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The effect of meaning making instruction about Kepler's laws at high school students' conceptual understanding

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Abstract

It is determined that ideas that were encountered in students are not generally compatible with scientific knowledge and these ideas were named as alternative conceptions. A large number of conceptual change studies were done intended for the change of alternative concepts that were encountered in students towards scientific knowledge. But no study was encountered intended for revealing students' alternative ideas related to Kepler's laws and for the conceptual change of these ideas in literature. The purpose of this study is to search the effects of education intended for creating 11th grade students' ideas related to Kepler's laws. This study was conducted with twenty-five 11th grade students. With the aim of provide students creating meaning of the concept forty-five minutes teaching were made. As a means of collecting data on the Kepler's laws a test consisting of two open-ended questions were used. This concept test was administered before instruction, after instruction and 15 weeks later after instruction. In the analysis of data analysis six categories were used. It is observed that students generally have no scientific ideas related to these concepts and have alternative ideas that are not related to scientific ideas. More than half of the students gave the scientific response after taking instruction. Rate of encountering alternative answers decreased after the instruction. At the delayed post-test responses in the category of scientific response rate increased. However, at students a higher proportion of alternative conceptions encountered according to before instruction.

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1. Introduction

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Since the 1960s, students' idea on the many concepts of physics was revealed by the studies in the field of science/physics education (Duit, 2009). It is determined that ideas that were encountered in students are not generally compatible with scientific knowledge and these ideas were named as alternative conceptions or misconceptions. A large number of conceptual change studies were done intended for the change of alternative concepts that were encountered in students towards scientific knowledge. But no study was encountered intended for revealing students' alternative ideas related to Kepler's laws and for the conceptual change of these ideas in literature.

Klammer's (1998) work on only Kepler's laws touched upon alternative concepts. Yu, Sahami and Denn's (2010) study aimed to elicit students' ideas about Kepler's laws. In this study it was identified that the nature of students' ideas regarding to Kepler's laws had alternative conceptions. In their study Ruzhitska and Speck (2009) examined the change in students' ideas in accordance with the constructivist-learning environment as a result of teaching. As a result of these studies simulations and cooperative group discussions, students' cause of alternative conceptions was determined. As a result of this study, Kepler's laws the various alternative concepts of teaching students to have pre-determined and made for conceptual change students' alternative conceptions of teaching, even toward the exchange of scientific ideas was reported to be effective. Kepler's laws focuses on teaching the law is only one of the number of studies and collaborative work groups in this study made is that this is not a very effective teaching. There has not been any research on the different methods used to teach Kepler's laws. Based on this situation the aim of the research was determined.

1.1 The purpose and the importance of the research

In this research the teaching of high school students, who are in their last year, before and after 15 weeks of instruction on Kepler's laws aimed to reveal the ideas that have been? Research and instruction to the creation of meaning those students' ideas about Kepler's laws changes in and discussed the impact of changes in the permanence. Encountered in the text field in the few studies dealing with the Kepler's laws students to have alternative ideas and teaching these ideas have been determined not to be very effective in changing. Conceptual change teaching after work often focuses to similar changes in students' ideas, with this study, immediately after education and training after a long period of permanence of the change in students' ideas were revealed. Therefore, the change in students' ideas could be discussed on the persistence of.

2. Method

2.1. Research design

In this research, an experimental research design pattern with one of the weak single group pre-test and post-test was used. This pattern is applied to the research group pre-test, the experimental research is carried out on this faculty group at the end of the final test and afterwards a delayed post-test is applied to the group (Cohen, Manion & Morrison, 2005).

2.2. Study group

This research was conducted with state high school 11th grade students who studying twenty-five high schools. Students in the sample are the students who had chosen science. These students did not receive any formal instruction related to Kepler's laws up to 11th grade-level physics courses.

2.3. Data collection tool and data analysis

Two open-ended questions about Kepler's laws, which had been developed by the researchers, were used as the data collection tool. While developing these questions a pilot study was conducted with 50 eleventh grade students and 133 tenth grade students. In the pilot study the questions were finalized in line with student feedback from students who have instructions about them and who don't have instructions about them. The first question is about when the world is in its orbit around the sun comparing the speed of the closest and most remote points to the sun. The second question is about comparing the space of the radius vector combining world and sun when the world is at its closest and most remote points in equal time intervals.

Analysis of students' answers to these two questions was analysed under the theme of Kepler's laws. Analysis steps, consisting of six response categories from categories that Trundle, Atwood and Christopher (2002) and Uçar

(2007) used in their research were created for the analysis of the questions. Categories and explanations used in the analysis of the questions in the following concept test are given.

•*Scientific*: It is defined as a consistent figure with scientifically accepted method. The answer given to this category, scientific correct, should include all aspects of the answer fully and students should answer all the questions correctly.

•*Scientific fragment*: If the answer does not include alternative conceptions but gets into only some aspects of the correct answer, it is located in this category. Not all the factors necessary for a correct answer are included in the answer.

•*Scientific fragment with alternative fragment*: It not only contains some aspects of the correct answer related to the alternative concepts, but also includes the answer in the nature of an alternative conception.

•*Alternative*: The question takes place in this category if it shows ideas related to the concept and is related to alternative concepts encountered in the literature of the subject in all the questions related to the subject.

•*Alternative fragment*: It is faced with alternative concept only in a question in the answers involved in this category and the student does not show his ideas related to this alternative concept in all the questions.

•*No conceptual understanding*: The answers in this category include explanations, which won't reflect scientific or alternative conceptual understanding, or students haven't noted an idea related to the concept.

3. Findings

In this section the two questions with the Kepler's laws together with the findings obtained from the analysis are given.

Table 1: Findings obtained from Kepler's laws theme

Response category	Pre-test n (%) (SN)	Post-test n (%) (SN)	Delayed post-test n (%) (SN)
Scientific	0	3 (%12) (S9, 17, 18)	7 (%28) (S2, 7, 9, 10, 11, 17, 20)
Scientific fragment	0	9 (%36) (S1, 2, 10, 11, 13, 14, 21, 22, 23)	2 (%8) (S16, 23)
Scientific fragment with alternative fragment	3 (%12) (S13, 19, 22)	9 (%36) (S3, 4, 7, 8, 12, 15, 19, 20, 25)	8 (%32) (S1, 4, 6, 12, 13, 15, 19, 21)
Alternative	1 (%4) (S9)	0	5 (%20) (S3, 5, 8, 22, 24)
Alternative fragment	12 (%48) (S2, 5, 7, 8, 10, 11, 12, 14, 15, 16, 21, 25)	4 (%16) (S5, 6, 16, 24)	2 (%8) (S18, 25)
No conceptual understanding	9 (%36) (S1, 3, 4, 6, 17, 18, 20, 23, 24)	0	0

Before they take this concept to the formal education of these students in the categories of scientific and scientific part of the answer is not expected to give answers. After teaching, three students gave a scientific answer and the correct answer rate increased after the delayed post-test and seven students gave a scientific answer. Teaching, students the teaching of scientific been effective in responding long after the scientific response rate has been increased. After teaching the scientific part of the response of the response category, 9 students taking part in the

delayed post-test after two students were included in this category. The increase in the response rate in the category of scientific answer scientific part of post-secondary students in Uncategorized response in the delayed post-test took place in the category of scientific answer alternative parts along with the scientific part of the answer before teaching three students in the category of the responses, while nine students after teaching has taken place in this category delayed post-test, the response of eight students in this category have taken place and more education, there has been more or less unchanged. The concept of alternative education students was faced with only one pre-teaching post and the delayed post-test took place in the category of scientific answers for these students. After teaching in the category of those answers were no ten countered with answers. After teaching was met in five students were faced with the alternative conceptions. Students' alternative conceptions increased in the delayed post-test. With regards to pre-or post-secondary education, three of these students had alternative ideas, and in the delayed post-test these ideas remained. Part of scientific education in the response category in the pre-12 students, four post-secondary students have encountered in the delayed post-test two students. In this response category the frequency of alternative concepts gradually decreased. Delayed in the final test before the second student teaching or understand the negative response in this category is included in the category. A large proportion of the students did not understand the teaching in the category of answers yielded the answer. Because the students didn't have learning, it is normal they did not have the necessary mental structure. In the final test and delayed post-secondary students in this category is not taking apart.

Students alternative concepts encountered in about Kepler's laws pre-test post-test and delayed post-test.

Table 2: Alternative conceptions about Kepler's laws theme

Alternative conceptions before instruction	n (SN)
The earth's speed is constant around the sun in its orbit.	3 (S9, S16, S25)
The earth's speed is far greater at the point where it is further away from the sun.	5 (S5, S7, S8, S10, S11)
When the earth is away from the sun, the sun's gravitational force decreases and the world spins faster.	2 (S14, S21)
When the earth is closer to the sun, the area of the position vector scan increases.	3 (S2, S12, S15)
Alternative conceptions after instruction	n (SN)
The earth's speed is far greater at the point where it is further away from the sun.	1 (S5)
When the earth moves away from the sun, the area of the position vector scan increases.	2 (S6, S16)
When the earth is closer to the sun, the area of the position vector scan increases.	1 (S24)
Alternative conceptions after delayed post-test	n (SN)
The earth's speed is far greater at the point where it is further away from the sun.	6 (S3, S5, S8, S18, S22, S25)
The earth is closer to the sun increases the area of the position vector scan.	1 (S24)

Teaching ideas for pre-13 students with alternative concepts were encountered in just four post-secondary students and in the delayed post-test, while seven students were faced with the alternative concepts. Five students before instruction had encountered "The Earth's speed is far more at the point where it is further away from the sun" alternative conception. After instruction the frequency of this alternative conception decreased and only one student (S5) gave this answer. This student continued to pursue the idea of this concept before and after instruction and the delayed post-test. In the delayed post-test, six students had encountered this alternative conception. Five of these students did not have this alternative conception before teaching, after a period of teaching these alternative ideas of the concept developed.

"The earth's speed is constant around the Sun in its orbit" and "when the earth is closer to the sun the area of the position vector scan increases" alternative conceptions had been encountered by three students before instruction. After the post-test and delayed post-tests were encountered with the first alternative idea. The "when the earth is closer to the sun the area of the position vector scan increases" alternative conception was encountered at post-test and post delayed-test by one (S24) student.

The "when the earth is away from the sun the sun's gravitational force decreases and the world spins faster"

alternative conception had been encountered with two students before instruction. This alternative conception was encountered after instruction and the delayed post-test. Instruction was effective in changing these alternative conceptions.

The “when the earth moves away from the sun the area of the position vector scan increases” alternative conception was encountered by two students (S6, S16) for the first time after instruction. Instruction was instrumental in the emergence of this alternative conception. In the delayed post-test ideas about this alternative conception had been eliminated.

4. Results and Discussion

As a result of this study, instruction creation meaning making were determined to be effective on eleventh grade high school students’ ideas about Kepler’s laws. While before instruction scientific and scientific fragment responses were not found in students’ answers, in the post-test and delayed post-test the frequency of scientific response increased. Before instruction alternative and alternative fragment response categories were the most common, while after instruction the number of alternative concepts was reduced.

The alternative conception that the Earth speed is constant around the Sun in its orbit was not encountered after instruction. Instruction was effective in changing students’ ideas when faced with this alternative conception. Yu, Sahami and Denn (2010) encountered this alternative conception with twenty-four university students during their interviews. Also Klammer (1998) met this alternative conception in a literature review related to Kepler’s laws.

5. Recommendations

It is determined to be effective instruction for meaning making exchange students’ ideas about Kepler’s laws. It can be studied meaning making instruction for teaching different concepts. In teaching the concepts which students have difficulty in learning teaching methods should be used to provide conceptual change rather than traditional teaching methods. This type of instruction methods will be effective on a permanent conceptual change. Therefore effects of using different teaching methods at conceptual change of Kepler's laws can be studied.

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