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The Student's Response To Solid Geometry Learning Using Information Communication Technology (ICT)

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Abstract

One of the fundamental capabilities which students do not have is the ability of the responsiveness of space. University students should already be in formal deduction and rigor level in the study of geometry, but students still have difficulties in studying the solid geometry. Therefore, instructional media required in learning the solid geometry, such as ICT-based learning media. This paper aims to describe the student's response in learning solid geometry by using ICT-based learning media. This study is part of development research. It uses the ADDIE model, includes 5 stages: Analysis, Design, Development, Implementation, and Evaluation to develop ICT-based Solid geometry learning instruments The instrument used to see the student's response is the questionnaire responses of students who perform learning using ICT-based learning media. Students who perform the learning process using ICT-based Student worksheet give a positive response. It has a score of 3.31 in the interval 1-4, in the excellent category. Based on student feedback questionnaire results can be concluded as follows: in general, the students interest in learning using ICT-based Student worksheet , the visualization ease in understanding the material. Through group discussions, students have the opportunity to convey his idea.
Keyword : student's response, solid geometry, ICT

A. INTRODUCTION

Geometry is the science that treats of the shape and size of things. Learning geometry is the mathematical study of the shape and size of objects. Pierre van Hiele and his wife, Dian van Hiele-Geldof put forward the theory of stages of learning Geometry. There are five levels, which are sequential and hierarchical. They are: Level 1 (Visualization): Students recognize figures by appearance alone, often by comparing them to a known prototype. The properties of a figure are not perceived. At this level, students make decisions based on perception, not reasoning. Level 2 (Analysis): Students see figures as collections of properties. They can recognize and name properties of geometric figures, but they do not see relationships between these properties. When describing an object,a student operating at this level might list all the properties the student knows, but not discern which properties are necessary and which are sufficient to describe the object. Level 3 (Abstraction): Students perceive relationships between properties and between figures. At this level, students can create meaningful definitions and give informal arguments to justify their reasoning. Logical implications and class inclusions, such as squares being a type of rectangle, are understood. The role and significance of formal deduction, however, is not understood. Level 4 (Deduction): Students can construct proofs,understand the role of axioms and definitions, and know the meaning of necessary and sufficient conditions. At this level, students should be able to construct proofs such as those typically found in a high school geometry class. Level 5 (Rigor): Students at this level understand the formal aspects ofdeduction,such as establishing and comparing mathematical systems.Students at this level can understand the use of indirect proof and proof by contrapositive, and can understand non-Euclidean systems. [1]

According to Van Hiele [2], all children learn geometry through every level of the same order, but the timing of the students began to enter a new stage is not always the same between the others. The process of development from one stage to the next stage is not determined by age or biological maturation, but rather depends on the instruction of the teacher and the student learning process

Based on these stages, university students already at stage 4 or 5. At the stage of formal deduction, the students have understood the role of the rank notions, definitions, axioms, and theorems in geometry. Students are able to perform formal reasoning about mathematical systems (including systems of geometry), without the need for concrete models as reference. At the level of rigor, the student has begun to draw up formal proofs. This means that students already understand the axiomatic-deductive thinking process and they were able to use it.

The fact shows that university students still have difficulties in understanding the solid geometry, although students had no difficulties in applying the formulas, such as surface area and volume formulas. The Student's ability of responsiveness of space is still inadequate. Students still have difficulties in visualizing the geometry, the relation between the elements of space, and the wedge geometry.

Learning activities should involve students actively. Common problems in learning activities is the lack of activity of students, both physically and mentally. Students have not gained widespread opportunity to perform activities that are more meaningful, such as finding itself the concepts and principles of mathematics, explore the concepts, and an analysis of mathematical problem.

In the process of learning, lecturer should be able to accommodate every student activity to be transformed as a learning activity. Students have the widest opportunity to develop his thinking process. Activity was done without ignoring the differences of each student's ability to think. The activities carried out in the study should be able to provide greater opportunities for students to perform high-level mathematical activity. Therefore, a high level of mathematical ability can be optimized. These activities can be designed through a learning device such as syllabi, lesson plans, teaching materials, and appropriate learning media.

The media is an important and necessary component in learning, especially in learning solid geometry, because the object being studied are an abstract object and visualization of three-dimensional objects in two dimensions. Currently, ICT-based media is a media that is suitable for studying the solid geometry. It can support learning when integrated with teaching methods, learning models and appropriate teaching materials. ICT-based media has several advantages over other media. Computer media can provide repeatedly and dynamic services; show presentation in a format and attractive design; present images animation and simulation; can be used in learning concepts that require high accuracy; present the proper completion of the graph fastly and accurately; and accommodate individual differences of students. ICT-based learning media is very suitable to explore the solid geometry objects.

Researchers consider it necessary to describe the solid geometry learning using ICT-based media and to determine the response of students to learning. The aim of this reasearch was to describe the student's response to the solid geometry learning using ICT-based media.

B. RESEARCH METHOD

This research is the development research. This study aimed to develop ICT-based learning tools on Geometry classes. Development models used in this study is a model ADDIE [3]. Stages taken are: Analysis, Design, Development, Implementation, and Evaluation. We do the analysis of learning and student characteristics on the analysis stage. At the design stage, we developed the framework for the content of learning the instrument. This is used to describe the overall learning activities and prepare the appropriate Student's Worksheet.

At the production stage, we draft the learning instruments. In the implementation phase, the prototype of the learning instruments that have been developed are implemented in the lectures. Based on the results of the implementation, we evaluate the responses of students who use the learning instruments. This learning instruments implemented in the course Geometry Space odd semester 2013.

This paper is intended to describe how the student responses to the learning by using ICT-based media. The research instrument used to describe the student's response is Questionnaire Responses to student learning process ofSolid geometry using ICT-based media.

C. RESULT AND DISCUSSION

Here we describe the implementation and results of the research. In the analysis phase, we identify problems in learning geometry, especially geometry space as follows.

1. Class that utilize IT is still lacking
2. Learning geometry is still a text-oriented
3. The student activity is limited to the completion of the regular math problems, for example the problem of volume calculation of geometry object.
4. Students are not many activities to explore
5. Student's responsiveness of space ability still needs to be improved
6. The ability of the student to provide arguments, representing mathematical ideas and looking for a relationship still need to be improved
7. We need to design courses that support student activities
8. We need to design the college student-centered
9. Activities in group discussions is not optimal

The results of this analysis are used to design the learning process and student activities. It is stated in the draft of learning instrument. The learning process is designed to meet the following: student-centered, cooperative learning approach, utilizing ICT-based media, giving students the opportunity to explore the concepts of geometry, giving students the opportunity to develop mathematical communication skills.

Utilization of ICT-based learning media is integrated with activities that should be discussed in groups. This is outlined in the Student worksheet . ICT-based media should have the ability to manipulate the geometry, so it can support the activities in exploring the concepts of geometry. This concurs with the opinion of Yaya S. Kusuma [4] which suggests that computer-assisted learning innovation is very good to be integrated in the learning of mathematical concepts, including geometry. These programs can be used to enhance the students' understanding of the concept of geometry and to introduce new concepts. NCTM believes that the use of technology can improve

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the understanding, because the technology can provide flexibility to the students to discover, to explore, and make a conjecture about mathematical ideas. It allows students to act and to think as a mathematician by strengthening students' conceptual understanding [5]

Based on the stages of geometry learning, university students already at stage 4 (formal deduction) or 5 (rigor). The students have understood the role of the rank notions, definitions, axioms, and theorems in geometry. Students are able to perform formal reasoning about mathematical systems (including systems of geometry), without the need for concrete models as reference. The fact shows that university students still have difficulties in visualizing the solid geometry. They need a tool to visualize it. Therefore, student activities as outlined in the student worksheet is designed to allow students to explore concepts through visualization with ICT-based media. Furthermore, some of the following concepts are found without the media. This is done so that students can develop the ability to generalize. It is one component of mathematical communication skills. Student mathematical communication skills are also developed through a few questions answered include the reason.

Stages of learning designed for group discussion activities to explore the concept of geometry ICT-based media-aided. An example of the learning activities as follow

Step Component	**Activity**
Opening	1. Lecturer open class and check the readiness of students in class. 2. Lecturer convey apperception of prism elements 3. Lecturer delivers learning objectives and competencies to be achieved by the students, ie determines the symmetry on the prism, particularly cube
Main activity	1. Lecturer asks students to work in groups and hand out the worksheet on the symmetry of the cube 2. Students discuss in groups to investigate the mirror symmetry and rotational symmetry in the cube by doing activities that exist in the worksheet 3. Some groups presented the results of discussions and other groups provide feedback 4. Lecturer together with students concluded on mirror symmetry and rotational symmetry in the cube
Closing	1. Lecturer together with students concluded the material being studied 2. Lecturer provide individual tasks that must be collected in the next week.
Follow up	Lecturer asked the students to learn the next material, namely Limas

Activity explores the material using ICT-based media is guided by the activities of the student worksheet . Below is an example of a fragment of the activity in the student worksheet

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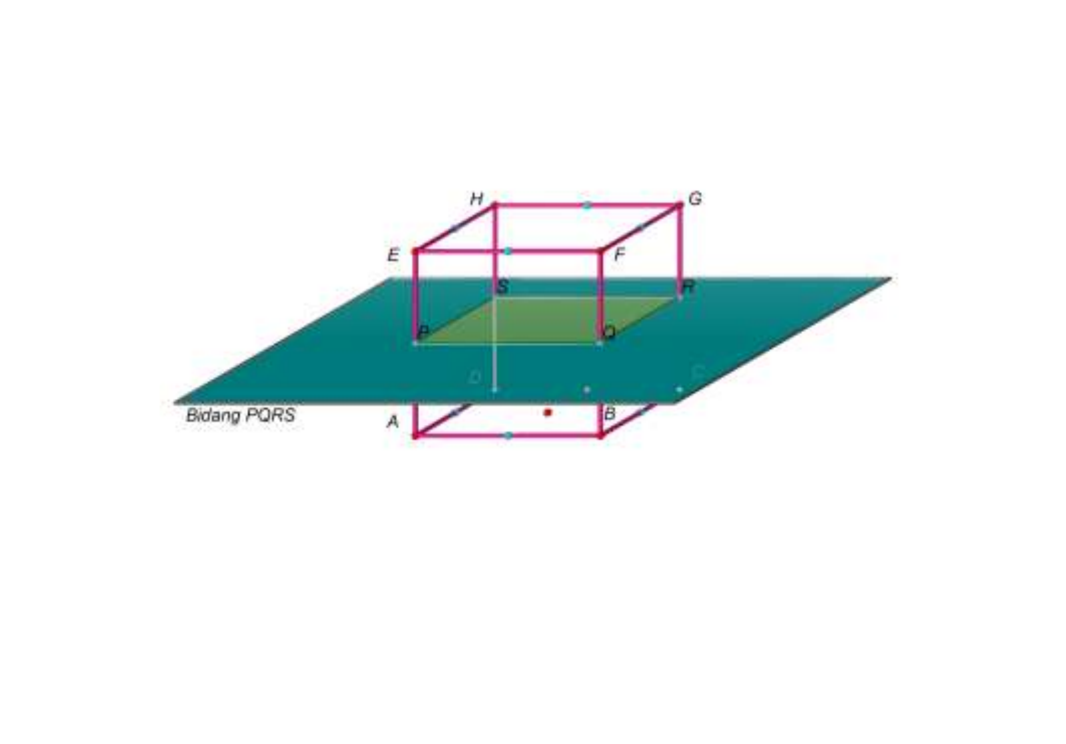
ACTIVITY 1

Objective: to investigate the properties of mirror symmetry of the cube.

1. Open the file “Simetri Cermin 1” The interface is shown as below. Drag one of its points to obtain a different appearance or to make it easier to explore..



1. Observe the cube ABCD.EFGH and PQRS plane in the file.
a. Is PQRS plane symmetry? Why?.
b. Are there other areas that had its position as PQRS field, which are also the symmetry plane? How many planes like that?
c. Investigate, are there other areas that had its position not equal to PQRS plane? How many planes like that?
d. How many symmetry planes on the cube?

ACTIVITY 2

Objective: to investigate the rotational symmetry of the cube

1. Open the file “Simetri Putar 1”. The interface is shown as below. Drag one of its points to obtain a different appearance or to make it easier to explore.

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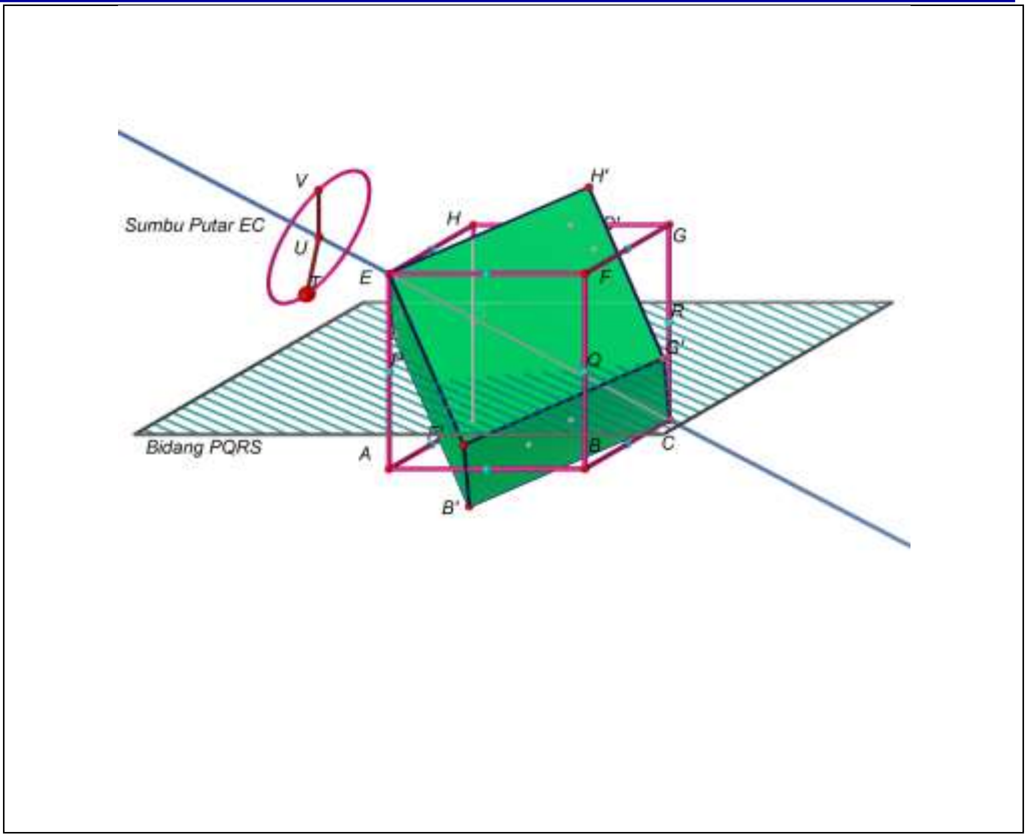
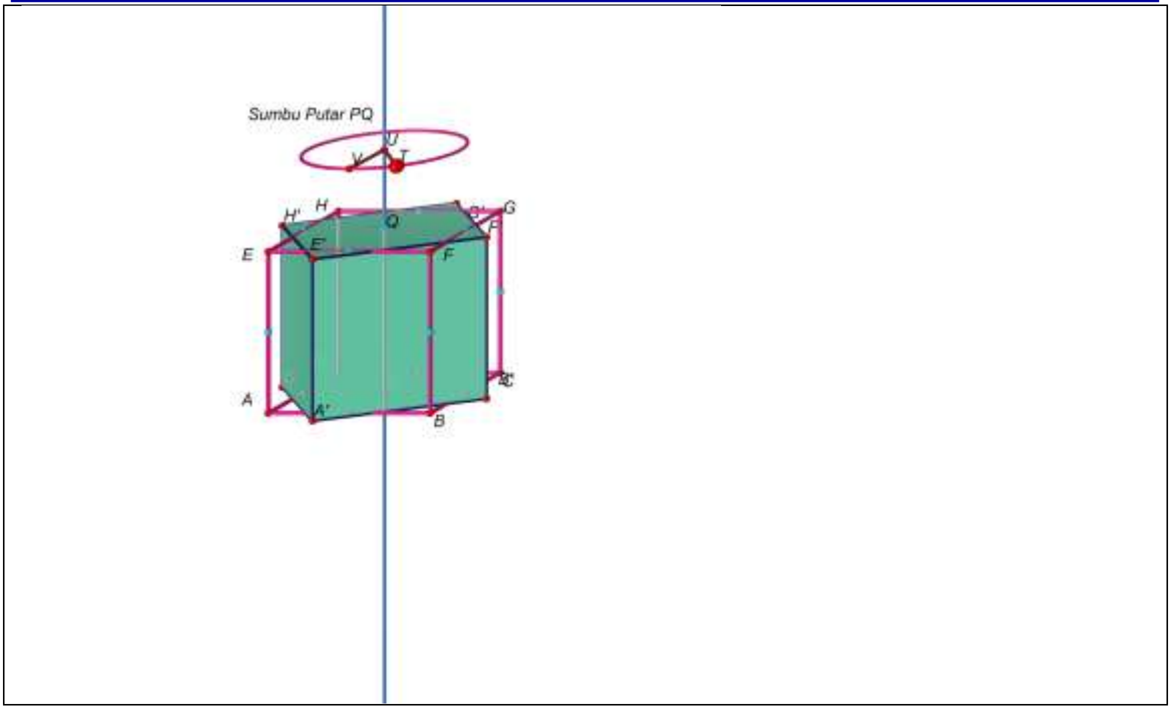


2. Rotate point T around the circle with U as a center
   a. What happened to the cube ABCDEFGH on line EC?
   b. Is cube A'B'C'D'.E'F'G'H' will coincide with the cube ABCD.EFGH?
   c. How many times cube A'B'C'D'E'F'G'H 'will coincide with the cube ABCD.EFGH if point T is rotated one full rotation..
   d. How many degrees is the angle on the rotation, so that the cube coincide?
   e. What can you say about the line EC ?
   f. Are there any other lines that have properties such as line EC? Mention.

ACTIVITY 3

Objective: to investigate the rotational symmetry of the cube

1. Open the file “Simetri Putar 2”. The interface is shown as below. Drag one of its points to obtain a different appearance or to make it easier to explore.



2. Rotate point T around the circle with U as a center
   a. What happened to the cube ABCDEFGH on line PQ?
   b. Is cube A'B'C'D'.E'F'G'H' will coincide with the cube ABCD.EFGH?
   c. How many times cube A'B'C'D'E'F'G'H 'will coincide with the cube ABCD.EFGH if point T is rotated one full rotation..
   d. How many degrees is the angle on the rotation, so that the cube coincide?
   e. What can you say about the line PQ ?
   f. Are there any other lines that have properties such as line PQ? Mention.

ACTIVITY 4

Objective: to investigate the rotational symmetry of the cube

1. Investigate, is there any other rotational symmetry in the cube?
2. If there is, how is the position of a line which is the symmetry axis of the cube?
3. What is the level of rotary symmetry of the line?
4. How many lines like that?

Based on observations at the implementation stage, we obtained some of the following. Discussion groups using the student worksheet beyond the expected time, so we should set a more detailed allocation of time in the lesson plan.

As a result of these problems, presentations and discussion of the results of the discussion groups is not optimal. This discussion groups should not oversized, which consists of 4-5 students. In this study, each group consist of 7-8 students, so that the discussion is not optimal. Students have difficult to see the shared files on the notebook. For example, "plane of symmetry in the same position". The term "position" should be

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improved by describing the characteristics of the area concerned, for example with the "plane of symmetry passing through one of the four sides of the plane and the midpoint of the opposite side".

At the end of the course, students respond to the learning process by using ICT-based learning media. The student's reaspons to study geometry space with ICT-based media is very good. It has a score of 3.31 in a maximum score of 4. The following table states the average score student responses for each statement.

NO	Statement	Average Score
1	I do not like to do activities in student worksheet	3.37
2	I enjoy participating in group discussions	3.61
3	I like to do activities in the student worksheet	3.4
4	I am happy to work on ICT-based activities	3.15
5	ICT-based media have helped me understand the geometry material	3.37
6	I do not feel that this ICT-based media helps to learn geometry	3.39
7	CT-based media can develop responsiveness of space capabilities	3.39
8	ICT-based media have helped me understand other geometrical concepts, which are not presented in this media	3.27
9	Student worksheet helps me to think critically	3.29
10	student worksheet helps me to visualize the concepts in the solid geometry	3.37
11	express my opinion in group discussions	3.46
12	I did not put the question to my friend or my lecturer about the material that I have not understood	3.17
13	If there is my friend or my teacher asked a question, I try to answer	2.98
14	I appreciate the opinions and be tolerant to my friends when we discuss	3.54
15	I do not give a response to the explanation of my friends	3.24
16	I provide support examples, when I expressed my answer to friends and lecturers	3.05
17	I am pleased to be able to explain the problem solving to friends and teachers verbally and in writing	3.20
18	I do not get the benefit of existing activities in the student worksheet	3.68
19	Activities in the student worksheet is easy to understand	3.22
20	Activities in the student worksheet easily implemented	3.22
21	Student worksheet is not attractive	3.49
22	This ICT-based media is interesting	3.17
23	The language used in the student worksheet is easy to understand	3.02
	Average	3.31

In general, students give a positive response to the use of ICT-based media. This is evident from the 39 responses which is a statement in the case helped, convenience, and attractiveness. Here are some statements that indicate this.

- Very interesting, and really helped me to better understand the material solid geometry
- Learning Solid geometry using the student worksheet is very helpful, especially the learning process carried out in a discussion forum so that we can share knowledge with friends. ICT-based Student worksheet helps to visualize geometric forms. However, the ICT media can be made more attractive.

- I easily understand the solid geometry with the use of ICT-based student worksheet. With this media, it is easier to visualize the geometry that is difficult if it only imagined.
- Nice media and further improved
- In my opinion, ICT-based student worksheets is helping students to learn Solid geometry. This media can visualize geometry and help students see and solve the problems, and allows us to understand the material
- This discussion method gives us the opportunity to discover my own learning experiences, so that we can learn the concepts better. The use of ICT also facilitate learners to visualize geometry.
- In general, this learning process is interesting and easy to understand. Students can conclude a geometry concept in group discussions. Activities in the student worksheet is also easy to implement. We also can practice to express our opinions in front of friends.
- This ICT-based media helped me to understand the concept of geometry. Learning with ICT provides an opportunity to visualize the concept of geometry
- We know much more about the solid geometry with ICT-based student worksheet than described in verbally learning
- I feel, this ICT-based student worksheet help me to understand the concept of geometry. With this group discussions, the learning process becomes more attractive.
- Outstanding, this enables all of us to participate.
- I am more easily to understand about the topics in the solid geometry. I do not need to imagine the shape of space, because thit media help me to visualize it.
- We do not need to make traditional props, because it can be facilitated by a computer program.

Some student's suggestions on learning using ICT-based student worksheet as follows.

- I suggest to always do the learning in this way and there is discussion at the end of activity
- In my opinion, learning by this method is very well done and it makes students more active. The time allocation to be more effective
- My advice, students should be taught how to sketch geometry in Cabri, so that students are able to develop their own programs.
- I hope that the students were trained to use the Cabri program
- It would be better if each student using a laptop alone or occasionally with an LCD display.
- It's good
- The images should be used to further problems.
- To be maximized
- I think that ICT-based student worksheet quite effective. However, sometimes the language used still make a difference of perception.
- It should be added that the variation problem. Members of the group too much.
- My advice: the language should be improved to make it easier to understand.
- Learning is done in the computer lab so that all students can practice it.
- We need to be taught how to make and use the ICT program. At the beginning of the learning needs demo programs first.
- It should be propagated material in the beginning of student worksheet
- My advice, keep using this medium because it's easier for me and helped me when confused to determine the axis of symmetry

- The instructions made clearer.
-
- My advice, it would be great if students are also taught how to make the geometry model with ICT, not only file from the lecturer.
- More frequent and covers many topics in geometry
- Student worksheet made more attractive again. This would be better if all the students can create their own props
- It's better if students are trained to make geometry with ICT. Making props with the group.
- My advice, there is a sentence that makes the difference of perception, then the sentence used to be made easier to understand.

. Students who perform the learning process using ICT-based **Student worksheet** give a positive response. It has a score of 3.31 in a maximum score of 4., in the excellent category.

D. CONCLUSION

Things that need to be considered in implementing the Solid geometry learning using ICT-based media are:

a. Sufficient time allocation for main activities
b. Group discussion method used to explore the material
c. Activities in the student worksheet to guide group discussions.,
d. The formation of the group is not too large,
e. There are presentations and discussion of the results of group discussions
f. Student worksheet use clear sentences and do not have a double meaning
g. It should have the ability to use the software.

Students who perform the learning process using ICT-based Student worksheet give a positive response. It has a score of 3.31 in the interval 1-4, in the excellent category.

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