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The Fourth International Conference on Combinatorics, Graph Theory, and Network Topology 2020

Dafik

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We gratefully acknowledge the presence of all participants on "The Fourth International Conference on Combinatorics, Graph Theory, and Network Topology (ICCGANT)". It is the 4th International conference of the CGANT Research Group to be held on 22-23 August 2020 by the University of Jember in collaboration with the Indonesian Combinatorics Society (INACOMBS). The conference welcome participants from several countries, with a wide and varied variety of mathematics research interests, in particular combinatorial research. It has been an annual international conference where members of society organizations, research students, educators and researchers, writers, physicists, teachers and practitioners meet and exchange ideas to communicate and discuss theoretical and practical knowledge of mathematical research and its applications. The aim of the fourth conference is to present and discuss the latest research that leads to the exchange of new theoretical, analytical and scientific knowledge and bring it to a deeper understanding of the fields of mathematics, application of mathematics, and mathematics education. The topics of this conference have been displayed on the ic.cgant.unej.ac.id website.

The conference was undertaken in dual modes, namely virtual and face-to-face basis, either for the plenary and parallel session. We invited five speakers in the plenary session. They are from Australia, India, and Indonesia. In detail, Prof Adil Baghirov, Ph.D and Dr Joe Ryan are from Australia, Dr. M. Venkatachalam from India, and Prof. Dr. Basuki Widodo, M.Sc., and Prof. Drs. Slamin, M. Comp. Sc, Ph.D are from Indonesia. Due to the travel restriction in the Covid-19 outbreak, the speakers from abroad delivered their slide presentation virtually, as well as the participants who stay far from Jember town joined the conference virtually by using ZOOM cloud meeting. For attaching and submitting the abstract and manuscript of the conference, we use online platform, namely Easychair system. The participants who stay nearby Jember town, they joined the conference in face-to-face basis. We had 58 participants were joining in person. They were placed in two classrooms respected to the medical protocol for Covid 19. Thus, each room of 98 m^2 area consisted of 29 participants. The time spent for each speaker was 60 minutes, and Q/A session after plenary session was run within 30 minutes. The total number of participants was 186 people, and the number of submission received by ICCGANT 2020 committee was 147. The number of paper sent to reviewer was 105 papers, and the number of accepted submission papers is 86 papers. Thus the acceptance rate is 58.5%.

The participants of ICCGANT 2020 were a bit less than the participant of ICCGANT 2019, since this year's conference was held coincidentally with the Covid-19 outbreak. However, the pandemic does not stop us to carry out researchers, we have been still hardly working on this job and persistently motivated the participants to finish their papers for publication. Finally, we have successfully selected some papers to be published on IOP Conference Series: Journal of Physics of 86 papers.

Furthermore, on behalf of the organizing committee, we thankfully accept the support of this conference from the University of Jember. We would also like to express our sincere gratitude to all the lovely participants who have engaged in this unforgettable and important science forum.

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Peer review statement

The committees of the Fourth International Conference on Combinatorics, Graph Theory, and Network Topology would like to express gratitude to all Committees and Reviewers for the volunteering support and contribution in the editing and reviewing process.

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Peer review declaration

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Peer review declaration

All papers published in this volume of Journal of Physics: Conference Series have been peer reviewed through processes administered by the Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

- **Type of peer review:** The type of peer review article is Double-blind review where the authors name and affiliation of the paper are hidden. The reviewer independently made some suggestion and corrections on the papers.

- **Conference submission management system:** All the papers were submitted online through EasyChair system https://easychair.org/conferences/?conf=iccgant2020

- **Number of submissions received:** 147

- **Number of submissions sent for review:** 105

- **Number of submissions accepted:** 86

- **Acceptance Rate (Number of Submissions Accepted / Number of Submissions Received X 100):** 58.5%

- **Average number of reviews per paper:** 3

- **Total number of reviewers involved:** 63

- **Any additional info on review process:** The reviewers gave some feedback to each paper based on the referring guidelines such as state of the art of research, methodology, gap, a proposed novelty, originality, and language. They also review the originality of the research finding, and the bibliography cited in their paper. In general they have made refereeing on three things, namely the content, layout, and language.

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The development of tangram-based geometry test to measure the creative thinking ability of junior high school students in solving two-dimentional figure problems

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The development of tangram-based geometry test to measure the creative thinking ability of junior high school students in solving two-dimentional figure problems

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Abstract. Geometry is a branch of mathematics that demands creative thinking. Teachers need a geometry instrument that is fun, simple, and meaningful to measure the creative thinking ability of junior high school students. This developmental research used a 4-D model consisting of defining, designing, developing, and disseminating the tangram-based geometry test. This research was intended to describe the process of developing a tangram-based geometry test. Tangram-based geometry test development included validation by experts. The product has passed the validation stage and obtained a score of 4,47 (scale 1-5), so it was feasible to use. Research try out subjects were 3 out of 30 students who were VIII grader at junior high school that was chosen due to van Hiele levels. Data on students' creative thinking profile acquired through tests and interviews. Fluency, originality, flexibility, and elaboration are the aspects of creative thinking ability. The results showed that in solving tangram-based geometry tests, a student at the creative level (level 3) satisfied all aspects of creative thinking, a quite creative student (level 2) satisfied fluency and flexibility aspects, and almost uncreative student (level 1) satisfied fluency aspect only. According to the results, this developed tangram-based geometry test was valid, feasible, and effective to measure junior high school students' creative thinking ability.

1. Introduction

Education is an essential element for the holistic development of the individual, society, and the nation because education takes the most part in creating the quality of Human Resources (HR) [1]. One of the subjects that must be in the education curriculum in Indonesia is Mathematics. Students are equipped with problem-solving abilities in learning mathematics, including critical, logical, and creative thinking ability. Seeing this fact, mathematics is necessary. Geometry is a branch of mathematics that studies points, lines, planes, and spaces, along with their properties, sizes, and relationships to one another.

Geometry is enjoyable and more comfortable to learn because it studies the visual patterns that can be linked to the real physical world. However, students' result in learning geometry was still not satisfying yet. This was clearly shown by the results of students' scores measured by the standard used internationally. The results of TIMSS 2015 and PISA 2015 showed that The mathematics ability of Indonesian students was still at the low benchmark [2]. Students faced difficulties in solving geometry problems, especially with applying and reasoning problems of geometry. Geometry presents various problems that require individuals to think divergent that is closely related to creative thinking [3].

Creative thinking is a thinking ability that allows students to apply their imagination and remain flexible in creating new ideas, alternatives, or possibilities and seeing new relationships between existing definitions that might be needed in solving problems and challenges [4, 5].

The problems in learning geometry in schools lie in the learning method, in which teachers are less varied and ignore visual media. Visual media and physical activities help the teacher facilitate a clear and accurate explanation, attract attention, and describe facts that might be quickly forgotten if not visualized [6]. A simple aid that teachers can choose as media in learning geometry, moreover, supports the development of students' creative thinking is Tangram.

Tangram is a Chinese puzzle consisting of a square card or board cut straight into several pieces of different sizes. The Tangram parts are geometric shapes, one piece of square, five pieces of triangles, and one piece of parallelogram [7]. Tangram may boost students' interest in mathematics, empower the student to distinguish various forms, develop students' understanding of the characteristics of shapes, find the relationship between the seven pieces of Tangram, and able to explore existing tangrams with the new forms that they imagine so it can increase their creativity [8].The use of Tangram can increase students' creativity by integrating it with the van Hiele learning phase. Van Hiele classified geometric thinking ability into five levels, visualization (level 0), analysis (level 1), informal deduction (level 2), deduction (level 3), and rigor (level 4)[9, 10]. Tangram game links to students' creative thinking ability. Playing tangram puzzles is an effective method to improve children's geometric thinking ability. Tangram provides students with empirical experiences [11]. In junior high schools, tangrams can be used in various tasks, such as finding area, axes of symmetry, and similarity of shapes, as well as proving the Pythagorean Theorem.

Encouraging students' creative thinking ability entails an instrument that embraces the fundamental aspects of creative thinking ability [12]. However, teachers still did not have sufficient test instruments. The test instrument is useful for providing stimulants to students and seeing student's achievements in fulfilling aspects of creative thinking. The test is a tool to assess in written form to record or see students' achievement in line with the assessment targets [13]. Teachers often gave tests that contained routine problems and low-level questions instead of open-ended problems. Hence, teachers did not optimize the measurement of students' creative thinking ability. Besides that, teachers still used conventional tests to see students' abilities. As a result, students were lack of motivation in solving geometric problems. Accordingly, the researcher wanted to develop a geometry test using simple, fun, and meaningful media. Students could be interested and challenged to solve the problems, and teachers could see students' creative thinking abilities. This article aimed to describe the process of developing a tangram-based geometry test package to measure students' creative thinking ability.

2. Research Method

This research design is Research and Development (R & D), which used the Thiagarajan 4-D model, and the try out research was at SMPN 1 Bondowoso for the 2020/2021 academic year. The development cycle of the tangram-based geometry test in this research was divided into four phases, (1) defining, (2) designing, (3) developing, and (4) disseminating [13, 14]. The method was chosen since it is suitable for developing evaluation components in education.

This development aimed to produce a tangram-based geometry test package is based on the aspects of creative thinking ability and was tested for validation, practicality, and effectiveness. The data obtained by conducting questionnaires, tests, and interviews. The first step was to determine the area and research subject. Furthermore, product development is processed with the 4-D stage [15].

2.1 Define

Examined the problems, student characteristics, needs, and materials to be used in development. The chosen material that relevant to this development was the Two-Dimentional figure. Students were grouped based on their geometric thinking degree utilizing test the Van Hiele Geometry Test (VHGT). Van Hiele Geometry Test comprises 25 multiple-choice questions. Every five items represent one van hiele level. Questions number 1 to 5 represents the visualization level, 6 to 10 for analysis level, 11 to

15 for informal deduction level, 16 to 20 represent deduction level, and 21 to 25 represent rigor level. Students are classified as that level if they can answer 3 to 5 questions correctly. Students cannot proceed to the next level if they cannot reach the previous level.

2.2 Design
The researcher designed the test package and produced a sample of the test package (prototype). The selected media was a tangram puzzle. The prototype was designed based on the content and material format.

2.3 Develop
The result of this stage was a draft of a test package that had been validated by the experts. Product try out was conducted to quantify the level of validity, effectiveness, and practicality of the test packages that had been developed.

2.3.1. Validation. Validation was needed to know the product feasibility. The tangram-based geometry test validation was carried out by a mathematics teacher and two lecturers of the mathematics education department.

2.3.2. Field test. Field tests were conducted to obtain direct suggestions from the education practitioner. Test legibility and limited try out were conducted on three students. The limited and field try out was conducted by using questionnaires and tests. Simultaneously, the test legibility obtained from interviews was intended to know the legibility of the product. If teachers and students used the test, the researcher would provide a user response questionnaire to determine the product's practicality.

*2.3.3. Revision.*The Tangram-Based Geometry Test was revised based on the result of the field try out and validation. We concluded the product feasibility as a consideration for the use of this product.

2.4 Disseminate
The tangram test package would be distributed to schools with the appropriate level that is grade VII of junior high school through Mathematics Teacher Organization for Junior High School (MGMP). This research was a pilot study for a larger-scale study.

The developed product was used to measure students' creative thinking ability through tests and interviews. Students' score becomes the primary consideration upon the effectiveness of this product. It is categorized as effective if 80% of the testing subject passed minimal completeness criteria (KKM). Creative thinking aspects involved are fluency, originality, flexibility, and elaboration [16]. There are five classifications of creative thinking abilities consisting of levels 0, 1, 2, 3, and 4, as shown in table 1. Level 4 is the highest, and level 0 is the lowest level of creative thinking. Each creative thinking level has its own characteristics to be assessed and to refer to the students' creative thinking levels. The criteria of each level can be seen in Table 1 [17].

Table 1. Level of Creative Thinking Ability.

Creative Thinking Level	Criteria
Level 4 (Very Creative)	Student achieves the entire aspects of creative thinking. Student can answer a problem with more than three possible solutions fluently (fluency), reveal new or unique solutions (originality), find many ways in solving a problem (flexibility), answer systematically and detail (elaboration)
Level 3 (Creative)	Student achieves three or all aspects of creative thinking and finds three unique possible answers (originality) in different ways (flexible) fluently (fluency).

Creative Thinking Level	Criteria
Level 2 (Quite Creative)	Student achieves two aspects of creative thinking and carries two possible answers flexibly and fluently.
Level 1(Almost Not Creative)	Student achieves one aspect of creative thinking, bring out one answer, and interpret their answer fluently (fluency).
Level 0(Not Creative)	Student achieves no aspects of creative thinking. Student gives no possible answers or solutions fluently.

3. Result and Discussion

The result of this research was a tangram-based geometry test on two-dimentional figure material. This study was designed to measure students' creative thinking ability in solving two-dimentional figure problems. The discussion of the results in this study was written as follows.

3.1. Tangram Based Geometry Test

The test package produced by the geometry test consisted of question instructions, test package grids, test question packages, answer keys, scoring guidelines, assessment guidelines, analysis, and recommendations. The test questions were essay questions with open-ended problem types in Indonesian. The problems raised were related to the sub-topic of triangular and quadrilateral shapes in mathematics for grade VII of Junior High School.

The defining stage began with defining the learning needs by analyzing the objectives and limitations of the material, examining students' characteristics based on the design and development by giving the Van Hiele Geometry Test (VHGT) to determine the students' level of thinking, and identifying the primary ability to be developed.

The next stage was designing the prototype of the product (draft I). At this stage, the material, media, and format were selected. The chosen material was a two-dimentional figure using Tangram media. The test designed referred to the creative thinking aspects with open-ended questions to measure students' thinking abilities. The prototype was validated by experts to determine the validity level of the product. The validators were lecturers at the Faculty of Teacher Training and Education, University of Jember. Validation was used to determine the test package product's feasibility, which determined its suitability for the research objectives. The test package was scored 4.47 points by the validators, which were categorized as good. Thus, the product was declared valid and feasible to use. The details of the validation result are shown in Table 2.

Table 2. Test Package Validation Results.

Aspect	Mean	Category
Contents	4.73	Valid
Construct	4.4	Valid
Language	4.3	Valid
Instructions	4.45	Valid

The examples of products that have been developed based on the aspects of creative thinking are shown in Figure 2 below.

1. Make as many shapes as possible like squares, rectangles, triangles, lines and trapezoid arranged using pieces of tangram! (minimum 2 pieces)
2. Ellen sees Charice playing tangram, Ellen wants to make a tangram with a triangular frame consisting of flat shapes out of colorful paper. Help Ellen make tangrams of different designs. Give the size of each shape and calculate the area of each color paper used.

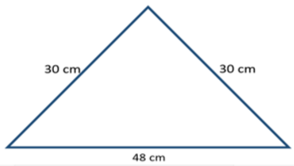

Figure 1. Tangram based geometry test.

Figure 2 is an example of a tangram based geometry test. Students answer with as many alternative answers as they can find. The students' answers and ways of solving these problems vary for each paper and shape color. The maximum score for each question is 16, and the maximum score for each aspect of creative thinking is 4. After obtaining the score, students will be analyzed for their creative thinking ability level. The test package obtained a percentage of P-value (practicality) by 80 and categorized as good, so it can be said that the product is easy to use.

3.2. *Profile of Students' Creative Thinking Ability*

The test package was tested on students of class VIII of SMPN 1 Bondowoso, who were selected after being given a van Hiele test package in the previous stage. The data were collected by using written tests and interviews. Then, the data were analyzed qualitatively by observing the test results and then confirming the results to the participants through an interview to confirm the validity of the data. The data obtained were then discussed extensively to conclude. Students' answers were assessed according to the assessment guidelines, then the students' scores were calculated. After getting students' scores, their level was determined with the following formula:

$$NP = \frac{\mathbf{R}}{\mathbf{SM}} \times 100$$

NP is the percentage value of the student's creative thinking ability score obtained from the student's raw score (R) in which it was then divided by the maximum score of the whole questions (SM). The scores are classified based on the interpretation of the student's creative thinking level, which is shown in the following Table 1 [17].

Table 3. Interpretation of Creative Thinking Level.

NP	Creative thinking level category
$80 < NP \leq 100$	Very creative
$60 < NP \leq 80$	Creative
$40 < NP \leq 60$	Quite Creative
$20 < NP \leq 40$	Almost Not Creative
$0 < NP \leq 20$	Not Creative

The written test questions were analyzed to check the correctness of the answers and find out what aspects of the students' creative thinking emerged. The interview results were analyzed to clarify the information provided by the students on the answer sheets. The students' scores were represented in Figure 2. The data were analyzed as follows.

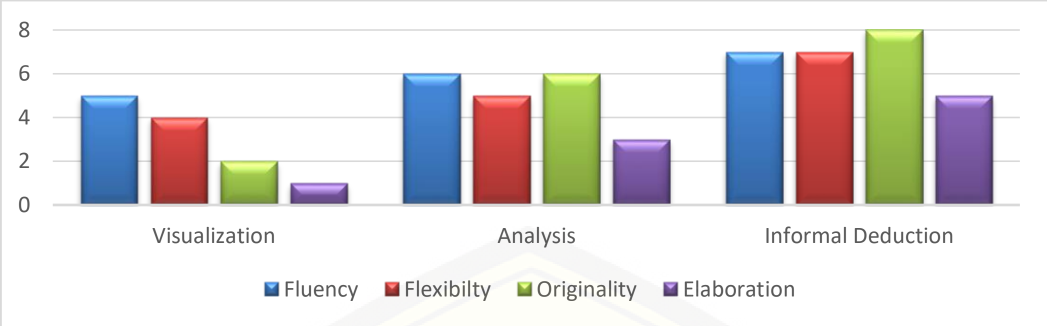

Figure 2. Scores of students' creative thinking ability.

3.2.1. The Student of Visualization Level

The students with level 0 or visualization level were called S1. The results of the S1 field try out on the test packages were revealed as follows.

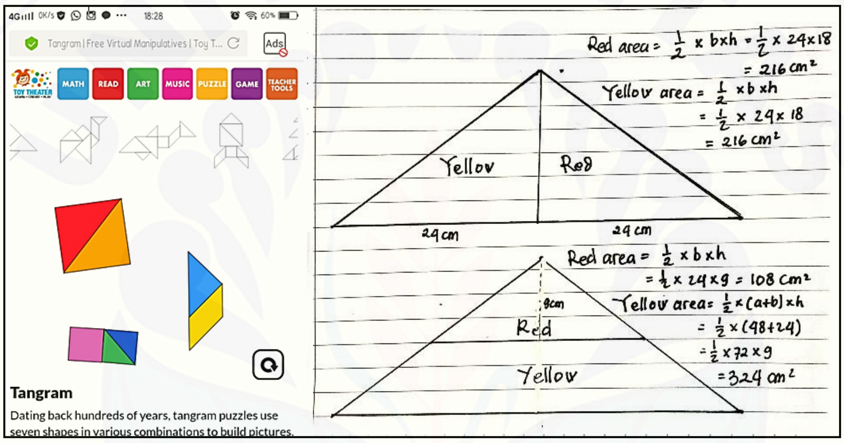

Figure 3. Students' answers with a visualization level.

The students at this level understood the meaning of these questions well. S1 was able to bring up the fluency aspect by providing three possible series of flat shapes with two pieces of the tangram. In creating a triangle tangram, the students provided two possible answers by cutting the big triangle into two small triangles horizontally and vertically and expressing their ideas correctly. However, they have not reached the flexibility aspect yet. S1 could not combine tangrams of different sizes to form a two-dimensional figure and provide other possible cuts. The following interview excerpt showed it. (R = Researcher, V = visualization student)

R: Have you ever worked on a problem like this before?
A: Never, ma'am.
R: Can you assemble a tangram of different sizes to make it a 2D shape?
A: I have no idea if the tangram of different sizes should be combined
R: Can you make a triangular tangram with more than two pieces?
A: No, ma'am

Regarding the originality aspect, S1 did not provide a common answer well by combining six tangrams into three flat shapes even though he could not combine tangrams of different sizes and make a triangular tangram with a larger number of pieces. While in the elaboration aspect, he was not capable of describing the answers systematically. Thus, the student's percentage score at the visualization level was 34 and categorized in level 1 of the creative thinking category (almost uncreative).

3.2.2. The Student of Analysis Level

Students with level 1 or analysis level were called S2. The results of the S2 field try out on the test packages were shown in Figure 4.

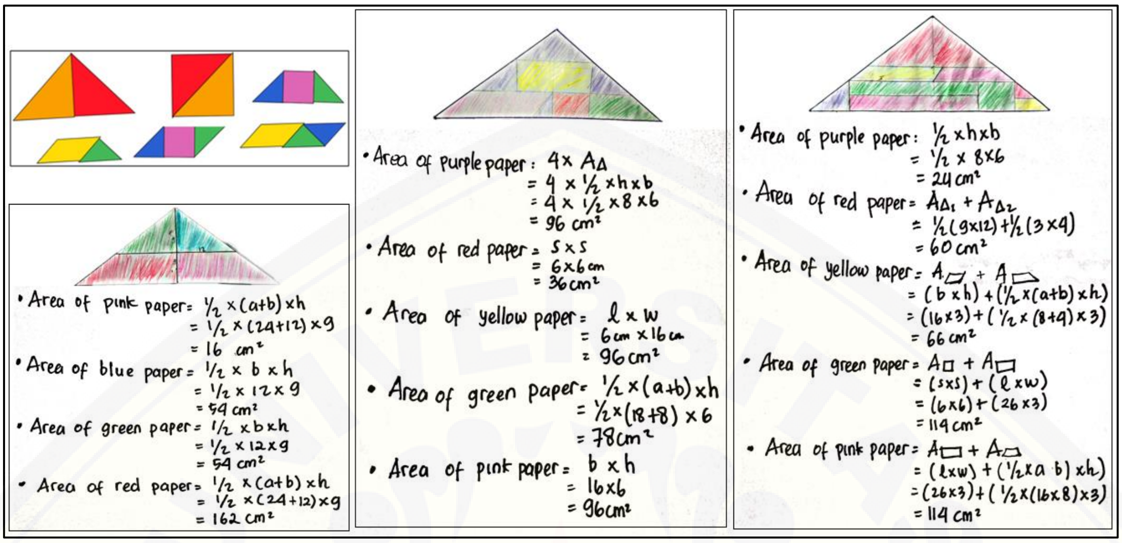

Figure 4. Students' answers with the level of analysis

S2 had a clear understanding of the problem and was able to interpret his ideas. S2 gave various answers; they were four flat shapes covering triangle, trapezoid, parallelogram, and square using several pieces of the tangram. It showed that S2 met the fluency aspect. Students with analysis level established levels in three different ways, combining triangles and levels and the combination of triangles and squares. The various ways to construct a flat shape revealed that S2 achieved the flexibility aspect. Besides, students could also make tangrams by cutting horizontally and vertically on a triangular frame, with the maximum number of pieces produced were 10. The originality aspect was reached by the student about his answer to the interview session. S2 did the first answer due to something he had ever seen. Even though he had never worked on a problem given, the first answer was common from S2. The following interview with S2 showed it. (R = Researcher, A = analysis student)

R: Have you ever worked on a problem like this before?
A: No, ma'am.
R: What do you think about this test package?
A: It's fun, it makes me easier to understand the material, and quite challenging.
R: How do you find the triangle tangram with 10 pieces?
A: I tried it myself by cutting the triangle and then adjusting the size. The first triangle was made because I have ever seen my sister's drawing.

Students can put forward their ideas in detail, but S2 did not write down the steps to solve it systematically. However, the elaboration aspect was not successfully fulfilled since S2 did not use any systematic solutions during the test. The students with the analysis level obtained score of 59 as final scores and they were classified as level 2 or quite creative.

3.2.3. The Student of Informal Deduction Level

Students level 2 or informal deduction level referred to S3. The results of the S3 field try out on the tangram-based geometry test revealed as follows.

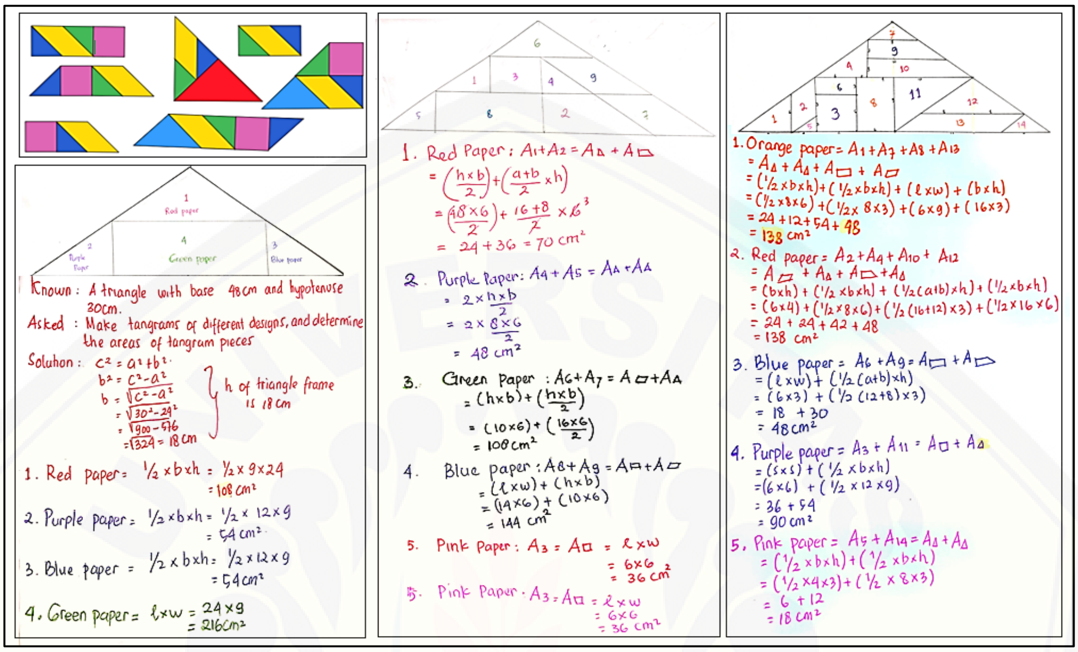

Figure 5. Students' answers with the level of informal deduction

The students at this level understood the questions well and were able to interpret ideas. S3 found eight tangrams in the tangram assembling problem and provided three possible alternative answers to the problem of creating a triangular tangram. The fluency aspect was achieved well, as it was shown by many types of flat shapes that he assembled, covering trapezoid, rectangle, triangle, and parallelogram. S3 was able to string all parts of the tangram into a rectangle. On the flexibility aspect, the students at the informal deduction level were able to answer problems from various points of view to achieve well. S3 assembled three trapezoids and three rectangles with a varying number of constituent pieces and different shapes. S3 met the originality aspect well; the answer he gave was unique and imaginative even though he had never gotten a similar question. It was shown by the way he cut the triangles horizontally, vertically, and diagonally which was supported by the following interview. (R = Researcher, DI = informal deduction student)

R : Have you ever worked on a problem like this before?
DI : I have never encountered a problem like this, ma'am. The test is quite challenging.
R : How do you find the 10-piece triangle tangram?
DI : I initially imagined having a cake and then cutting it up. Then I first thought about the parts that I could cut and whatever the shape was, then I imagined putting it in the triangle.

S3 was able to describe his ideas well and solve the problem in detail and systematically, but S3 did not explain how he found the sizes of each shape. Therefore, S3 achieved the elaboration aspect incompletely. S3 got the final score of 68 and they were classified as student with level 3 or creative.

Based on these results, it can be seen that the level of students' creative thinking abilities was in line with their geometric abilities. For this reason, the researcher suggests the teachers guide the students to practice solving problems more often with open problem types under the guidance of the subject teacher. Also, the teacher should use simple, fun, and creative media in measuring the students' abilities so that they would not experience a lack of motivation in solving problems. Therefore, they can develop their potentials, ideas, and enthusiasm to come up with new ideas and be more creative.

4. Conclusion

This research produced a tangram-based geometric test that was valid, practical, and effective on flat shape material. The test package was declared valid by the validator. It was feasible to measure the creative thinking ability of junior high school students on two-dimensional figure material. The field try out on junior high school students showed that the student with visualization level reached the fluency aspect so that they were classified into Creative Thinking Level 1 or less creative. The students under the Analysis level tended to bring up fluency and flexibility. They were categorized into the students with Creative Thinking Level 2 or quite creative, even though they had no elaboration and originality aspects. The students at the informal deduction level almost reached all aspects of creative thinking, and it made them classified as the students with level 3 or creative.

Acknowledgement

We give our best gratitude to all parties who supported this research. We also thank the Faculty of Teacher Training and Education at the University of Jember and SMPN 1 Bondowoso.

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