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Identiying the skills of classrom teacher candidates in identification and control of variables by using various assessment tools

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Abstract:

The purpose of this study is: i) to identify the skills of classroom teacher candidates in determining and control of variables by using 2 different assessment tools and ii) to examine the effect of assessment tools in evaluating these skills. 101 classroom teacher candidates participated in the study. Scientific Operation Skill Test (Test-1) with multi-selective questions and Test of Scientific Processing Skills For Teachers (Test-2) with an open ended structure depending on a scenario were used as data collection tools. According to the findings obtained from these two tests, most of the teacher candidates wrongly chose and identified the variables that were controlled. Also there were big differences between the ratio of candidates that answered correctly about the dependent and independent variables and the candidates that answered correctly about hypothesis building skills. One of the important findings of the study is that various assessment tools are found to be effective factors in the success of understanding about identification and control skills related to the variables

Keywords: Identification and control of variables; assesment tools.

1. Introduction

The advances in science and technology have been on the increase in our era. The pace and amount of information that is provided have gone beyond the borders of the human memory. It is of vital importance for the future of people and communities to keep up with these developments and to use these advances for their benefit (Tan & Temiz, 2003). Along the same lines, it is not possible for individuals to keep up with this process by trying to store the current and available information and knowledge in their minds or to take the available information from

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its source in a passive manner. Instead, the individuals should prefer the ways that will help them obtain and reach information and they should have skills that this process entails. In this regard, science education plays an important role.

One of the fundamental aims of modern science education is to create individuals who employ research, who ask questions, who examine concepts, who can relate their daily lives to science topics, who can use the scientific method in solving the everyday problems that are found in every field of life and who can look at the world with the perspective of a scientist (Tan & Temiz, 2003). In order to make this possible, science lessons should be taught in a manner that is compatible with the nature of science and lessons should be dependent on research, scientific methods and skills that these methods consist. Science education and training should be a process in which the students take an active role. Students should be able to identify and describe the objects and phenomena, ask questions, obtain information, be able to develop possible explanations for a natural phenomenon or problem, test these possible explanations through different manners and be able to share their ideas with each other (NSES, 1996. quoted in Ateş & Bahar). The procedures and skills that the students need in order to learn the science topics, to explain and describe the natural phenomenon in a correct manner are regarded as mental skills that are called scientific processing skills (Ateş & Bahar, 2002).

Scientific processing skills are the skills that make learning easier in science education, contribute to the active participation of students, develop a sense of responsibility in self-learning, increase the permanency and sustainability of learning and provide methods and procedures in research (Çepni, Ayas, Johnson and Turgut, 1996, quoted in Tan and Temiz). These skills are the ones that the scientists employ during their own work (Tan & Temiz, 2003). Scientific processing skills are classified in two groups in general: basic processes and combined processes. Brotheton, P. N. & Preece, P.F.W (1995) list these skills as below:

Basic processes: Observation, evaluation, classification, prediction, using numbers, using space-time relationships, induction, recording of data.

Combined processes: Interpretation of the data, identification and control of variables, operational descriptions, hypothesis building and experimenting.

2. The Assessment Tool To Identify, Control And Evaluate Variables

Some of the skills mentioned above are of a higher order than the others. They may be hard to understand and practise since they consist of both cognitive and psychomotor skills. Various studies point to that fact (Ateş & Bahar, 2002; Germen & Odom, 1996). Skills of identification and control of variables is one of the skills that the students have a hard time with and can not fully employ and they are among the skills that are more difficult to understand compared to the rest. Grifith & Thompson(1993) identified by face-to-face meetings with students that the students perceive the concept of independent variable as the variable that is out of the limits of the study. In addition to that, the concept of dependent variable was perceived as the variables that are under our control and can be changed as we wish during the course of the study (Ateş, 2005). Ateş and Bahar(2002) determined that although the classrrom teacher candidates that took part in the *investigative science education approaches* developed their skills in hands-on approaches and hypothesis building, they had a hard time in developing their identification and control skills related to the variables.

There are some studies that examine the effect of various assessment techniques on the success of science education and on the level of conceptual understanding. As a result of these research, it was seen that the students with particular individual differences (gender, cognitive styles, different ethnic and culutral groups, learnnig styles etc) receive different scores from various assessment tools (Bahar & Hansel, 2000; Lawrenz et al. 2000; Klein et al. 1997, Ateş & Karaçam, 2004). It was also seen that the content and items in different assessment tools (theoretical or hands-on) have an effect on the success rate in the class (Sencar & Eryılmaz,2004).

Lawrenz et al.(2000) established as a result of the study they performed on 3500 10th grade school children that the correlation among the scores obtained from different assessment techniques (multiple choice, open-ended, hands-on,hands-on full investigation) by successful students was higher than those of less successful students. It was also seen that students from different ethnic and cultural groups vary in their scores in the tests.

Although there are prior studies in the literature related to assessment tools that affect the success in the classroom in different fields, there have been no prior studies on the level of understanding the scientific processing skills. In this study, 2 assessment tools with different formats and contents were used to investigate their effects on the the level of understanding the scientific processing skills. In this regard, the study is thought to be beneficial and important.

3. Purpose

The purpose of this study is i) to identify the skill level of identification and control of variables for classroom teacher candidates by using 2 different assessment tools and ii) to investigate the effects of these different assessment tools on the level of identification and control skills.

4. Procedure

This study is a survey which was realized on one group. The sample of the study consisted of 102 2nd year students from Abant İzzet Baysal University, Education Faculty, Classroom Teaching Department during 2008-2009 educational year Fall Semester.

In the study, Scientific Operation Skill Test (Test-1) developed by Okey, Wise and Burns with multi-selective questions and Test of Scientific Processing Skills For Teachers (Test-2) with an open ended structure depending on a scenario that was developed by Ergin et. al were used in order to evaluate the skills of classroom teacher candidates related to the identification and control of variables. Test-1 has a multi-selective structure and consists of 4 questions each for 3 different situations. The students were given situations in which dependent, independent and controlled variables were present and they were asked questions such as: *which one is the dependent variable? which one is the independent variable?* and *which is the controlled variable?* Each of the skills was placed in the multiple choice options and the students were asked to choose the correct skill. The students were also required to select the correct hypothesis which consisted of dependent and independent variables. The original published consistency co-efficient is Cronbach alfa(α) 0,86. The reliability co-efficient for the test translated into Turkish using a sample of classroom teacher candidates was found to be 74% (Ateş ve Bahar, 2002). Thest-2 provides the students with two different scenarios. After each scenario, a research question is given. The dependent, independent and controlled variables were questioned according to the scenario and the research question, along with the hypothesis that can be formed in relation to the variables. As a result of a pilot application undertaken in a different study (Aydoğdu, B. 2006) one item with an item-specificity index of lower than 0.30 was deleted for Test-2 and the reliability co-efficient was calculated as (KR–20) 0.70.

5. The Analysis of the Data

The analysis of the data obtained from the study required the reading of answers given to the multiple choice and open-endend questions. The situation of identification and control of varibles by the candidate students was examined in general. Later, individual analysis for each student was undertaken by investigating which questions were answered correctly and incorrectly. In order to increase the validity of the study, all the answeres were scored and examined by 2 researchers. The data obtained by the study was transfeered to tables and presented in the Findings Section.

6. Findings

Table 1 presents the answers of teacher candidates to Test-1. The correct and incorrect answers for the 3 different situations for multiple choice Test-1 were analysed one by one and counted. In Test-1 there are 3 questions regarding the selection of dependent, independent and controlled variables. In addition to these, there are 3 questions regarding the hypothesis that the variables are involved in. Table 1 displays the data that shows how many correct and incorrect answers were provided by the teacher candidates. Since the sample was composed of 101 individuals, the values in the table show approximate percentages (%).

Table 1: The status of answers provided by candidate teachers to Test-1

	3 true answer	2 true 1 false	1 true 2 false	3 false answer
İndependent	25	37	21	18
Dependent	46	32	13	10
Controlled	3	2	14	82
Hypothesis	85	10	4	2

Regarding the independent variable: when the data in Table 1 is examined, it is seen that about 25% of teacher candidates selected the independent variable correctly in all three conditions. 37% of the candidates chose the independent variable correctly in two conditions and 21% selected the dependent variable correctly in one condition whereas selecting it incorrectly in the other remaining conditions. About 18% of the candidates made an incorrect selection by choosing the wrong independent variable in all three conditions.

***Regarding the dependent variable*;** About 46% of teacher candidates selected the dependent variable correctly in all three conditions. 32% of the candidates chose the dependent variable correctly in two conditions and made mistake in one condition. 13% selected the dependent variable correctly in one condition whereas selecting it incorrectly in the other remaining conditions.. About 10% of the candidates made an incorrect selection by choosing the wrong independent variable in all three conditions.

Regarding the controlled variable; Only 3% of teacher candidates selected the controlled variable correctly in all three conditions.. Only 2% of the candidates chose the controlled variable correctly in two conditions and made mistake in one condition. 14% selected the controlled variable correctly in one condition whereas as many as 84% of the candidates made an incorrect selection by choosing the wrong controlled variable in all three conditions.

Regarding the hypothesis; For the questions that consist of dependent and independent variables that are mentioned above, about 85% of the candidate teachers could select the corect answer. Thr ratio of participants who selected two hypothesis correct and made an incorrect selection is 10%. The segment of teachers who correctly selected two hypothesis by making mistake in one hypothesis is 4%. 2% of the candidates made incorrect selections in all three hypothesis.

One of the interesting findings of the study is the fact that although very low levels of candidates could correctly select the independent and dependent variables for each of the three conditions, they showed a high ratio (85%) of correct choice of the hypothesis that these skills are related. The difference of the amount of correct and incorrect answers in the same test for different conditions also show that the contect and scope of questions may be factors that affect success.

Table 2: The status of answers provided by candidate teachers to Test-2

	3 true answer	2 true 1 false	1 true 2 false	3 false answer
İndependent	24	44	20	14
Dependent	26	33	29	14
Controlled	9	19	47	27
Hypothesis	43	33	14	12

Regarding the independent variable; When the answers to the open-ended questions are examined, it is seen that about 24% of the teacher candidates did not have any trouble in identifying the independent variable and could answer correctly to both of the open-ended questions. Almost half of the teacher candidates (44%) gave one correct and one incorrect answer in identifying the independent variable. 20% of the participants had difficulty in identifying the independent variable and 14% of the participants did not (or could not) make any comments.

***Regarding the dependent variable*;** It is observed that 26% of the teacher candidates could write the dependent variable correctly in both conditions. 33% of the teacher candidates gave one correct and one incorrect answer to the related questions. The percentage of students who answered incorrectly in both conditions is 29%. The number of students who did not write any comments about the identiication of the dependent variable is the same as the students who had no comments regarding the independent variable which is 14%.

***Regarding the controlled variable*;** When tested with both assessment tools, very low results have been obtained. The percentage of students who could write all the controlled variables in Test-2 is only 9%. 19% of the students could answer correctly to one of the variables that were controlled according to the scenarios and they answered the other one incorrectly. About half of the teacher candidates (47%) wrote the controlled variable incorrectly in both conditions. The percentage of participants who did not answer this section is 27%.

Regarding the hypothesis; this is the skill that the teacher candidates showed the biggest success rate (43%). The participoants could write the true hypothesis for both conditions. 33% of the participants could write one of the hypothesis correctly according to the scenario whereas they were unsuccessful in the other one. The percentage of teachers who could not form a hypothesisin both conditions is 14%. The participants who left that section blank without any comments is about 12%.

7. Results and Discussion

By using 2 different test techniques, it was established that most of the teacher candidates had misconceptions regarding the controlled variable which is a sub-group of identification and control of variables. Most of the teacher candidates (82%) could not select the controlled variable correctly in Test-1 under all three conditions. In tTest-2 which has an open-enden scenario dependent structure, that percentage was assessed as 47%. Thesefindings have been found to be paralel to the other studies in the literature (Ateş 2005, Ateş&Bahar 2002). The students may think along the lines 'if we can control a variable, that is a variable we changed ourselves' (Grifith&Thompson, 1993; quoted in Ateş&Bahar). While 25% of the teacher candidates selected the independent variable correctly in Test-1 in all conditions, 24% of them wrote it correctly for all condiitons in Test-2. Regarding the dependent variable, 46% of the candidates couls select all conditions correctly in Test-1 whereas 26% of them wrote these correctly in Test-2. The skill of hypothesis forming consists of both of these skills and 85% of the candidates could select the correct hypothesis in all conditions in Test-1 while 43% could write the true hypothesis in Test-2. An interesting finding of the study is the fact that although the teacher candidates could select and write the independent and dependent variables in low percentages, in high ratios they could select and write the hypothesis which is formed of these skills. The different percentages of the data related to all the skills for both tests show that the format of the test is an effective factor in the success of understanding these skills. Especially the fact that while the hypothesis in Test-1 was selected correctly in high percentages whereas the percentage decreased in Test-2 can be interpreted that the candidates could understand the variables in the hypothesis and knew which variable affected what but they had trouble in expressing their ideas regarding these concepts. Teacher candidates could select the hypothesis presented in the multiple choice options. But when they were asked to form the hypothesis themselves according to the scenarios in Test-2, they form the hypothesis with expressions that are either incorrect or incomplete. The fact that different results can be obtained from questions regarding different conditions show that the content and format of the test can affect success.

8. Suggestions

It can be seen in this study and related prior studies that the teacher candidates have difficulty in comprehending the concepts of 'dependent variable', 'independent variable' and 'controlled variable'. Because of this reason, it can be stated that the terminology may have a negative impact on the understanding of the students (Ateş, 2005). Instead, terms that are easier to comprehend may be used. For example, '*the variable that is changed, the variable that affects, affecting variable or active variable*' can be used instead of independent variable, and '*answering variable or passive vari*able' can be used for dependent variable. In the place of controlled variable, 'constant variable' can be preferred.

Data with different percentages from 2 diferent tests was obtained in evaluating the skills mentioned before. The high difference between he success rate obtained from dependent and independent variables in Test-1 with its multiple choice format and the skill of forming hypothesis decreases in Test-2. Because of this reason, we can say that test-2 with its open-ended format can provide more logical and meaningful results. It can be suggested to use 2 or 3 phase tests and techniques such as interviews in similar studies in order to get more detailed and comprehensive data. Also, studies that focus on the effect of different assessment tools on understanding the scientific processing skills.

When the results are examined, it can be stated that the skills related to identification and control of variables are low in both formats. . Because of this reason, teaching techniques, in-class activities and experiments can be utilized in order to develop these skills in educational settings. It can be suggested to use techniques such as investigative science teaching and cooperative learning

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Appendix A.

TEST-1

Ayşe is wondering whether the sun warms the land and the seas in the same degree. She decides to do some research and takes two same size buckets. She fills one of the buckets with soil and the other with water and positions them in such a way that both buckets get the same amount of sunshine. She measures the heat every hour between 8.00 - 18.00

Which of the hypothesis below are tested in the study?

a different elements in diferent degrees**.**

d. The heat from the sun is different at different times of the day.

Which of the variables below controlled in the study?

a. the type of water in the bucket

b. the temperature of soil and water

c. the type of the ma**.** The more sunshine soil and water gets, the warmer they become.

b. The more the soil and water stay under the sun, the warmer they become.

c. Sun warms terials in the buckets

d. the amount for each bucket to stay under the sun

What is the dependent variable in the study?

a. the type of water in the bucket

b. the temperature of soil and water

c. the type of the materials in the buckets

d. the amount for each bucket to stay under the sun

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What is the independent variable in the study?

a the type of water in the bucket

b. the temperature of soil and water

c. the type of the materials in the buckets

d. the amount for each bucket to stay under the sun

TEST-2

1. Hasan ve Ahmet are playing in a park. During the game, Ahmet rolls a piece of marble down the slide in the play area. Hasan claims that if the piece of marble is rolled down a longer slide, it will gain more momentum. This discussion leads to the research question below. After reading the research question, determine the hypothesis, dependent variable, idependent avaribla and the controlled variable.

Research Question: What is the pace of a piece of marble when it is rolled down a ramp when the height of the ramp is changed?

İndependent variable:…….
Dependent variable:…….
Controlled variable: …….
Hypothesis:…….