

Neuroscience: "The Process Of Mathematical Creative Thinking Of Vocational High School Students Viewed From Gender And Personality Types Dimension Of Myer Briggs Type Indicator (MBTI) "

N Adiastuty , S.B Waluyo , I Junaedi , Masrukan

¹*Universitas Negeri Semarang, Jl. Kelud Utara III Semarang, Central Java, Indonesia*
E-mail: anitha_dyaz2@students.unnes.ac.id

Abstract. This study aims to find out how the process of creative thinking according to Wallas Theory in Vocational High School students in solving creative thinking problems in terms of personality type dimensions of the Myer Briggs Type Indicator (MBTI) and also gender. The study was conducted in the Department of Multimedia, SMK Negeri 1 Kersana, Central Java. The research method used is the descriptive qualitative method. There are 35 students in a class, we choose 4 subjects from 2 personality types that are dominantly owned by the male and female students, the next step is The researcher gave a test of the ability to think creatively through a description sheet about a matter of validated mathematical creative thinking. The results of this study are two male and two female students have different tendencies in mathematical creative thinking processes in solving creative thinking problems and the processes were influenced also by the personality type of selected students. How the males and females with rational and guardian personality have own different characteristics in every step in process of creative thinking, and it's very unique.

Introduction

Differences in the Characteristics of a Vocational School curriculum with the characteristics of a High School curriculum which emphasizes more on psychomotor skills than the cognitive aspects of students. In the era of globalization and rapid technological advancements, special thinking is needed on how to improve automation and optimization of intelligence so that finally able to master the scientific field that continues to evolve with the times. Future job demands and requirements tend to involve higher levels of knowledge and skills, placing increasingly greater learning demands on the curriculum in Indonesia.

Research [1] found that humans (students) have not optimally used their brains in various ways both to solve problems and find new ideas, the novelty of ideas, creativity, and

innovation. The current education system only focuses on the left outer brain and does not balance with the use of the right brain. This left-brain plays a role in the processing of logic, words, mathematics, and the dominant sequence for academic learning. The right brain that deals with the rhythm of music, images, and creative imagination have not yet received a proportionate proportion to work.

Neuroscience study is science related to the brain and ways of thinking. The process of creative thinking in this study is viewed from gender differences, where gender is currently the research trend variable. This was also revealed [2] who examined by observing data for 6 years in the vocational population and made the conclusion that the ability of male students was higher than female students in mathematics, science, and STEM. To find out the basic ability

of creative thinking skills of each student, researchers also began to pay attention to the process of answering between male and female

students. Following are the results of tests of creative thinking about class X.C students majoring in multimedia in the form of tables

1st Table

Score Of Creative Thinking Test (Silver) Multimedia 10th grades, SMK N 1 Kersana

Number	Gender	Score		Score
		Grade > 76	Grade ≤76	
1.	Males	9	7	16
2.	Females	5	14	19
Totally				35

Based on the results of table 1. the average value of male students is still relatively better when compared to female students. Some of the obstacles by female students are those who cannot think creatively and are also less thorough. This is because female students prefer to memorize formulas and are in a hurry when solving problems so they find it difficult to be creative in other newer ways. In the process of teaching and learning, students do not understand the stages in the process of creative thinking. Human thinking patterns vary greatly depending on gender, but one that affects the mindset of students one of which is the type of personality they have. That way we have to know the type of personality they have because that is the most effective and easiest way to find out fellow human beings with well. So hopefully when the teacher can understand the character and personality type of their students, it can determine the method or model of learning chosen in the classroom.

David Keirse, an expert in psychology from California State University, classifies personality types into 4 types, namely: Guardian, Artisan, Rational, and Idealist [6][7][8][9]. To see the type of personality they have, this researcher uses the MBTI or Myers Briggs Type Indicator application. MBTI was developed by Kathrine Cook Briggs and her daughter named

Isabel Briggs Myers (from which they later came from the name MBTI) in the era of World War II in 1940. This application is very useful to see the type of personality each student has.

Based on the explanation of the problem above. Researchers are very interested in researching at the Vocational School because to be able to see the difference in the creative thinking process of students both male and female students. the difference is also viewed from the personality types they have because each student must have a different personality type and way Different thoughts are different. So this researcher is very interested in conducting a study entitled "The Creative Thinking Process of Vocational Students in terms of Gender and Personality Types of Myer Briggs Dimension Type Indicator (MBTI)"

Methods

This research uses a qualitative research method with a descriptive approach. This data obtained were in the form of descriptive qualitative data, in the form of written or oral words from people and the behavior observed by [1]this study uses indicators of creative thinking according to Wallas to see how students process in solving mathematical problems by looking at each step in doing it. So that researchers can conclude and describe it. The test instrument used to observe

the process of creative thinking is a test to test the ability of students' creative thinking using Indicators of the creative thinking process according to [3]. namely fluency, flexibility, and novelty.

Before determining the sample or subject, data reduction was carried out first using the creative thinking ability instrument and also the personality type based on the MBTI theory. Students were given a questionnaire to find out their personality type, then continued by giving questions about their creative thinking skills. The selected subjects were students with the greatest value of creative thinking skills in the class and

selected 1 male and 1 female guardian personality type and 1 male and 1 female rational personality type. The choice of guardian and rational personality types was chosen based on the results of a questionnaire where the two personality types were dominant in the research class.

The student's creative thinking process uses guidelines developed by Wallas. Theory [11], [12] and [13]. Wallas Theory is the most commonly used to know the creative process which includes four stages namely, (1) preparation, (2) incubation, (3) illumination, (4) verification .. The following stages and indicators are written in table2

2ndTable
Level and Indicator Of Creativity Process (Wallas Theory)

Step	Component	Indicator	Code
Preparation	Look at the problem	Stating about the language itself	A
	Identify the problem	Mention what is known in the problem	B
	Formulate the problem	Mention what that asked the question	C
	Link information with prior knowledge	Relate what is known to the problem with prior knowledge	D
	Think of alternative solutions with the knowledge that is possessed	Think of alternative solutions with the knowledge that is possessed	E
Incubation	Prioritize information / problems	Stop for a moment while working	F
	Arrange concepts or facts to find solutions to problems	Try to think of solutions to problems	G.
	Find key ideas to solve problems or the emergence of "insight"	Describe problem solutions	H
Illumination	Find key ideas to solve problems or the emergence of "insight"	Find a solution to the problem	I
	Build and develop ideas in solving Problems	Determine how / ideas to solve problems	J
Verification	Test the solution to the problem	Applying the method / other ideas are in complete issue	K
	Evaluating solutions	Re- examine the solution to the problem	L

Adopt from (Jannah, 2006)

Results and Discussion

This study was conducted by grouping SMK students according to the personality type dimensions of Myer Briggs Type Indicator (MBTI) and gender. The reduction data process

based on test results that revealed the personality characteristics of the MBTI according to Keirsey. After knowing the personality types of each of these students, the next step is that the researcher chooses 2 personality types that are dominantly

male and female and chooses 4 subjects from 2 personality types that are dominantly owned by the male and female students, the next step is The researcher gave a test of the ability to think creatively through a description sheet about a matter of validated mathematical creative thinking.

After obtaining valid question data, then tests are performed on 4 selected subjects. The subject of this research was a class X.C

Multimedia major. The selection of research subjects is based on several criteria, namely: based on the results of the MBTI questionnaire test adopted from Mudrika (2011) students who have high creative thinking abilities (initial tests of Mathematical Creative Thinking Ability (CBC)), using valid and reliable questions) and the availability of students to become subjects of research.

3rdTable
Subject Of Research

No	Subject	Gender	Type Of Personality
1	AL	Male	Guardian
2	AM	Male	Rational
3	AN	Female	Guardian
4	SA	Female	Rational

Based on the results of the analysis of the data reduction process using the MBTI questionnaire distributed via a questionnaire (online facility), four students were chosen with different types/personality types of MBTI, two were male (AL and AM) and two were female (AN, SA), besides that the initial test results of creative thinking ability also influence the determination of research subjects. Furthermore, the process of analyzing students' creative thinking processes when solving problems related to mathematical creative thinking ability tests on the matrix material. The following is a table of student identities selected for later use only the initials in this article.

Neuroscience in Mathematics Creative Thinking Process

AL Subject

Based on the results of interviews, observations and questionnaires it was concluded that the AL thinking process can be described as the following table, the following is a breakdown of the steps that the Navy conducted when completing three validated creative thinking questions that were in accordance with the mathematical creative thinking indicators

4thTable

Data Triangulation of Students' Creative Thinking Process Stage in Solving the Matrix Type of Personality Guardian Initials AL

Step	AL Creative Subjects (Males) Type : Guardian
Preparation (A,B,C,D,E)	<ul style="list-style-type: none"> • Students can understand the problem by reading 2-3 times • students can pass this stage perfectly

<p>Incubation</p> <p>Coding</p> <p>F</p> <p>G</p> <p>H</p>	<ul style="list-style-type: none"> • Students cannot prioritize information by pausing for a break (refreshing) leaving themselves from the problem (problem). • Students can map out concepts or facts to find solutions to problems by trying to think of solutions to problems based on a plan from the beginning that has been made. Besides thinking of other ways also think of other ways that can be used to solve problems by trying to apply methods or formulas that are already owned.
<p>Illumination</p> <p>Coding</p> <p>I</p> <p>J</p>	<ul style="list-style-type: none"> • Students can find key ideas to solve problems or the emergence of "insight" by finding solutions to problems that are given. This is indicated by writing a solution based on the initial plan that has been made previously and based on logical reasons. • Students cannot build and develop ideas in solving problems by finding other ways to solve problems.
<p>Verification</p> <p>Coding</p> <p>K</p> <p>L</p>	<ul style="list-style-type: none"> • Students can test problems by applying other methods found in the Illumination stage, but Students cannot test problems by applying other methods found in the Illumination stage • Students can evaluate solutions by re-examining solutions by matching solutions between one method and another.

Note: Red/underline: The stage of a creative thinking process that cannot be passed or is not the same as the test stage I to stage III.

Based on table 4 it can be concluded that male students with Guardian personality types can go through the stages of preparation, incubation, verification well, because in the preparation stage students can understand the questions only by reading 2-3 times, but at the incubation stage students don't have time to stop for a moment because students rush to finish quickly and only in the Illumination stage the subject was able to build a solution to the problem using the idea but in stage III students have not been able to develop the idea because students cannot implement other methods, because according to students the

problem is too difficult must require logic high so that students can only do it using one method commonly applied by the teacher.

AM subject

Based on the results of interviews, observations and questionnaires it was concluded that the MA thought process can be described as the following table, The following are details of the steps taken by the MA when completing three validated creative thinking questions that are in accordance with mathematical creative thinking indicators

5thTable

Data Triangulation of Students' Creative Thinking Process Stage in Solving Matrix Problems of Personality Type Rational Initials AM.

Step	The Process of Creative Thinking for AM Subjects (Men)
	Rational

Preparation Coding (A,B,C,D,E)	<ul style="list-style-type: none"> • Students can formulate problems by mentioning but not writing down the known elements • Students can formulate problems by mentioning but not writing down the element in question
Incubation Coding F G H	<ul style="list-style-type: none"> • Students cannot prioritize information by pausing for a break (refreshing) leaving themselves from the problem (problem). • Students can map out concepts or facts to find solutions to problems by trying to think of solutions to problems based on a plan from the beginning that has been made. Besides thinking of other ways also think of other ways that can be used to solve problems by trying to implement the methods that are already owned.
Illumination	<ul style="list-style-type: none"> • students can pass this stage perfectly
Verification (K,L)	<ul style="list-style-type: none"> • Students can test problems by applying other methods found in the Illumination. • Students cannot evaluate solutions by re-examining solutions by matching solutions between one method and another.

So based on table 5 it can be concluded that male students with the Rational personality type can get through the preparation phase quite well, because it only takes 1 time to read the students can understand the purpose of the questions given, but there are several stages of preparation that are missed namely where students only mention information elements that are known and asked but students do not write down elements that are known and asked. At the incubation stage students tend to be directly in the process of doing it and do not have time to stop because students feel they have understood it. In the Illumination stage students can find ideas correctly and correctly. At the verification stage students can

apply other methods but the results are less precise because students feel rushed in doing so do not have time to check the results of the answers.

AN subject

Based on the results of interviewed, observations and questionnaires it can be concluded that the AN thinking process can be described as the following table, following are the details of the steps AN undertook when completing three validated creative thinking questions that were in line with mathematical creative thinking indicators

6th table

Data Triangulation of Students' Creative Thinking Process Stage in Solving AN Initial Guardian Personality Type Matrix Problem.

Step	The Creative Thinking Process of AN (Female) Subjects Type : Guardian
Preparation	<ul style="list-style-type: none"> • students can pass this stage perfectly
Incubation	<ul style="list-style-type: none"> • students can pass this stage perfectly
Illumination (I,J)	<ul style="list-style-type: none"> • Students can find key ideas to solve problems or the emergence of "insight" by finding solutions to problems that are given. However, weakness occurs in the

third stage because students cannot build and develop ideas in solving problems by finding other ways to solve problems.

<p>Verification</p> <p>Coding</p> <p>K</p> <p>L</p>	<ul style="list-style-type: none"> Students cannot checked problems by applying other methods found in the Illumination stage Students can evaluate solutions by re-examining solutions by matching solutions between one method and another.
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Note: Red: The stage of a creative thinking process that cannot be passed or is not the same as the test stage I to stage III.

So based on table 6 it can be concluded that female subjects with Guardian personality types can go through the stages of preparation, incubation, verification well, but only at the Illumination stage the subject has been able to build a solution to the problem using the idea but at stage III students have not been able to develop the idea because students cannot apply other methods, because according to students the problem is too difficult must require high logic so students can only work using one method that is commonly applied by the teacher.

SU subject

Based on the results of interviews, observations and questionnaires it was concluded that the SU thought process can be described as the following table, SU can go through every stage of the thought process properly and coherently. The following are the details of the steps that the SU conducted when completing three validated creative thinking questions that were in accordance with the mathematical creative thinking indicators

7thTable

Data Triangulation of Students' Creative Thinking Process Stage in Solvi ng the Problem of Personality Type Rational Initials SU.

Step	The Process of Creative Thinking for SU Subjects (Female) Type : Rational
Preparation	• students can pass this stage perfectly
Incubation	• students can pass this stage perfectly
Illumination	• students can pass this stage perfectly
Verification	• students can pass this stage perfectly

Difference in Creative Thinking Process Between Males and Females

Based on 4 subject on this research it can be concluded that female students with the rational personality type can go through the stages of preparation incubation illumination and verification well, but in the preparation stage students can understand the questions by reading over and over again, but at the incubation stage students have paused to rest to compress the brain and stretch the hands that are weak from writing. In the Illumination stage students can already

build solutions to problems using their ideas appropriately. At the verification stage students can apply other methods correctly and correctly and when given a problem that is a bit difficult students can work on it by developing ways in the book with those on the internet by tweaking themselves until they find the answer.

Of the four selected samples, all four have different thought processes. When viewed from gender Girls students have a tendency to coherent or according to the flow or stage of thinking according to Wallas Theory [13] , they have only

a few deficiencies in stages three and four. While male students have many jumps in the stages of thinking, or there are some indicators that are not found in each stage. However, when viewed in terms of personality, rational types have characteristics that are more thorough and detailed in understanding a problem, and guardian types tend to be less careful in making decisions and conclusions.

In Neuroscience theory, There is a gender-specific advantage which is domain general: Females good in verbal and spatial or males good in quantitative, although has not been clearly corroborated [4]. But gender cannot affect general intelligence [14], Different research on creativity to explain that there is a relationship between gender differences in Male and female with the level of creativity of the students both in quantity and quality [15].

Assess the function of the brain woman explained that the structure of the brain, there is a difference between the brain men and women, differences in ways of thinking, a way of looking at things, a way of communicating, and so forth. This different way of thinking also influences students' creative thinking processes [16]. The results showed that men's thinking styles are more legislative, liberal, and global, while women's thinking styles are more executive, juridical, conservative, and local. Students with female sex tend to be higher on indicators of fluency, originality, and elaboration. Male students tends to be higher aspect of his flexibility, although the different is not too significant when compared to thinking ability of female students.

Conclusion

From four subject ini this research concluded that female student with the rational personality, male student with rational personality, female student with guardian personality and male student with guardian personality.

we can find out how the process of creative thinking according to: Wallas Theory in Vocational High School students in solving creative thinking problems. Gender differences affect the thinking process of students in solving creative thinking problems, because in theory of neuroscience, that men and women do have different brain structures that affect the thought process of solving problems. In addition to the gender factor, the student's personality also influences the thought process, because a person's personality is a character formed over the years that affects a person's thinking habits in getting things done.

This topic is very interesting to be studied further and in depth. However, further research should be done by connecting the three variables to see how the relationship between gender, personality and creative thinking processes in solving creative thinking problems in quantitative research to generate general conclusions. For better results research should combine science in the field of Mathematics Education as well as psychology and medical science, this is in accordance with the advice given

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