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Chemistry Education Research on Performance Evaluation in Determining the Student's Academic Success

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Abstract

This study involves the suggestion of an alternative evaluation methodology to the traditional evaluation methodologies to be utilized in the evaluation of acquisitions that students are required to attain. The unit containing "Mixtures" was selected for the administration of the study over 98 students aged 14-15 and studying at Grade 9. Following the teaching of the topic, performance evaluation, which consists of the assessment of the process and the result, was applied as an alternative to the traditional evaluation methodologies. Students were provided with the activity content together with information regarding five stages that would guide students during the completion of the activity. With the aim of assessing and evaluating the student activities, a detailed chart of measures was prepared. This evaluation scale displayed the fields, where student performances could be evaluated. Student performances were evaluated using a 3-point Likert-type scale. Pearson's correlation coefficient analysis was utilized on SPSS in order to assess the relationship between the activity application stages. It was found that the stages students followed during the course of the study were pair wise correlated. It was also concluded that students, who managed to accomplish the planning stage accurately, also completed the following stages successfully. This study enabled teachers to evaluate their students in terms of connecting chemistry topics with daily life experiences as well as coming to conclusions and attaining scientific studying skills. It is also supposed that this study would contribute to chemistry teachers by providing them an alternative experience in evaluating their students.

Keywords: *Chemistry education, performance evaluation, mixtures, solutions*

1. Introduction

In order to comply with the rapid developments in science and technology all over the world, some changes need to be done in the field of science education. These changes started with the reformation of the science curriculum. The new curriculum started to be implemented in 2005 step by step, which gave way to the new curriculum in Chemistry in 2008. The new teaching programs lead to many changes in the teaching techniques used in teaching environments. One of the fields affected by this change is the assessment and evaluation field. Modern teaching programs require the utilization of alternative assessment and evaluation methodologies along with the traditional ones. Alternative assessment and evaluation techniques are known to be ways of evaluation, which are different from the traditional methodologies (Cepni et.al., 2007). While the aim of traditional evaluation techniques is to classify students according to certain criteria, alternative methodologies of assessment and evaluation tend to determine the phase where students are within the process of learning (Wilson, 1994; Bekiroğlu, 2008). Some examples of the alternative assessment and evaluation techniques could be portfolios, drama activities, experiments and projects (Smith, 2003). Utilization of alternative assessment and evaluation techniques would result in giving more importance to individual developments of students by focusing on their interests and abilities instead of their achievement or underachievement through evaluating the process as much as the product of learning such as dealing with real life issues (MEB, 2004).

These methodologies are in line with cognitive teaching and motivation theories as they require advanced skills and guide students in learning, while developing students' scientific process skills and preparing

them for more complex problems that are experienced in daily lives (Maeroff, 1991; Briscoe & Wells, 2002).

Students would find a method where they find themselves more effective among discussion, oral presentation or written expression. Therefore alternative assessment and evaluation techniques are required to be utilized together with alternative tools. For evaluating students in chemistry classes in terms of their knowledge, skills and attitudes, traditional assessment and evaluation methods such as short-answer, long-answer, multiple-choice or true-false questions shall be enriched with tools that aim to assess their performances (MEB,2008).

Performance evaluation indicates the assessment and evaluation that allows students to solve real-life questions using their knowledge and skills through authentic evaluation with reliable and valid assessment tools (Cepni et.al., 2007). In other words, performance evaluation is a dynamic process, which requires students to produce original responses (Büyüköztürk, 2007).

Performance evaluation has been more commonly used recently due to its aspect that enables students to be evaluated through activities, determines their advanced-level thinking skills and produce products as a result of their studies (Airasian, 2001)

Performance evaluation could be done in three different ways, the first of which is the evaluation of the process. Within this evaluation activity, the focus is on the skills that students develop during the course of their process. The second evaluation type is the evaluation of the product, which consists of the evaluation of the product obtained at the end of the process rather than observation of their behaviors within the process. The third type involves the evaluation of both the process and the product together as sometimes evaluation of the process or the product only would be inadequate. This evaluation type would be beneficial in such cases (Orhan et.al, 2006; Linn, Gronlund, 2000).

This type of evaluation would guide teachers in preparing activities where student performances could be evaluated on unit or topic basis. In this respect, students were provided with an activity topic and guiding steps. A scale was prepared for the teachers to evaluate the students. This study aimed to make a contribution to the evaluation of students' applications as well as the results they acquire.

2. Method

The study was conducted with 98 students studying at 9^{th} grade at a vocational school in Ankara. "Mixtures" unit was selected as the study topic among the 9^{th} grade curriculum subjects. The acquisitions listed among the National Chemistry Teaching Program content were instructed to students in classes within two weeks. Students were asked at the end of this period to complete an activity on solutions within a certain plan. Students were taken to laboratories in groups of 20, where they completed their individual plans and submitted without time restriction. The activity and the guidelines provided to students are given below:

Subject of Activity:
Put 100 ml water into glass. Measure and record the temperature of the water. Let one sugar cube into the water. From the moment we throw the sugar into the water, measure and record the time until the sugar thoroughly dissolves.

Can we take different measurements during these steps, you prepare a plan in your mind.

1- Lets make a plan to accomplish the activity (Let us know if you make any changes while performing the activity. Specify under article 3.)

2- Draw a table to record your measurements which have been taken while performing the activity.

3- If the plan being applied in the first step has not occurred, write the reasons and describe the changes you have done.

4- While using the water at different temperatures;

Is there a connection between the elapsed time from the moment sugar thrown into the water until sugar dissolves completely in water? Explain, why.

5- As a result of observations and measurements, have you use the concepts given below in the activity? Solution, solvent, dissolve, homogeneous, heterogeneous

An evaluation scale was prepared with the aim of evaluating students' performances regarding the study. The activity steps formed the main parts of the scale. The scale consisted of five parts according to the guidelines of the activity. The details indicated by students were determined according to activity steps.

The determined evaluation measures as parts of the scale were as follows:

1) Planning
2) Data collection
3) Changes in planning
4) Results
5) Explanations

Three-point Likert-type scale was utilized in evaluation of students' performances according to the given measures. Within the scope of the expected student responses, the criteria in the scale were written in progress stages. The expected achievement and overachievement was scored as "3" for each criterion. Similarly, underachievement was scored as "2", the existence of incompetence or misconceptions was scored as 1, and the blank answers were scored as "0". The highest score that a student could receive was 15. The performances of the students were evaluated as high level for scores between 12 and 15. Similarly, the scores between 11 and 7 were evaluated as intermediate level and the scores between 6 and 0 were evaluated to be at "low level".

Expert opinions were taken for providing the reliability and the validity of the scale. The scale in this study was planned according to the rubric preparation and utilization criteria defined by Airasian (2001). The evaluation scale is displayed at the conclusions part of this study together with student evaluations.

3. Conclusions

Students, who participated in this study, were found to be learning at different levels depending on their individual differences. Some of the students managed to attain all of the acquisitions and some comprehended less. There were also students who attained none of the targeted acquisitions. When these students were asked to apply their learning in an activity, their levels of acquisition were also reflected on their practices. For some students, it may be easy to express their knowledge orally or in writing, while they find it rather difficult to apply and reveal them. It may be just the opposite for some other students. Shortly, students' performances of doing an activity could be as different as their levels of learning during teaching. Students were asked to proceed with the activity according to the operational stages and write their conclusions on the worksheets they were handed out. In order to evaluate students' performances the submitted worksheets were assessed according to the scale prepared. Table 1 displays the scores of students obtained from the activity.

Table 1. The scores of students obtained from the activity.

High Level			Intermediate Level			Low Level		
Score	Number of students	Total	Score	Number of students	Total	Score	Number of students	Total
15	6	26	10	12	28	6	12	44
14	2		9	8		5	8	
13	6		8	6		2	6	
12	12		7	10		1	10	
						0	8	

As mentioned before, the activities that students completed were evaluated in five stages. Each stage was divided into measures and scored. Students are classified as high-level, mid-level and low level performance according to their activity score. and also Table 1 gives the number of student with their score ranges. The number of students with high level scores was found to be 26 and the number of students with intermediate level scores was 28. Students with low performances were found to be 44 in number. These results lead to conclusions about students' performance levels.

The criteria used to evaluate the performance of students are presented in Table 2. According to these criteria, the percentages of students respond to activity in the same steps given in the table.

Table 2. The scores and percentages of the students through the evaluation process of the activity.

Planning	**%**	**Score**	
Time measuring, temperature measuring, and changing values according to the number of sugar cubes were recorded.	6.1	**3**	
Planning was complete; however, the changing values were not completed.	40.81	**2**	
Partially correct, important variables were missed; however, the activity was explained.	14.3	**1**	
Single variable was considered.	12.3		
Only required tools were explained.	2.04		
Information was repeated.	2.04	**0**	
There is inaccurate information.	16.3		
Left blank	6.1		
Data Collection			
Time and temperature measures were recorded more than three times, trials were made on different numbers of sugar cubes	14.3	**3**	
Time and temperature measures were recorded three times; trials were made on different numbers of sugar cubes	16.3		
Time and temperature measures were recorded twice; the number of sugar cubes was not changed.	20.41	**2**	
Various definitions were expressed except from the above-mentioned measurable values.	8.16		
Two or more measures were made; however, the time of dissolution did not decrease according to the increasing of the temperature.	16.3		
Temperature measures were irrelevant.	6.13	**1**	
Measures were partially accurate.	4.08		
Single measure was done for each variable.	4.08		
Measures were made on a single variable.	2.04		
Inaccurate.	6.13	**0**	

Left blank.	2.04		
Changes in Planning			
The plan has been enhanced and explanations were made for the changes.	14.08	**3**	
Data were found irrelevant and it was expressed that changes were made in order to repeat the data collection.	-		
The plan has been changed; the plan has been shortened; however, no reasons were given.	6.12	**2**	
Plan has been implemented partially accurately.	6.12		
Changes were made in the independent variables.	-		
No changes were made in the plan; however, the plan was not completely implemented.	55.10	**1**	
Plan was not implemented accurately.	2.04	**0**	
Left blank.	16.32		
Results			
The data obtained were displayed on a table. The data on the table and the observations were expressed accurately and in connection.	22.45	**3**	
The data obtained were displayed on a table. The observations made on cold and hot water were expressed accurately.	32.65		
The data obtained were not displayed on a table. The observations made on cold and hot water were expressed accurately.	10.21	**2**	
The data obtained were displayed on a table. The observations made on cold and hot water were expressed inaccurately.	2.04		
Other effects of the temperature were expressed.	-		
Results did not reveal the data obtained throughout the activity.	6.12	**1**	
The results given were mistaken. (time instead of temperature and temperature instead of time)	2.04		
The data were repeated at the end; however, the result was not expressed.	12.24	**0**	
The numerical information was given in results randomly.	6.12		
Left blank.	6.12		
Explanation			
The concepts of solvent, soluble, dissolution, particular structure and the increase of solution speed were explained in connection with energy.	-	**3**	
Concepts were expressed; particles and energy were mentioned.	2.04		
Concepts were expressed; dissolution (the interaction of the soluble with temperature) was expressed through the temperature measures.	2.04		
Concepts were expressed but not connected to other variables.	4.8		
The explanations were partially accurate.	-	**2**	
There were misconceptions. (temperature-heat) (dissolution-melting) (soluble-solvent) (homogeneous - heterogeneous)	18.36		
The stages of the activity were repeated.	26.53	**1**	
Other information was inaccurate.	20.41	**0**	
Erased, unreadable, unable to be evaluated.	6.12		
Left blank.	20.41		
Total Score			15

As displayed on Table 2, 6.1% of the students submitted their activities fully in the planning stage of the activity. Among the students, 30.6% recorded the data obtained through measuring by changing the number of sugar cubes with thermometer and chronometer. The percentage of students, who changed their initial plans and expressed these changes in writing, was 14,8. Students, who displayed the data they obtained on tables and made connections between the values obtained were 55,10% of the sampling. Only 9,6% of the students expressed the connections and concepts at the expected level in the explanation stage.

In order to assess the relationship between the activity stages, Pearson correlation coefficient was utilized on the SPSS software. Pearson's correlation coefficient assesses the correlation between the five tests pairwise. In order to determine the significance of the correlation made through Pearson's Correlation Analysis on SPSS on the obtained data, a test was made. The pairwise correlation between all tests was found to be high according to the data obtained. In the meantime, significant results were found for Alpha=0.01. The stages that students progressed throughout the study were also found to be correlated pairwise. Students, who accomplished the planning stage, were found to progress other stages successfully. Table 3 displays the results regarding the activity.

Table 3. Results regarding the activity

	test_1	test_2	test_3	test_4	test_5
test_1	1	.868**	.791**	.895**	.844**
test_2	.868**	1	.836**	.847**	.766**
test_3	.791**	.836**	1	.676**	.876**
test_4	.895**	.847**	.676**	1	.718**
test_5	.844**	.766**	.876**	.718**	1

**. Correlation is significant at the 0.01 level (2-tailed).

4. Discussion

Performance evaluation studies in science enable the evaluation of practical applications, scientific questioning and problem solving skills along with each other. This study promoted students to apply a topic they had learnt in a simple method, which creates the required environment to evaluate their observations and outcomes obtained via an activity without question-answer method. The study was presented to students in connection with an activity where students could apply the chemistry topics.
It enables the objective evaluation of a student when students plan on an activity related to a topic, followed by measuring the temperature with a thermometer and time with a chronometer to obtain the data and displaying their outcomes on a table as well as making explanations depending on their whole experience.

This method is used with the purpose of evaluating student performances and prevents the anxiety they experience during exams by enabling them to transfer their knowledge to an activity in a laboratory environment without a time limitation.

Performance evaluation reveals the individual differences between students such as the differences between students' thinking skills, skills to connect learnt knowledge with real life issues, problem solving skills when they perform during the stages in planning as well as the differences between their cognitive behaviors.

The above-explained performance evaluation study allows students to present their knowledge and skills on an application. The lack of knowledge in students determined through this type of evaluation could be compensated through alternative applications. Students' misconceptions could be revealed through these types of studies. This study presents an example that could easily be applied to students regarding a

chemistry topic. A chemistry teacher could apply this study in its exact way or s/he may change the number or content of the evaluation criteria according to another topic s/he intends to teach.

Researchers could reorganize the performance evaluation studies according to different topics for their studies. Additionally, same study could be applied along with a traditional evaluation methodology in order to compare and contrast students' academic achievement levels in both methodologies.

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