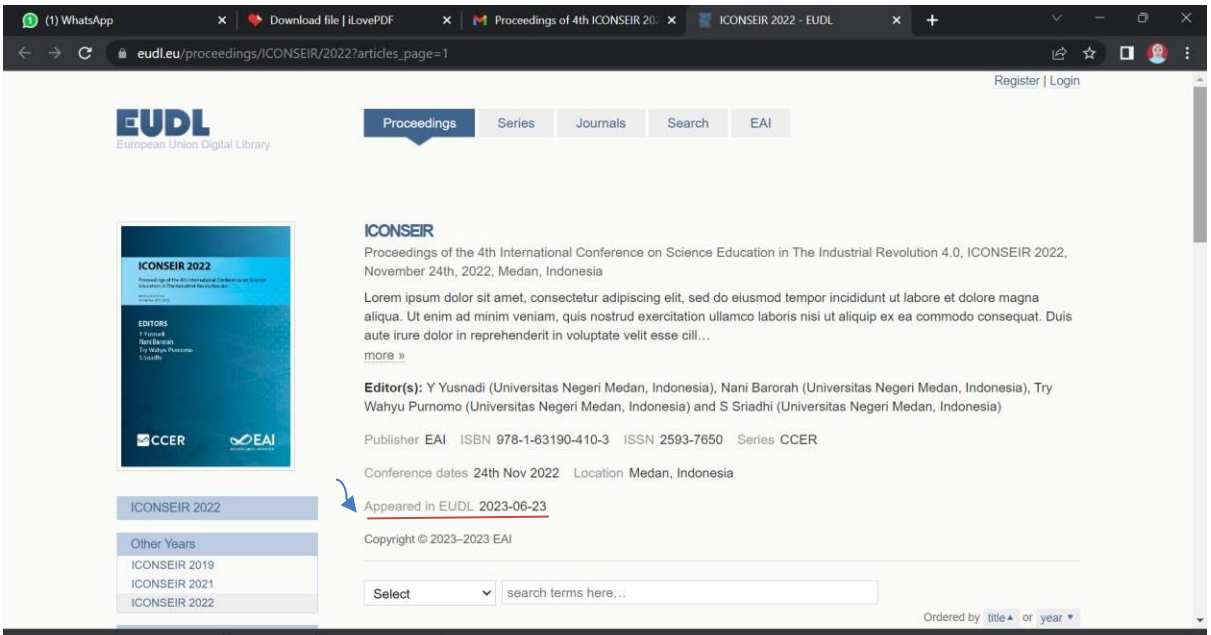
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Publisher EAI ISBN 978-1-63190-410-3 ISSN 2593-7650 Series CCER
Conference dates 24th Nov 2022 Location Medan, Indonesia
Appeared in EUDL 2023-06-23
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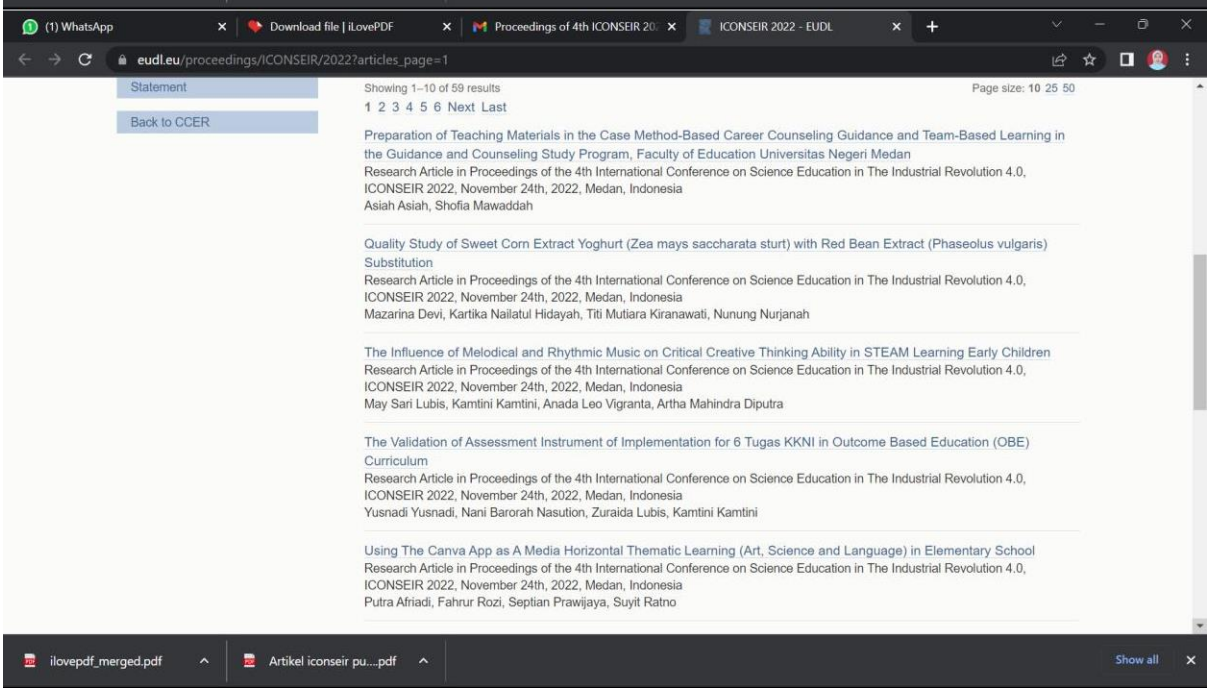
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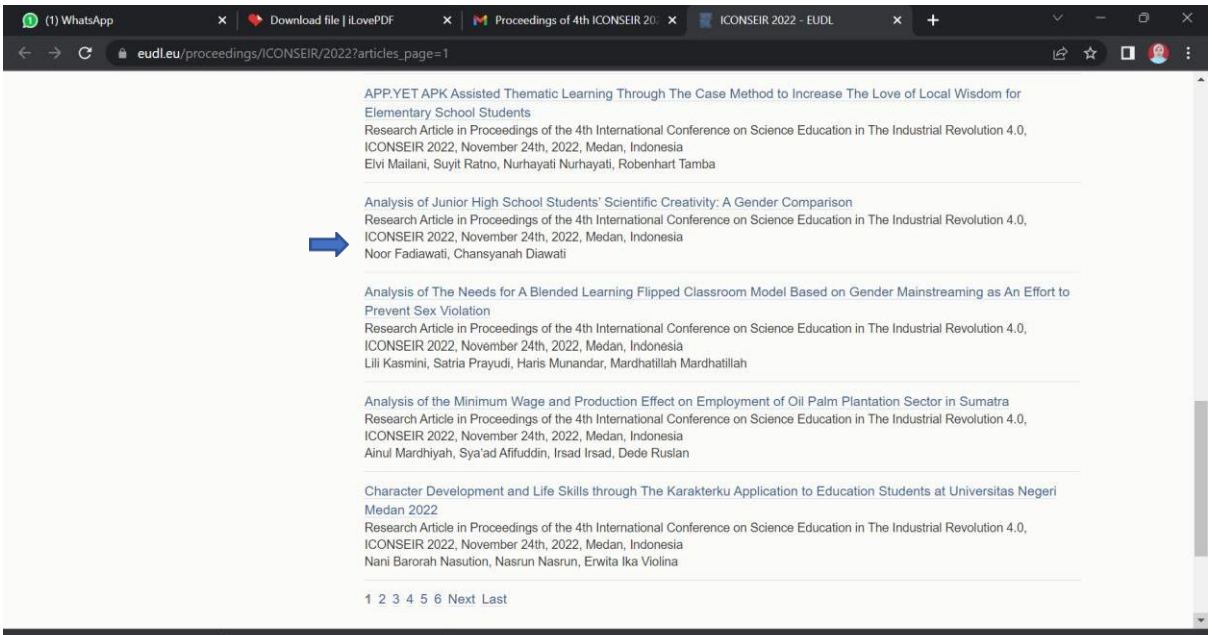

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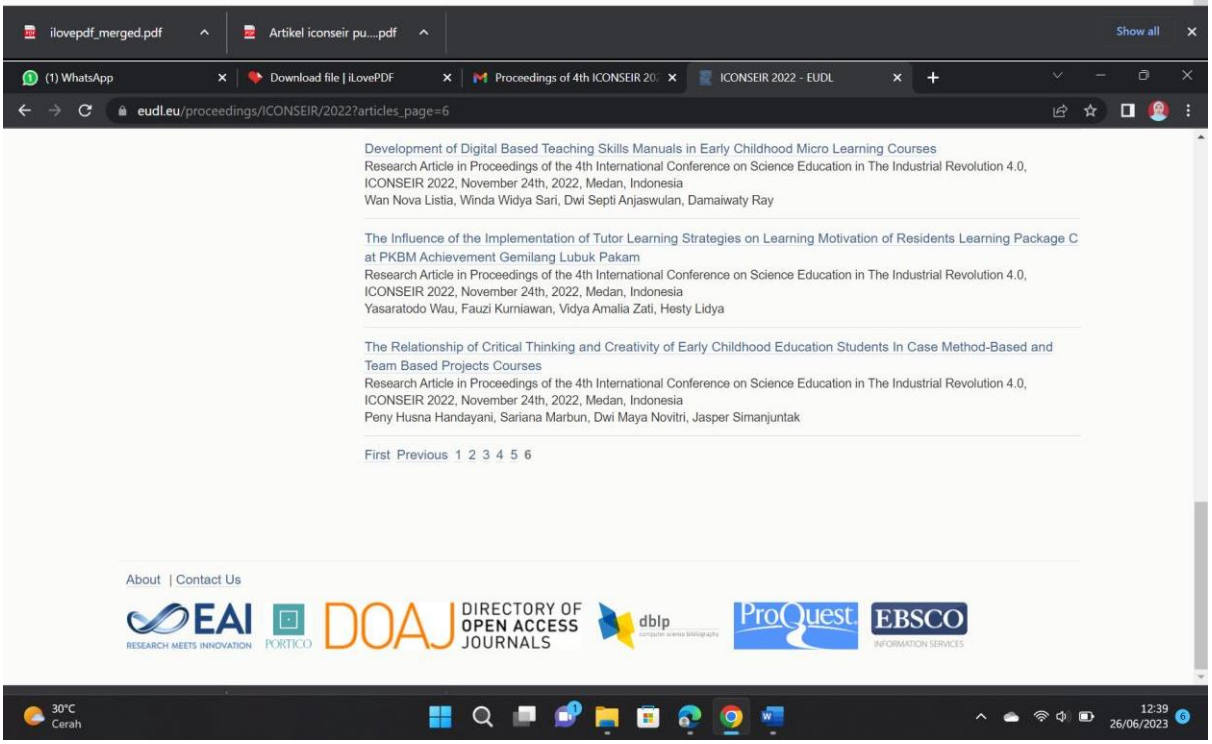

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Analysis of Junior High School Students' Scientific Creativity: A Gender Comparison

Noor Fadiawati[1], Chansyanah Diawati[2]

{noor.fadiawati@fkip.unila.ac.id[1], chansyanah.diawati@fkip.unila.ac.id[2]}

Universitas Lampung, Bandar Lampung, Indonesia

Abstract. Research on scientific creativity has been widely carried out. This study aims to determine whether is there any difference in scientific creativity between boys and girl students. These things are important to research, because the effectiveness of the learning process can be further improved if educators know the characteristics of their students. The research has used a qualitative method, and the data collection used a scientific creativity test instrument by Hu & Adey. The research subjects were 114 junior high school students in grade 9, has been selected using a purposive sampling technique. The research data were analyzed descriptively, and statistically using the independent t-test. The results showed that there is no significant difference in scientific creativity between boys and girl students, although there is a tendency for female students' scientific creativity to be greater than male students

Keywords: Scientific creativity, junior high school students, gender.

1 Introduction

Today's students need to prepare to face complex global challenges. One of the main goals of education is to increase their creativity. Researchers and educational policy makers believe that efforts to foster student creativity will produce skilled resources in the future [1]. Students must hone their potential while studying at school, in order to be able to solve problems in the future [2,3]. Creativity means creating new designs and according to high value [4]. Creativity and Intelligence are closely linked concepts, so much so that the existence of one is the measure of the other [5]. The general consensus is that the main components of creativity are domain-specific knowledge and skills [6-8]. In science education, creativity related to scientific creativity [1,9,10]. It is demonstrated as a personal ability that makes people inclined to design different and useful products needed to generate scientific ideas, theories, methods, or findings [11,12]. Therefore, scientific creativity is a creativity that separate from general creativity, in other words, it stand-alone [13, 14].

Research on scientific creativity (SC) has been widely carried out in the last two decades, some researchers focus on its effect on learning outcomes, such as science process skills, critical thinking, and problem solving to prospective science teachers [15] [16] [17]. The research finding indicated that SC was related to the improvement of the studied learning outcomes. other researchers focus on SC as a result of learning from various approaches and learning models that are applied [10,18-25], The findings are that all models or approaches applied can increase students' scientific creativity.

Many studies on the relationship between creativity and gender have been conducted [26-

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DOI 10.4108/eai.24-11-2022.2332686

31]. Some studies showed a significant role of gender in differentiating creativity, indicated that male students have higher creativity than female, but other finding did not support the hypothesis regarding the significance of gender. Torrance, stated that there are no gender differences in performance on tests measuring creative potential, but there are some significant differences between gender in self-perception: female did not perceive themselves as inventors and were strongly influenced by their environment [26]. Other study found that statistically significant differences on the majority of subtest, between males and females with women prevalence, and gender differences creativity is greater among students in grade 8 than in grade 11 [27]. Baer and Kaufman argue that any gender differences in creativity probably stems from environmental factors [30]. Other author considered the creative process to be essentially the same among humans, as it arises directly from some fundamental features of the human brain as an information processing system, and argues that there are other aspects that can work differently depending on gender, ethnicity, socioeconomic level or demographic variables [31]. However, research on gender and scientific creativity as stand-alone creativity is rare. Therefore, creativity and its relation to gender need to be investigated.

So that the research problem is there any significant difference in the SC of 9th junior high school students between boys and girls in Provinsi Lampung?

1.1 Scientific Creativity

Scientific creativity is a process of interaction between general creativity, science-related skills, and scientific knowledge, to produce original ideas or product [32]. It means, SC is creativity that is specific to science [1,9,10]; that separate from general creativity or stand-alone [13,14]. There are several models of SC, some of which are often referred to by researchers are Hu and Adey's Scientific Structural Creativity Model [8], Son's Scientific Creativity Model [33], and Park's Scientific Creativity Model [34].

The theoretical framework of SC used in this research is based on the Scientific Creativity Structure Model (SSCM) developed by Hu and Adey [8]. A three-dimensional model of scientific creativity developed Hu and Adey which consist of a personal or individual characteristic, product, and process. The dimension of individual characteristic consists of three aspects, namely fluency, flexibility, and originality, adopted from Torrance's definition of creativity [26]. Fluency is the ability to generate similar ideas, flexibility is the ability to generate ideas from a variety of categories, originality is the ability to generate rare ideas [6]. Product dimensions named creative product consist of four aspects, namely technical products, scientific knowledge, science phenomena, and science problems. Technical product relates to the ability to think about product improvement. The third dimension is the creative process, includes aspects of imagination and thinking.

2 Research Method

This research has used qualitative methods, was conducted on the three junior high schools in three districts in Provinsi Lampung. The research subjects were 114 junior high school students in grade 9, has been selected using a purposive sampling Technique. The Scientific Creativity Test (SCT) used in this research was developed by Hu & Adey [8], as a data collection instrument. The SCT consists of seven open-ended questions as presented in

Table 1, designed to measure seven aspects of SC, namely “unusual uses”, “problem finding”, “product development”, “scientific imagination”, “problem solving”, “scientific experiment”, and “product designing”. The SCT instrument used has previously been adapted according to the context in Provinsi Lampung. The adaptation of the SCT instrument is to replace apples with guava in item 7, because students are not familiar with apple trees.

SCT involves 144 junior high school students in Provinsi Lampung (consisting of 63 girls and 51 boys), namely 55 students in Kota Metro, 32 students in Kabupaten Tanggamus, and 27 students in Kabupaten Pesawaran. After the test, the answers given to the SCT are scored. The Score of the data obtained were analyzed statistically by independent t-test, and qualitatively analysis was carried out using, including data reduction, coding, and categorization [35]. The detailed scoring of task items is presented in Table 1.

Table 1. The item task and scoring of SCT

Item	Task	Scoring
1	Please write down as many as possible scientific uses as you can for a piece of glass *For example, make a test tube*	Task item 1 – 4 Fluency score: 1 point for each correct response Flexibility score: 1 point for each field category Originality score: 2 point for each response given by less than 5% of people, 1 point for between 5% to 10%, if greater than 10% it is given 0 point
2	If you can take a spaceship to travel in the outer space and go to a planet, what scientific question do you want to research? Please list as many as you can. *For example, are there any living things on the planet?*	
3	Please think up as many possible improvements as you can to a regular bicycle, making it more interesting, more useful and more beautiful. *For example,make the tyres reflective, so they can be seen in the dark*	Task item 5 Flexibility: 1 point for each category of the method Originality: 3 point for each response given by less than 5% of people, 2 point for between 5% to 10%, if greater than 10% it is given 1 point
4	Suppose there was no grafity, describe what the world would be like? *For example, human beings would be floating*	
5	Please use as many possible methods as you can to divide a square into four equal pieces (same shape). *Draw it on the answer sheet*	Task item 6 Flexibility: a maximum of 9 points for each method (3 points each for instruments, principles and procedures) Originality: 4 point for each response given by less than 5% of people, 2 point for between 5% to 10%, if greater than 10% it is given 0 point
6	There are two kinds of napkins. How can you test which is better? Please write down as many possible methods as you can and the instruments, principles, and simple procedure	
7	Please design an *guava** picking machine. Draw a picture, point out the name and function of each part	Task item 7 Flexibility: 3 point for each function Originality: 5 point for each response given by less than 5% of people, 3 point for between 5% to 10%, if greater than 10% it is given 1 point

**apple in SCT replaced with guava*

3 Result and Discussion

SCT was applied to see the differences in the SC of 9th grade junior high school students between boys and girls. The results of data analysis of SCT on seven aspects are presented in Table 2.

Table 2. Average scores of SCT on boys and girl students

		Average Scores SCT Aspect							
Gender	N	Unusu-al uses	Finding the problem	Product deve-lopment	Scientific Imagina-tion	Problem Solving	Scientific Experiment	Product Desig-ning	Total
Girls	63	2.14	6.05	4.54	4.48	3.62	3.24	4.24	28.30
Boys	51	1.75	4.27	4.14	3.88	3.90	3.00	4.41	25.35

In Table 2, there are 5 aspects where the average score of girl students is higher than boys, on the other hand, there are 2 aspects, whereas the average score of boys is higher than girls. However, when an independent t-test was conducted, only 'the finding the problem aspect' showed a significant difference. The results of independent t-test on seven aspects of scientific creativity can be seen in Table 3.

Table 3. Independent t-tes analysis of scientific creativity test score

	Gender	N	Average	Sig	t	t_{tab}	df	Sig(2-tailed)
Unusual Uses	Girls	63	2.14	.990	.948	1.983	112	.345
	Boys	51	1.75					
Finding the problem	Girls	63	6.05	.745	2.397	1.983	112	.018
	Boys	51	4.27					
Product development	Girls	63	4.54	.146	.720	1.983	112	.473
	Boys	51	4.14					
Scientific imagination	Girls	63	4.48	.633	1.216	1.983	112	.227
	Boys	51	3.88					
Problem solving	Girls	63	3.62	.116	-.708	1.983	112	.480
	Boys	51	3.90					
Scientific Experiment	Girls	63	3.24	.849	.512	1.983	112	.609
	Boys	51	3.00					
Product Designing	Girls	63	4.24	.412	-.213	1.983	112	.832
	Boys	51	4.41					

The results of statistical analysis on seven aspects, it seen that the two data groups have homogeneous variance, it is indicated by the Sig value > 0.05. Only on the aspect of 'finding the problem' that differs significantly (Sig 2-tailed < 0.05 and $t_{count} > t_{table}$).

When the SCT results are analyzed based on the dimensions of trait, consisting of fluency, flexibility, and originlaty; the data obtained are as presented in Table 4.

Table 4. The average fluency, flexibility, and originality scores of 9th grade students

	Gender	N	Average	Sig	t	t_{tab}	df	Sig(2-tailed)
Fluency	Girls	63	7.38	.223	2.428	1.983	112	.017
	Boys	51	5.94					
Flexibility	Girls	63	12.59	.214	1.044	1.983	112	.299
	Boys	51	11.55					
Originality	Girls	63	8.33	.746	.584	1.983	112	.560
	Boys	51	7.86					

The results of statistical analysis on the dimension of individual trait, it seen that both data girls and boys group have homogeneous variance. The three aspects on the dimension of individual traits/characteristics showed the average score of girls is higher than of boys, but only fluency aspect differ significantly. It is Indicated by the value of (Sig 2-tailed) < 0.05, and $t_{count} > t_{table}$. In this study hypothesis testing was carried out at the 95% confidence level.

In general, it can be stated that there is no significant difference in SC between boys and girl students. Although there are significantly different aspects, but only a small part. This finding is in line with previous finding which stated that there are no gender differences in performance on tests measuring creative potential [26], [28]. The trend of female students' SC scores being higher than male students is in accordance with previous findings [29], but contrary with other finding [30], [31]. This finding shows that the relationship between gender and creativity in general and SC has not been clearly expressed, because it is influenced by many factors such as gender, ethnicity, socioeconomic level or demographic variables [31].

The qualitative finding related to task item number one to five are presented respectively in Table 5, Table 6, Table 7, Table 8, and Figure 1.

Table 5. Categories to be generated from the answers about question number one

Category Code	Category Name	Girls	Boys
A1	Use for research	√	√
A2	Use for chemistry	√	√
A3	Use for physics	√	√
A4	Use for biology	√	√
A5	Use for other	√	√

It can be seen that there are only 5 categories be generated from the answers of 9th grade junior high school students. The answers given by students were 112, categorized based on the similarities and differences, then coded, obtained 5 categories as presented in Table 5. The categories that appear between boys and girl students are not different, probably because the knowledge and experience in everyday life is the same. The number of categories obtained is much less compared to the results of other studies that give rise to 12 categories, with a sample of prospective teachers [17]. This is reasonable, because in SC there is a component of knowledge, meaning that the creativity that arises is influenced by the amount of one's

knowledge. Therefore, prospective teachers who have more knowledge will be more creative than junior high school students.

Table 6. Categories to be generated from the answers about questions number two

Category Code	Category Name	Girls	Boys
B1	Is there life on the planet?	√	√
B2	Can living things from earth live there?	√	√
B3	What is the climate on the planet?	√	√
B4	Does it have gravity?	√	√
B5	What is the size of the planet?		√
B6	How old is the planet?		√
B7	How is solar system on the planets?	√	

From 256 answers given by students, 7 categories were obtained as shown in Table 6. There were 6 categories that emerged from the answers of boys and 5 categories of answers from girl students.

Table 7. Categories to be generated from the answers about question number three

Category Code	Category Name	Girls	Boys
C1	Installed the engine/propeller so that it can fly	√	√
C2	Decorated to make it more attractive	√	√
C3	Added a float so that it can be used on the water	√	√
C4	Expand the seat	√	√
C5	Made to be folded so that it is compact when stored	√	
C6	Adding two small wheels on the rear wheel so that it is used for people with special needs	√	
C7	Add a solar/electric engine so you don't have to pedal	√	√
C8	Add radio music so you can sing while pedaling a bicycle	√	√
C9	Adding luggage to store items	√	
C10	Adding jagged tires so that you can walk on slippery roads		√

From 198 answers given by students, 10 categories were obtained as shown in Table 7. There were 7 categories that emerged from the answers of boys and 9 categories of answers from girl students.

Table 8. Categories to be generated from the answers about question number four

Category Code	Category Name	Girls	Boys
D1	Living things will perish	√	√
D2	Floating seawater		√

D3	No means of transportation	√	
D4	The earth will be chaotic/destroyed	√	√
D5	No buildings		√
D6	There is no change of time of day and night	√	
D7	Earth does not rotate on its exist	√	

From 212 answers given by students, 7 categories were obtained as shown in Table 7. There were 4 categories that emerged from the answers of boys and 5 categories of answers from girl students. Based on students' answers to number 5, five categories were obtained, as shown in Figure 1.

Fig. 1. Categories that emerged from students' answers about divide a square

Category E1, E2. And E3 emerged from the answers of boys and girl students. Category E4 emerged from the answers of boy students, while category E5 emerged from the answers of girl students.

The number of categories that appear is almost the same between male and female students. This is probably due to the knowledge of science that they get mostly from school, which of course is relatively the same between all students. Experiences in everyday life may also affect students' creativity. The experience between students in the same area may not be too different from one student to another. This is in accordance with the opinion of previous researchers [31] who said that the creative process to be essentially the same among humans, as it arises directly from some fundamental features of the human brain as an information processing system, and argues that there are other aspects that can work differently depending on gender, ethnicity, socioeconomic level or demographic variables. This qualitative finding supports the statistical test results.

4 Conclusion

The conclusion in this study is that there is no difference in scientific creativity based on gender. However, in most aspects girl students' scientific creativity is slighty higher than boys. This finding is different from some previous findings, where boys are superior in terms of creativity than girls.

Acknowledgement

Several parties have participated in this research. For this reason, I want to thank the principal who has given permission for the research, and the teachers who have assisted in data collection, namely Mr. Nasiruddin, Mrs. Anadia Rosaria, and Mrs. Nanda Wiguna.

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