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COMPARISON OF SCIENCE TEACHER CANDIDATES' METACOGNITIVE AND SCIENTIFIC STORY WRITING SKILLS

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ABSTRACT

In this research, it is aimed to investigate the metacognitive skills and scientific story writing skills of science teacher candidates. For this reason, the research was conducted with 80 science teacher candidates studying their 3rd year in one of the governmental universities in Turkey. The participants were expected to display a number of metacognitive skills and to make an interesting introduction to the lesson to capture students' interest as a result of their science and technology laboratory applications. Hence, the participants were asked to write a scientific story concerning heat concept which can be used in the beginning of the lesson. In addition, their metacognitive skills were measured with a Likert type scale. In the analysis, a rubric will be used to evaluate individual scientific stories. Also, metacognitive skill scales will be analyzed via SPSS. The correlation between the scores of metacognitive scale and scientific stories will be determined and recommendations will be given upon the findings.

Key Words: Teacher candidates, scientific story, metacognitive skills.

INTRODUCTION

The significance of the education is perceived in every part of daily life nowadays with rapid changes. The societies which cannot follow up those changes are poorly influenced from them. As a consequence of those poor effects, individuals who cannot reply even very simple questions are encountered frequently in TV programs (Açıkgöz, 2002: 5). Hence, development of the quality of the education is a major issue.

When we deal with the education in more specific and consider science education, in Turkey, teacher centered science education was given as a tradition for long periods. In this frame, transferring of scientific phenomena, concepts, theories and laws from teachers to students constitute the focal point of science education. However, in 2004, the education system was modified and inquiry based and constructivist science education was adopted. In this context, the targets of the science education can be summarized as follows:

1. To know and comprehend the scientific information
2. To research and discover (scientific processes)
3. To imagine and develop
4. To be affected and value
5. To utilize and apply (Ayas et al., 2010; 8).

With this science program, the students are expected to embrace scientific process skills, possess imagination and creativity, and develop positive attitudes and values and being aware of science in daily life in addition to scientific facts. In another words, with the provided science education, students' curiosity to know should be triggered and it should be aimed to develop individuals who are respectful to themselves and to the environment, who are qualified, who investigate, question, reflect his/her learning to the daily life.

To actualize the above mentioned aims, critical thinking, reflective thinking, creative thinking and metacognitive skills are expected to be in advanced levels especially for the individuals who will give science

education in the future. Because a person can accomplish his/her own learning when his/her thinking skills are improved (Doğan, 2013). For this reason, metacognitive level should move to the upper levels as possible from knowledge and comprehension levels. From these properties, metacognition is a concept which was firstly used by Flavell in 1976 (Bağ, Uşak & Caner, 2006: 250). According to Flavell, metacognition is the total of one's own cognitive process, products or one's information about them (Flavell, 1979).

In order to make the function of metacognition more concrete, a number of questions are listed below. Metacognition gives chance to individual to answer those questions (Senemoğlu, 2009: 336):

- What do I know about this subject?
- What length of time do I need to learn this topic?
- What kind of a plan should I make in order to teach this topic effectively?
- How should I revise and edit the limitations of the plan in order to edit them?
- How should I find the mistake when I make a mistake?
- Is the product as a result of all those steps compatible to my expectations? If not, how do I change my plan?

An individual who asks those questions to himself possesses the responsibility from his learning and he can organize his learning with his needs. With the help of metacognition, he perceives science as a part of daily life and can make connections among science concepts in different areas (Bağ, Uşak & Caner, 2006: 262). So, metacognition has a significant place in science instruction.

In our schools, unfortunately, the relationships between scientific concepts and daily life events are not mentioned satisfactorily (Demircioğlu, Demircioğlu & Ayas, 2006). However, scientific stories can be good instruments in order to trigger the imagination and thinking skills of the students. Stories can be used in the instruction of the related concepts by producing stories intended to the solution of the problems encountered in scientific manner (Demircioğlu, Demircioğlu & Ayas, 2006). Relately, scientific stories take place recently in science education research (Demircioğlu, Demircioğlu & Çalık, 2009; Demircioğlu, Dinç & Çalık, 2013). In these studies, several science concepts are intended to teach primary, secondary and high school level students. The number of research related to the training of teachers and teacher candidates about scientific story writing is very small. Considering that they can be used in terms of constructivist approach, teacher candidates should be well qualified about scientific stories. Çelik, Yılmaz, Şen and Sarı (2013) investigated scenario construction skills of science teacher candidates and found that despite being successful in general, they were not sufficient in problem solution, creative thinking and relating concepts with daily life.

Qualification of teacher candidates in terms of the utilization of scientific stories is also significant for making their students love science. However, sufficient research has not been encountered related to the instruction of specific science concepts. From this thinking, the problem of the study has been identified.

The Aim and Significance of the Study

The purpose of this study is to investigate the relationship between metacognitive and creativity levels of science teacher candidates used to write scientific stories for the instruction of heat concept.

With this study, metacognitive levels and scientific story writing skills of teacher candidates will be examined. In addition, the correlation between metacognitive level and story writing skills will be found out. It will be discussed in what level, those two variables can be correlated and how this correlation could be improved.

METHOD

Study Design

Correlational survey study method was utilized in this study. Correlational survey studies aim to specify the level of change among two or more variables (Karasar, 2013). In this research, the correlation between scientific story writing skills and metacognition was found out.

Participants

This study was conducted with 80 third year science teacher candidates who were studying in the education faculty of one of the governmental universities in Turkey. 17 of the participants (21.2%) were male whereas 63 (78.8%) of them were females. All of the participants had prepared lesson plans related to the heat concept during the semester in terms of the "Science Instruction and Laboratory Instruction I" course. For this reason, the participants possess pre-knowledge related to the instruction of this concept. In this research, the participants were asked to write a scientific story related to the heat concept which will trigger the curiosity of the students.

Data Gathering Instruments

In data collection, the scientific stories written by the teacher candidates and metacognition scale which involve 27 items were utilized. The scientific stories related to the instruction of the heat concept in elementary level were written by the participants in 40 minutes period (see appendix 1). Metacognition scale is a Likert type scale and it was developed by Tüysüz, Karakuyu and Bilgin (2008) to determine the metacognitive levels of teacher candidates. Its alpha reliability coefficient was calculated to be .783. This reliability coefficient shows us that it can be utilized in the study. Hence, the scale was applied to the participants without making any changes on it.

Data Analyses

Content analyses were utilized in the analyses of the scientific stories written by the teacher candidates. Content analyses aims to collect similar data under particular concepts and themes by organizing and interpreting them (Yıldırım & Şimşek, 2011). In this content analyses, the content of the scientific stories were assayed with the themes related to creative thinking. To determine the creativity level of teacher candidates while writing scientific stories, a rubric which consists of ten themes was developed by the researcher by considering the steps utilized by Doğan (2013). In Table 1, the details of the rubric are presented with the themes and their explanations.

Table 1: Scientific Story Analyses Rubric with its Explanation

Theme	Explanation
Purpose compatibility	Is it compatible for the purpose of the question?
Cognitive level compatibility	Is it compatible for the grade level of the student?
Fluency	While solving the problems, can s/he produce valid ideas and construct the relations between them easily?
Analogical Thinking	Can s/he think via analogies?
Theoretical thinking	Can s/he combine the ideas in a focus point while constructing new solutions?
Inference-Prediction	Can s/he think by modeling? Can s/he anticipate for the future?
Planning	Can s/he construct the steps for the solution by considering the issue before beginning to solve the problem?
Hypotheses Construction	Can s/he produce alternative solutions related to the problem?
Application	Can s/he apply the plans to convenient cases?
Summarizing	Can s/he summarize the findings?

The scientific stories written by the teacher candidates were analyzed according to ten themes mentioned in Table 1. The themes were scored during this procedure. Scoring of the themes was mentioned below:

1 point: The theme and its explanation were not encountered in the scientific story.
2 points: The theme was present in the scientific story however it was not sufficient.
3 points: The theme and its explanation were completely present in the scientific story.

To raise the reliability of the research results, ten scientific stories were randomly selected from all the scientific stories written by the teacher candidates. Those selected stories were analyzed by the researcher and by an external researcher independently. The reliability of the analysis is accepted to be high when the correlation between two analyzers is more than 70 % (Yıldırım & Şimşek, 2011). In this process, the correlation between two analyzers was found to be 80 % and this value indicates that the content analyses conducted with the rubric have a high reliability. The scores obtained from the content analyses of the scientific stories were transferred to SPSS. Teacher candidates could obtain ten points as a minimum score whereas they could obtain thirty points as a maximum from these analyses.

Metacognition scales which were Likert 5 type scales were scored from 1 to 5 points to each category (5 for absolutely agree, 4 for agree, 3 for uncertain, 2 for disagree, 1 for absolutely disagree). The score of each participant were transferred to SPSS. 19 items of the scale were positive items whereas 8 of them were negative items. The negative items' scores were reversed during the analyses. The minimum score that can be obtained from this scale corresponds to 27 whereas the maximum score corresponds to 135. The reliability analyses showed α alpha reliability coefficient of .854 from this research.

The relationship between teacher candidates' scientific story writing skills and metacognitive skills were investigated via simple correlation. It is researched that in what level metacognition explains teacher candidates' scientific story writing skills.

RESULTS

The Analyses of the Scientific Stories

The details of content analyses of the scientific stories are shown in Table 2 with the frequencies for each theme.

Table 2: The Results of the Analyzes of the Scientific Stories according to the Rubric Developed

Theme	f		
	1 point	2 points	3 points
Purpose compatibility	11	7	62
Cognitive level compatibility	11	4	65
Fluency	16	26	38
Analogical Thinking	61	17	2
Theoretical thinking	36	34	10
Inference-Prediction	25	40	15
Planning	41	31	8
Hypotheses Construction	48	20	12
Application	48	22	10
Summarizing	39	31	10

As it is seen on Table 2, the theme which teacher candidates show the most accomplishment is "cognitive level compatibility". On the other hand, the theme which teacher candidates show the least accomplishment is the "analogical thinking". Teacher candidates were determined to be successful at the themes "purpose compatibility" and "cognitive level compatibility". Also it was seen that their scientific stories are appropriate for their purpose as well as the grade level. In addition, teacher candidates got high scores from the theme "fluency". The participants had difficulty in generating different ideas for problem solving and establishing relationships between these ideas. They were found to be in low level success for the "inference-prediction" theme. The themes "analogical thinking", "theoretical thinking", "planning", "hypotheses construction", "application" and "summarizing" were determined to be received low points by the participants as a result of

the analyzes. Most of the teacher candidates do not utilize analogies and cannot collect their ideas under their own solution proposals. They do not produce satisfactory steps for the solution of the problem mentioned in their scientific story. Additionally, they cannot make the application of it to different areas since they do not make any planning according to the solution of the problem. It is clear that teacher candidates have problems with producing alternative solutions for the problem they constructed and summarizing the consequences they collected.

As a result of these analyzes, it is seen that teacher candidates are not successful enough in writing scientific stories.

An example from the scientific stories written by the participants is provided in the appendix (see appendix 2).

The Analyses of the Metacognition Scales

The analyses of the metacognitive scales indicated that the participants (N= 80) had an average score of 104.68 points with a standard deviation of 12.86.

The Correlation between Scientific Story Writing and Metacognition Skills

It can be interpreted that the distribution is normal as p value is less than .05, z statistics is less than 1.96 and skewness coefficient is between $\pm$ 1 at α=.05 significance level according to the results of Kolmogorov-Smirnov test (Büyüköztürk, 2010: 40-42). When the distribution of scientific story writing skills scores are investigated, it is seen that p= .05, z statistics is -.11 and skewness is -.10. When the metacognition scores are considered, p=.20; z statistics is .05 and skewness is -.95. According to those results, it can be concluded that the distributions are normal. So, the correlation between those two variables can be checked.

Table 3: The Correlation between Metacognition Scores and Scientific Story Writing Scores

		Metacognition Scores	Story Writing Scores
Story Writing Scores	Pearson Correlation	.282*	1
	Sig. (2-tailed)	.011	
	N	80	80

* Correlation is significant at the 0.05 level (2-tailed).

As can be seen from Table 3, there is a positive and significant relationship between scientific story writing and metacognitive skills (p=.01<.05). As metacognition score increase, scientific story writing skills increase however this relationship is in low level (r=.282). Metacognition level explains 7.9 % of the variance of scientific story writing skills. According to those findings, as metacognitive level increases, scientific story writing skills increase, too. However, metacognition is not the leading factor that drives scientific story writing. 92 % of the variance is affected by other various factors.

DISCUSSION AND CONCLUSION

According to the results of this study, teacher candidates were seen to not successful at scientific story writing. The reason of this situation might be due to the fact that they do not use creative thinking skills sufficiently and as a result of this, they cannot write a creative story related to the solution of a problem. Teacher candidates have difficulty in suggesting solutions for the problems from daily life. They are not competent for solving their problem analytically. We can say that teacher candidates lack creative thinking skills and skills to solve problems from daily life.

The mean of the metacognition scores of the participants were specified to be 104.68 out of 135.00. According to this score, it can be said that they have high metacognitive levels. Their cognitive awareness is also high.

As a result of this study, the relationship between scientific story writing and metacognitive skills indicate that metacognition explains only 8 % of the scientific story writing skill. This ratio is very low. Despite having high scores from metacognition, their scores are not so satisfactory for scientific story writing. 92 % of scientific

story writing skills can be explained by other various factors. Those factors were not addressed in the present study. However, it can be the research question of other future studies. Determination and development of the factors that influence the creativity of teacher candidates from this aspect can be dealt in such future studies. There might be a number of reasons of teacher candidates for not utilizing creativity in writing scientific stories. This situation is also can be researched further. What factors influence the creativity of teacher candidates can be determined via studies regarding the improvement of scientific story writing skills of them.

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APPENDIX

Appendix 1. Scientific Story Writing

Write a scientific story which can be use in the instruction of "**heat**" concept in elementary level (grades 4-8) in order to arouse curiosity among students in the beginning of the lesson.

Appendix 2. Sections from Teacher Candidates' Scientific Stories

Teacher Candidate 9

"As you all saw, last week it had snowed. Before it snowed, the weather was so cold. We all were ill. However, after it had snowed, the weather got warmer. Even, it was very warm a few days ago. You didn't get cold. Have you ever thought about the reason of this situation? When it had snowed, you got ot of the house, you played with your friends and had fun. When it began to melt, it again got cold. Have you ever thought about the reason of this situation? .....

Teacher Candidate 37

……

Ezgi: Today it is so sweltering. When I saw that the temperature would be 40 ^{0}C in the morning news, I got mad.
Mine: Yes, I also saw that news on TV but you are wrong at one point.
Ezgi: What was that?
Mine: It is not the temperature, it is the heat that would be 40 ^{0}C.
Ezgi: Oh no. You are drooling now.
Mine (a bit unhappy): One of us is telling the truth but which one? If only we had listened the lesson well that day. Also, one thing that the teacher mentioned made me think.
Ezgi: I also such things in my head. What was yours?
Mine: They say that it is better to wear thin but dense clothes to keep warm than those of thick clothes. I do not understand this. How? Isn't it foolish? What do you think Ezgi?

Ezgi: Yes, I agree. I have one more thing confusing in my mind. The teacher said that there will be no dealing between the cold and the hot. So, can't the cold turn into the hot? ……..

Teacher Candidate 79

The researcher, Ayşe observes her mother cooking. Ayşe, being so carefully, notices that the meal in the small saucepan requires less fire from the stove. After the meals are cooked, she measures the temperature of the sucepans and observes that they are the same. And she wonders the reason of this situation. She immediately constructs an experimental set up. She places a glass of and a bottle of water on the stove inside two pots. She frequently measures the temperature of them. And she realizes that the glass of water gets warmer faster than the other despite being on the same type of fire on the oven. Ayşe discovers that the heat and temperature are different concepts. The heat depends on the amount. Because despite the fact that two different amounts of water are at the same temperature, different amount of heat was given……..