then RCS inputs "4" in the first digits. When he writes the next numbers,RCS shakes his pen while memorizes the question rule that states no numbers are the same. RCS inputs in the second digit with "3" as numbers left, then the third digit with two numbers in the rare last digit. Finally, RCS multiplies the numbers based on the multiplication rule so that RCS gets 24 arrangements formed from the number 1, 2, 0, 7. It can be seen in Picture 2 below.

Picture 2. Written answer of RCS related with multiplication principle strategy

RCS looks at the answer, then decides to use another way to make sure his answer. The next strategy used by RCS is using the pattern. In the beginning, RCS determines the pattern will be used by

memorizing the question rule by shaking the pen that is no same numbers. RCS determines the pattern of different object permutation that will be used. RCS writes the different object of permutation pattern, namely P(n,r) = n!/(n-r)!. RCS represents the available numbers and the numbers asked are as many as the numbers in the password by using the mathematics symbol, namely n and r. It is shown in Picture 3. And the interview result in Table 1 below.

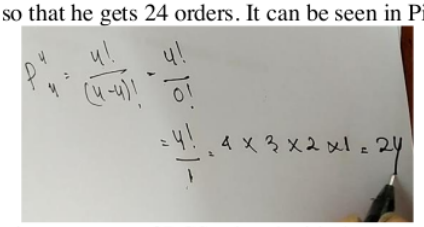


Picture 3.RCS' mathematics symbol representation

Table 1. Interview sample related with mathematics symbol representation by RCS

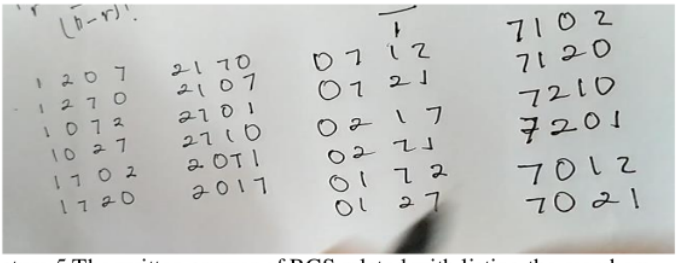
Researcher	:	What is n?
RCS	:	n is the available numbers
Researcher	:	How about r ?
RCS	:	r is the numbers wanted

RCS understands the exclamation mark in the pattern as the factorial which means the multiplication in order from 1 or decrease. Then, RCS inputs number four as n because there are four numbers, namely 1, 2, 0, 7, then inputs number four as r because the passwords of the object are different with four different numbers. RCS continues it with counting process namely 4!/0!. RCS understands 0! is same with 1 for factorial rule. RCS continues the counting process to become 4!/1= 4!. RCS explains 4! It becomes $4 \times 3 \times 2 \times 1$ so that he gets 24 orders. It can be seen in Picture 4 below.



Picture 4.The written answer of RCS related with the pattern of the strategy

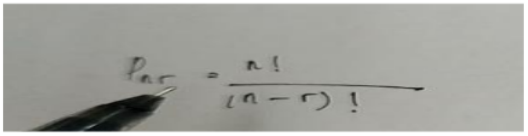
After that, RCS makes sure that the result is correct by having multiplication principle and the pattern by listing the number of the password one by one. RCS writes the numbers arranged in the beginning namely 1, 2, 0 and 7. Then, RCS determines the first constant variable namely 1. RCS lists all the possibilities of the passwords such as: 1270, 1072, 1027, 1702, 1720 and 1207. After listing all of them, then RCS determines the second constant variable namely 2. RCS lists all the possibilities of the passwords such as: 2170, 2107, 2701, 2710, 2071 and 2017. Then RCS determines the third constant variable namely 0. RCS lists all the possibilities of the password such as: 0712, 0721, 0217, 0271, 0172 and 0127. At last, RCS determines the fourth constant variable namely 7. RCS lists all the possibilities of the password such as: 7102, 7120, 7210, 7201, 7012 and 7021. It can be shown in Picture 5 below.



Picture 5.The written answer of RCS related with listing the members

3.2 Student's strategy in Senior High School with impulsive cognitive style (ICS) in solving combinatorial question.

In the beginning, ICS understands the question by reading the question rule first then he takes parts of question by not using his own words. While looking at the question, ICS gets information that Reno and Tomi makes the robot with four digits from the date and the month the robot made that the four digits may not be the same. ICS formulates the information questioned by reading the question command namely: in your opinion, how many passwords that can be made by Reno and Tomi and explain how he can find out. The beginning strategy used by ICS in solving the pattern is that ICS mentions the password in order spontaneously with non random, so that he decides the permutation pattern used. ICS keeps silent because he forgets the name of permutation that is chosen but he writes it correctly, namely $P_{n,r} = \frac{n!}{(n-r)!}$. ICS represents the password and the digits that must be fulfilled by using mathematics symbol, namely n and r. It can be shown in Picture 6 and the interview result below.



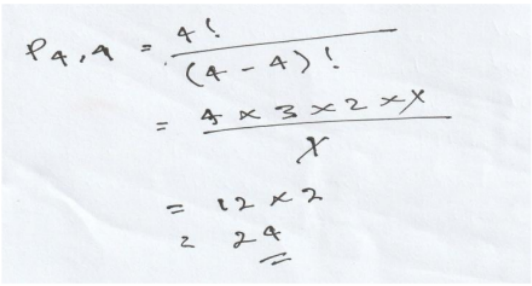
Picture 6. The representation of ICS mathematics symbol

Table 2.The interview sample related with the representation of ICS mathematics symbol

Researcher	:	What is n?
ICS	:	n is the number of the password
Researcher	:	ow
ICS	:	Eh, do you mean they are the numbers for the password?
Researcher	:	How about r?
ICS	:	r is the digit that must be fulfilled

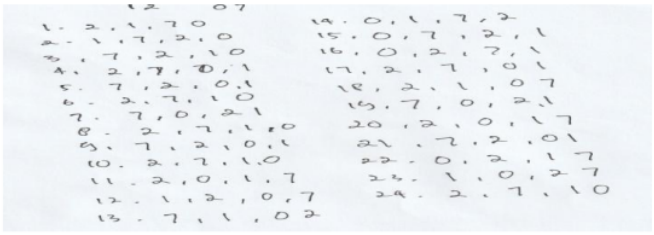
ICS thinks that the exclamation mark is the factorial. ICS thinks that factorial is the multiplication in order from 1. After that, ICS decides the n value is same with 4 because the password is made of the date and the month the robot made and ICS determines the r value is same with 4 because there are four digits. After that, ICS counts it $\frac{4!}{(4-4)!}$. ICS decreases $(4-4)!$, to become $\frac{4!}{1}$. ICS understands that is same with 1. He answers quickly based on the permutation rule. Then, ICS explains 4! to become $\frac{4\times3\times2\times1}{1}$, the he crosses the same number namely 1. Then ICSmultiplies 4 with 3 to become 12 and

finally multiplies12 with 2 to become 24. ICS states that 24 is the number of possibilities in making the password. It can be seen in the Picture 7 below.



Picture 7.The written answer by ICS related with the pattern strategy

Then ICS makes sure his answer by using the strategy of listing its members. ICS writes first the lottery numbers made. After that ICS lists one by one such as the first 2170, the second 1720, the third 7210, in the fourth step ICS changes 2170 to be 2701, then ICS continues to the fifth 7201, the sixth 2710, the seventh 7021, and the eighth 2710. When ICS writes the ninth and the tenth, he makes a mistake because of carelessness such as the ninth is 7201 that repeats the fifth and also same for the tenth 2710 that repeats the sixth. Without realizing his mistakes, ICS continues listing the members that the eleventh 2017, twelfth 1207, thirteenth 7102, fourteenth0172, fifteenth 0721, sixteenth 0271, seventeenth 2701. ICS repeats the fourth, eighteenth 2107, nineteenth 7021 repeats the seventh, twentieth 2017 repeats the eleventh, twenty first repeats the fifth and the ninth, twenty second 0217, twenty third 1027, twenty fourth 2710 repeats the sixth and the tenth. ICS thinks that he is right by seeing the result of permutation strategy without rechecking. It can be shown in Picture 7 below.



Picture 8.The written answer of ICS related with listing member strategy

4. Discussion

This research finds that there is relation between the strategy of RCS and ICS in solving the combinatorial question. Students of RCS and ICS in solving the question are same in answering the question by understanding the question, identifying the information known, formulating the question, doing the representation, and answering the question but they have different strategy and process. It shows that RCS and ICS does the strategy competence based on [11] that competence strategy can be seen from three aspects namely formulating, representing and solving.

In formulating, RCS tends to read slowly with stressing intonation then retell it what he understands by using his own words for the information known and questioned, while ICS reads by taking parts the question without intonation based on the question language, consistent with [3] who states that student with impulsive cognitive style responds faster more carefully. In the representation, RCS represents the beginning situation by using four boxes picture because there are four digits where RCS draws the first box, the second box, the third and the fourth in parallel way and RCS uses the

mathematics symbol representation namely P, n and r. Pn, r is the representation form amount of password orders, n represents the number of the password and r represents the digits. It equals with [12,13] that representing is the interpretation of the question to find out the solution.

In solving stage, RCS uses three strategies namely multiplication rule strategy, pattern strategy, and listing member strategy while ICS uses two strategies namely pattern strategy and listing member strategy. The strategy can be used to solve the combinatorial question refers to [9] who states that solving combinatorial problem needs listing, combinatorial operation, and counting principle. In the counting principle, RCS starts by drawing four parallel boxes as the representation of the password numbers then inputs the numbers in the box base on the rule that the numbers must be different. The numbers are then multiplied based on multiplication principle while ICS does not use this strategy. RCS mentions the strategy as the multiplication principle as [9] states that the multiplication principle is the counting principle. In the pattern strategy, RCS and ICS are similar in using permutation and counting process but they have different reason in determining the pattern. RCS chooses the permutation with different object by seeing the condition that there must be different object, while ICS mentions the order password spontaneously. This refers to [9] that permutation pattern is combinatorial operation. In listing member strategy, RCS and ICS have different listing strategy where RCS tends to be more careful in listing one by one. RCS determines the constant variable first then lists one by one overall. It refers to [10] who states that Odometer is a perfect strategy where students determine variable and enumeration. It refers to [3] that the reflective cognitive style tends to be slower in responding and more careful while ICS tends to be careless so that there are many mistakes in listing by using trial and error strategy. It refers to [10] who states that they can use trial and error way and ICS carelessness is consistent with [3] that impulsive cognitive style responds fast and dare to take a risk.

5. Conclusion

The finding shows that the subject of RCS is more careful in formulating, representing and solving. In formulating, RCS reads the question slowly with stressing intonation and delivers the information by using his own words. In the representation, RCS draws four parallel boxes which represent the number of the digits. In solving, RCS chooses the strategy based on the question rule by memorizing and rechecking one by one. While ICS tend to be spontaneous and careless in doing formulation, representation, and solving. In the formulating step, ICS reads the question first then takes parts the question by not using his own words. In representation, ICS uses mathematics symbol. In solving stage, ICS chooses the strategy fast without seeing the question rule overall and use the strategy spontaneously without rechecking so there are many mistakes found.

References

[1] National Council of Teachers of Mathematics 2000 *Using NCTM's Content and Process Standards* http://www.math.vt.edu/people/lloyd/curriculum/teaching_activity2.pdf. [Accessedon 4 Oktober 2013]
[2] LeshR 1981 Applied mathematical problem solving *Educational Studies in Mathematics* **2**(12) pp 235-265
[3] Acharya Ms Chandrama 2002 Students' Learning Style and Their Implications for Teacher *Center for Development of Teaching and Learning (CDTL)* **5**(6) pp 1-3
[4] Hanali A 2013 *Students' Ways of Thinking about Combinatorics Solution Sets* (America:Arizona State University) p 316
[5] Kapur J N D 1970 Combinatorial Analysis And School Mathematic *Reidel publishing company* **3** pp 111-127
[6] Batanero C, Navarro-Pelayo V, and Godino J 1997 Effect Of The Implicit Combinatorial Model On Combinatorial Reasoning In Secondary School Pupils *Journal Educational Studies In Mathematics* **32** pp 181-199

[7] Syahputra E 2017 Combinatorial Thinking (Analysis Of Students Difficulties And Alternative Solution) *Proc Int Scien and Scien. Edu 7th – 8th October* pp 1-12
[8] Hadar1981 The Road To Solving A Combinatorial Problem Is Strewn With Pitfalls *Educational Studies in Mathematics* **12** pp 435-445
[9] Höveler K 2016 Children´S Combinatorial Counting Strategies and Their Relationship to Mathematical Counting Principles *Jurnal International Congress on Mathematical Education* **1** pp1-8
[10] English L D 1993 Children's strategies in solving two- and three-dimensional combinatorial problems *Journal for Research in Mathematics Education* **3** (24) pp 255-273.
[11] Sukriyani A, Juniati D, and Siswono TYE 2017 Strategic competence of senior secondary school students in solving mathematics problem based on cognitive style *AIP Conference Proceedings* **050009** pp1-6
[12] Ainswort S 2006 Deft: A Conceptual Framework For Considering Learning With Multiple Representations *Elsevier* **16** pp 183-198
[13] Hwang W Y, Chen N S, Dung J J, and Yang Y L 2007 Multiple Representation Skills And Creativity Effects On Mathematical Problem Solving Using A Multimedia Whiteboard System *Educational Technology & Society* **10**(2) pp191-212
[14] Johnson S 1998 What's In A Representation, Why Do We Care, And What Does It Mean? Examining Evidence from Psychology *Automation in construction* **8** pp 5-15

Profile of Students' Strategy in Senior High School with Cognitive Reflective and Impulsive Style in Solving the Combinatorial Questions

ORIGINALITY REPORT

9%	7%	8%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Jenderal Soedirman Student Paper	4%
2	www.semanticscholar.org Internet Source	2%
3	Submitted to Far Eastern University Student Paper	1%
4	mst.polban.ac.id Internet Source	1%
5	A Qolfathiriyus, I Sujadi, D Indriati. "Students' Analytical Thinking Profile Based on Reflective Cognitive Style in Solving Mathematics Problem", Journal of Physics: Conference Series, 2019 Publication	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		