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Connection between science instructors' evaluation devices and understudies' psychological turn of events

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Abstract

In order to determine students' achievement, science teachers have to develop their own assessment tools. This study attempts to find out the relationship between the teachers' assessment tools and students' cognitive development according to the teachers' teaching experiences. Six open-ended survey questions were developed and delivered to 59 middle school science teachers. It was clear that the majority of science teachers used only written and oral assessment tools. Regardless of teaching experiences, almost all the samples do not have detailed knowledge on students' cognitive development and its relation to asking questions.

Keywords: Cognitive development, science teacher, assessment tools, exam questions, middle school, formal operational level.

Introduction

Everybody should have enough knowledge, skills, and abilities in order to handle society's problems. If we want students to cope with the future problems, schools should improve students' cognitive developments that will help them to think critically and make powerful decisions about the current issues. In this content, the aim of teaching is to prepare the next generation with high level thinking skills (Howe and Jones, 1998).

While determining the quality of instruction at an institution, assessing the learning products play an important role. There are many ways to determine the quality of teaching. Some of them are; the number and the qualities of newly developed products, published manuscripts, graduates' entrances to the professional works and their contributions to the related disciplines. In this process, students' cognitive thinking levels may provide useful data about how they are able to use the current knowledge and how they contribute them to the generation of new knowledge and technology. So it can be said that the assessment of students' cognitive levels play very crucial role in learning and teaching process.

Quality assessment is based on the quality of questions. The question levels which are asked in the examinations play an important role while assessing students' achievement and developing their critical thinking skills. High-level questions can lead students to think more creatively and multi-dimensional (Brualdi, 1998). Students, who are continuously encountered with the low level questions, are tented to be lower thinkers (Çepni and Azar, 1998).

The context and type of the level of questions have important act for developing the students' cognitive skills. For this reason, the questions teachers ask should focus on students' cognitive skills. Besides measuring students' success, the questions should make students think free of the context. Therefore, questions asked should critically examine their assumptions, both scientific and social. At the same time, questions should be leading to the construction of new cognitive schemes.

Teachers usually ask low-level questions at the school examinations thus making students get high marks from these examinations (Hosseini, 1993). These questions generally measure students' algebra abilities. Because of using low level questions, students are not encouraged to challenge their cognitive schemas and this will not take them a stepforward. These things cause students to have low achievement both in international and national exams (Ersoy, 2006).

For example, Turkish students' achievement on the TIMSS-R is under international average (Ersoy, 2006). The same students are able to solve a few questions asked at the University Entrance Examination (OSS) in Turkey. Because, these questions mainly accepted as higher level (Çepni, Özsevgeç and Gökdere, 2003). Çepni, Özsevgeç, Bacanak and Gökdere (2001) investigated the middle school science teachers' exam questions and LGS (Entrance Examination of the High Schools) to determine their relationship with the characteristics of formal operation level (hypothetical, combinational, correlation, probability, controlling variables, proportional reasoning). They analyzed 1000 questions asked by science teachers and the results show that only %9 of these questions were suitable for characteristics of formal operation level. In the same study, 600 questions asked in LGS were also examined for the same purpose. The results showed that %37 of these questions were suitable for the characteristics of the formal operation level.

In another study, Çepni, Özsevgeç and Gökdere, (2003) analyzed 515 questions that were asked about high school physics topics and 230 questions that were asked in OSS exams from 1990 to 2000. The results show that 72% of teachers' exam questions and 62% of OSS exam questions were classified as application level in the Bloom taxonomy. 64% of OSS exam questions and only 26% of teachers' questions were suitable for characteristics of formal operation level. In the same study, 25.5% of teachers' exam questions and 53% of OSS exam questions were appropriate for both formal operation level and Bloom taxonomy.

It is seen that there are significant relationships between exam questions and students' cognitive development levels. Science teachers, in many cases, develop their own assessment tools and questions to determine their students' achievement. These assessments questions- instruments should be reliable and objective and at the same time suitable for all of the instructional aims and characteristics of subjects in the program. However, there has been a debate about the efficiency of assessment done by science teachers at the middle school levels. It is believed that the main problem came from the issue of not establishing a relationship between students' cognitive developments and assessment tools used by science teachers. This study attempts to investigate the middle school science teachers' assessment tools and their relation with students' cognitive development according to their teaching experiences.

Methodology

In this study, 6 open-ended survey questions were developed by the authors and delivered 59 to middle school science teachers in different 15 cities in Turkey. The sample was classified into three groups according to teaching experiences. These are; 9 teachers (0-5 years; Group A), 25 teachers (6-20 years; Group B) and 24 teachers (21-above years; Group C).

The cities and teachers in the sample were selected randomly. The participants were selected from different regions of Turkey. The purpose of selecting participants from different regions was to make better inferences about the population. The senior science education students in Fatih Education Faculty were asked to find out about the teachers who have volunteered to participate in the study and also to know their addresses when the students were on winter break. The surveys were posted to each participating teachers. The participating teachers wrote their opinions about the questions to the spaces left in the survey. The following topics were included in the survey: (a) the measurement and evaluation approaches of teachers in science lessons, (b) the points that they consider while preparing exam questions, (c) the points that should be taken into account to make and effective measurement and evaluation, (d) the cognitive development differences between elementary and secondary students, (e) the reasons why they take or do not take these cognitive development differences into account while preparing exam questions, and (f) which techniques do they used while preparing questions inother to understand the cognitive development levels of their students.

The answers that were given to each question were analyzed and the frequencies were recorded quantitatively. The statements with similar meanings were grouped and recorded in the frequency table. Some interesting statements were presented without changing the meaning. By presenting the ideas with no change, we/I aim that the data were presented to the reader with no bias. This provides the reader to make their own interpretation of the data (Cohen and Manion, 1994).

Findings

Data which are related to each question were organized into the sentences item by item and these sentences were converted to quantitative findings with frequencies and presented with the tables below. Some qualitative data were also presented by using teachers' own statements.

Question 1: Which measurement techniques do you use in class? As seen from the Table.1, science teachers mostly use written and oral examinations. The Group B teachers used multiple choice test techniques more than others.

Table 1. The types of measurement techniques used by the sample

N= 59	**%A**	**%B**	**%C**
Written and oral examinations	100	80	41
True-false, matching questions	22	8	-
Multiple choice tests	33	44	24
Experiment and observation report	22	12	12

Question 2: What do you want to measure in your examinations? The teachers usually fix exams to measure the knowledge level and new knowledge of their student. However, only the Group C teachers assess student performance in the laboratory as seen from Table 2.

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Table 2. The aims of examination for teachers.

N=59	%A	%B	%C
Knowledge level and new knowledge gained	78	60	50
Their attitudes towards science lessons	11	8	8
Specific knowledge and translating formulas	-	16	8
Determine successful-unsuccessful students	44	40	42
Their performance in the science laboratory	-	-	21

Table 3. Criterions in preparing questions.

N=59	%A	%B	%C
Lesson behaviours	22	12	-
Students' levels	22	16	17
Relating them with daily life	22	16	17
Establishing cause-effect relationship and developing their cognitive abilities	11	8	4
Comprise all of the topics	22	36	37

Table 4. Differences between middle and primary school student.

N= 59	%A	%B	%C
Perceive abstract concepts and draw conclusions	11	16	29
Discover knowledge by doing experiments, make research without help, discuss the results with his friends and teachers	22	4	8
Look at the phenomena scientifically and see relationship between concepts	33	12	8
Increase interpretation of the events in a sequence of logic	33	12	37
Look at scientific events more carefully	33	24	16
Use languages more effectively	-	20	8
Feel more responsible from their learning	-	16	4
Solve difficult problems	-	12	8
Make connection between knowledge and the daily life events occurring around them	-	8	12

Question 3: What types of criteria do you consider in preparing questions?

Few teachers consider students' cognitive development in preparing questions (Table 3). A three year-experienced teacher said that "Actually, I measure behavioural changes which suppose to be reached at the end of the instruction. I also prepare my questions clear, understandable, and should be suitable for both my aims and student's level". A ten years experienced teacher indicated, "We should not measure what students do not know, but what they know. Instead of questions, which we think students cannot solve, we should ask those ones that they can do. In the process of preparing exam questions, not specific knowledge but general subjects or sub subjects are taken into consideration by me ". Twenty-eight year experienced teacher clarified that "% 30 of my questions are at low level, % 40 middle level and % 30 at high level"

Table 5. Beliefs for asking questions suitable for cognitive domain.

N= 59	%A	%B	%C
If I do not notice the cognitive development, I feel that I am making mistakes	44	12	25
I believe (but, no reason is given)	11	-	12
Increasing motivation	11	4	4
I take attention into general condition of the classroom and regional differences, not individual	22	12	8
Curriculum and textbooks are appropriate for cognitive development	-	4	8
In order to develop students' self-confidence	-	8	-
Because of student differences from each others	-	12	12

Question 4: What are the differences between middle and primary school students according to cognitive development?

Group B teachers have slightly more knowledge about students' mental development than others (Table 4). A 10 year experienced teacher explained that "A middle school children pass from childhood to adolescence and his feelings start to become more mature. His friend's environment, attitudes towards his family and psychology, imaging world and future understanding are different from primary school children".

Question 5: Do you believe that student's cognitive development should be taken into consideration while preparing the exam questions? Why?

Apart from data from the Table 5, some teachers believe that high or low- level questions do not help in developing student thinking. On the contrary, they argued that this situation could reduce their motivations and performances. An eleven years experienced teacher stated that "on one hand there should be a relationship between question levels and students' thinking, because if I ask easy questions, students' most likely think that the subject is very easy so they do not operate their minds. On the other hand, when they encounter difficult questions, they probably decrease their self-esteem and performance". Twenty-one years experienced teacher stated that all of the students were not homogeneous in the class; each student has different capabilities. Therefore, he asked low, middle and high level questions.

Question 6: What do you use to determine students' cognitive development levels?

The majority of 6-20 year experienced teachers' ways in understanding student's cognitive development are; looking at their answers and experimental abilities, using language, making abstract concepts concrete and reaching new results. Only 6 teachers within 59 teachers have used or mentioned about learning theories to determine students' cognitive development (Table 6).

Table 6. The ways of understanding students' cognitive development.

N=59	%A	%B	%C
Their logical answers, using language, imagining world, experiment and observation abilities, degree of the abstract concepts making concrete and reaching new results	33	80	46
Benefit form Piaget, Ausubel, Bruner and Bloom's and other learning theories	22	8	8
Economic and social condition of their families, friend groups and their ages	11	8	16
Benefit from characteristics of adolescence period	-	8	8
My experiences and their classroom activities	11	12	16
Counselling services, other teachers and printed materials	-	20	16
Achievement in exams	-	8	8

Conclusions and Discussions

Zoller (1993) and Zoller and Tsaparlis (1997) found that chemistry teacher's exam questions has very low cognitive levels in order to assess their students at high school levels. Questions at the low levels of cognitive development only encourage students to memorize the facts that this hinders their intellectual development (Çepni and Azar, 1998). Majority of the students are influenced not to force themselves to think more creatively and examine some events in analytical ways. Even some of the future scientists who are chosen within these students are not frequently encountered with the high cognitive levels of questions during their formal education. It is believed that this negative situation influences the quality of their future products.

All science teachers mostly use written and oral examination tools. Because preparing these assessment tools quite easy and do not require much expertise. In addition to the oral and written exams, science teachers in the Group B also apply test techniques. Yi it, Saka and Akdeniz (1999) also found similar results. Their study included 39 physics teachers and the majority of these teachers use only oral and written exams for students' assessment.

All group samples' main purposes in doing exams are to determine students' knowledge levels and new knowledge gained from their lessons. Only teachers in Group C take into consideration students' performance at laboratories when assessing their students. While they prepare the exam questions, the majority of them only consider the content of curriculum and their importance for the students. Establishing a relationship between cause-effect and developing students' cognitive abilities, which suppose to be main purpose of the assessment, are ignored almost by all science teachers. Even if teachers know the importance of intellectual capabilities of students in learning process, they are not able to consider these issues in preparing their exams (Chiappetta, 1976). However, surprisingly teachers in Group C are yet to consider the attainment targets of their lessons in preparing their exam questions. Through this, one would conclude that they do not spent time to prepare new questions and mostly use previously asked questions.

Science teachers in Group A not given much information about differences between primary and middle schoolchildren. The other groups mainly mentioned differences about using language, solving difficult questions, and feeling more responsible from their learning and daily life events occurring around them. It could be concluded that with experiences in teaching, distinguish primary from middle school children. Because more experienced teachers are often concerned with difficulties students encounter in understanding and applying basic scientific concepts. Primary students mostly do not understand abstract concepts and reflect their conceptual framework, however middle school children have done it and reach formal operational level. Çepni, Özsevgeç and Cerrah (2004) found similiar results that support above results

The sample also stated that there should be a parallelism between students' cognitive levels and question levels asked in the exams. However, the sample in this study has not given more reasons about this issue. From this result, it could be concluded that the majority of the sample do not carry specific knowledge about operational stages and their uses in the practices. In determining the ways of understanding students' cognitive development, it is seen that special methods or studies have not been used by the science teachers to reveal students' mental abilities (Çepni et al., 2004). While only two teachers are aware of learning theories at each group, the others take into consideration only their experiences and observations which are not tested scientifically, to determine students' cognitive levels.

It is clear that science teachers' measurement-assessment tools effect students' cognitive development directly. When student reach high cognitive development level, he/she gain high science achievement. Lots of studies in literature reported meaningful relationship between them. Lawson (1983), Mwamwenda (1993), Vass et al., (2000) and Özsevgeç (2002) reached same result; as if students have upper cognitive levels; they have high scores in science exams. In this way cognitive development could be significantly increased, and that such efforts affect students' academic achievement positively.

Assessment tools, which are used by the science teachers, should be suitable for students' level of thinking, background, experiences, environment, given instruction, educational targets and their level of know-

ledge. Assessment tools and approaches also should encourage students to develop their levels of mental abilities. Thus, in the process of preparing questions for exams, science teachers should have benefit from the characteristics of formal operation and Bloom's taxonomy. Meetings covering science teachers at different teaching experiences should be arranged in each city. In these meetings, effective assessment approaches (puzzle, project work, manipulation tasks, portfolio and standardized tests, etc.) should be introduced to science teachers with advantages and disadvantages. Also, in this process, performance assessments should be used. Because, it allows not only "see" but also "hear" what students know and can do with more clarity (Veronesi, 2000). With performance assessments, students spent much of their time by involving in learning activities.

Because of the fact that the most of the science teachers have not taken courses related to teaching profession during their academic development, they are not able to cope with the issues concerning teaching, such as; preparing questions according to the cognitive development levels or teaching active learning strategies in their courses. To solve these kinds of problems, some courses related to teaching and learning science and a course including measurement and assessment and asking high-level question techniques should be given to science teachers.

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