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Developing General Chemistry Computer Assisted Demonstration Experiments Scale: Validity and Reliability Study

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ABSTRACT

In this study, the aim is to teach some subjects in General Chemistry lesson by means of computer assisted demonstration experiments and developing a Likert-type valid and reliable scale to analyse the effectiveness of this method on students. Before developing the scale, the current scales had been carefully analyzed, the views of experts were taken, and the first draft of scale was prepared. The validity and reliability studies of the scale were carried out by applying the first draft on 250 students. The total item and remainder item correlations, item discrimination, factor analysis and internal consistency measures were respectively implemented on the scale for a deeper validity and reliability analysis. Scope validity of the scale has been maintained by consulting the specialists. Factor analysis has been conducted for structure validity. According to the results of the analysis, the scale had three subscales. Cronbach alpha coefficients were calculated for all subscales as 0.81, 0.74, and 0.63 respectively and for whole scale as 0.85. The value of Kaiser-Meyer-Olkin is 0.872, Barlet's value is 950.344. These findings demonstrate that the scale has a valid and reliable structure.

Keywords: Computer assisted instruction, chemistry education, third keywords, developing scale, demonstration experiments

1. Introduction

Nowadays the technological tools, especially computers, were designed to facilitate the lives of people. In education area, these tools were available to educators and students. It is a fact that the more sensory organs are addressed, the more persistent the learning is. In this sense, technology is an entity that brings sight, which is one of learning and knowledge acquisition means, hearing, reading and objects that arouse curiosity together and offers them together. It is equally important that the students develop their

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researching side in education for learning to be persistent and meaningful. The results of the study in this field, especially when computer assisted education is compared with traditional education, shows that computer assisted instruction improves the success of students significantly (Chang, 2002; Hacker & Sova, 1998; Yalçınalp, Geban & Özkan, 1995; Yaman, 2007). It's especially important that the students connect the abstract terms of science with real life, and in this sense, the lessons that are enriched with experiments, are expected to improve the students' attitude towards chemistry which is an important subject in science (Ayas, Çepni, Johnson & Turgut, 1997; Aycan, Arı & Türkoğuz, 2001; Aydoğdu, 2000; Aydoğdu, 1991; Ergin, Akgün, Küçüközer & Yakal, 2001). Arousing curiosity for using technology in science lessons and developing positive attitudes in this field also helps students to develop their cognitive abilities (Akgün, 2005). Using computer technologies in teaching of science and of many other lessons has been proven to have developed the students' attitude positively and to have increased their success in the lessons (Akaygün & Ardaç, 2001; Akı, Gürel, Muştu, & Oğuz, 2005; Arıkan, 2006; Berger, Lu, Belzer & Voss, 1994; Büyüköztürk, 2000; Çekbas, Yakar, Yıldırım, & Savran, 2003; Derviş & Tezel, 2009; Geban, 1995; Kesercioğlu, Balım, Ceylan & Moralı, 2001; Yenice, 2003; Yiğit & Akdeniz, 2003; Zavrak & Tarhan, 2001).

Most of the study in chemistry education is about determining the students' learning difficulties and their misconceptions. According to these studies, many students are not adequate in understanding and comprehending concepts regarded as scientific. In chemistry education, developing conceptual understanding and making conceptual understanding possible has always been important (Sanger, Phelps & Fienhold, 2000). The solution for this is creating an effective learning environment (Chiu, Chou & Liu, 2002). With this aim, computer technologies have been used recently. Many obstacles are thought to be overcome in this way (Burke, Greenbowe & Windschitl, 1998; Ebenezer, 2001; Kelly & Jones, 2007; Marcano, Williamson, Ashkenazi, Tasker & Williamson, 2004). Computer technologies abolish many difficulties within the learning environments such as; providing the chemicals, the high cost of undertaking the experiment, extensive preparation of the experiment and safety issues (Russell, Kozma, Jones, Wykoff, Marx & Davis, 1997). So students can understand chemistry much easier and can build their own knowledge (Ebenezer, 2001; Hagen, 2002; Kumar, Smith, Helgeson & White, 1994). It also helps the students to develop knowledge (Krajcik, 1991; Russell et al., 1997) and visualize complex scientific models in students' minds and comprehend them (Cavanaugh & Cavanaugh, 1996; Duchastel, Fleury & Provost, 1988; Yeung, 2004).

Schwan and Riempp (2004) studied cognitive uses of videos in learning. It has been observed that, in order to adapt to students' speed of learning, video presentation features such as; pause, replay, rewind and change of speed were used. It was confirmed that teaching with videos was more effective. It was stated that for the videos to be considered pedagogically helpful, the rhythm of the video should be controlled by the viewer (Ongel-Erdal, Sonmez & Day, 2004). By using videos in the classroom, the students can have more accurate scientific understanding. It becomes easier for students to understand the discussions on chemistry knowledge presented in the videos. Videos are an important means of teaching chemistry when there is not enough time to execute the experiments and when the teacher is not satisfied enough with the teaching (Laroche, Wulfsberg & Young, 2003).

In this study, developing computer assisted demonstration experiments effectiveness scale and studying its validity and reliability are aimed. In this sense, computer based demonstration experiments have been prepared by consulting the specialists, and a reliable Likert Type scale to study the effectiveness of the method on students has been developed. The experiments of computer assisted demonstration experiments have been prepared by means of real video footages. Computer assisted demonstration experiments are materials that have been prepared by recording real video footages, by introducing experiment equipment and running with authentic equipment in chemistry laboratories, which makes it possible to watch the videos in whatever way wanted.

2. Method

2.1. Study Group

Developing the scale stage was run on 250 pre-service teachers in Educational Faculty Science, Elementary school and Gifted educations department. 40% (n=100) of pre-service teachers were made up of Science Education, 30.4% (n=76) of Elementary school Education, 29.6% (n=74) of Gifted Education department. 37.6% (n=94) of pre-service teachers that took part in the study were male; 62.4% (n=156) were female.

2.2. Studies about Developing the Scale

General Chemistry Computer Assisted Demonstration Experiments Effectiveness Scale has been developed in five stages; Defining the items stage, consulting the specialists scale, pretesting stage, validity and reliability scale. Field literature was scanned at "Defining the Items" stage and scales that might be concerned with the study were analyzed, however no scale with the same context was found. A scale of 23 items has been prepared. The scale is a quadruplet Likert Type scale that includes items of: "I totally disagree", "I partly agree", "I mostly disagree" and "I totally agree". "I totally agree" choice was given 4 points, "I mostly agree" choice 3 points, "I partly agree" choice 2 points and "I totally disagree" 1 point. The draft scale that was prepared was submitted to specialist opinion to maintain scope validity. A final testing form of 23 items was created in accordance with specialists' suggestions. Finally, it was decided that the scale items were adequate to evaluate the effectiveness of computer assisted demonstration experiments on students. In the testing of the scale, assessing the scale in terms of answering duration and comprehensiveness was aimed and the scale was applied on 25 random students. As a result, the scale was found adequate and the answering duration was declared as 10-15 minutes. The scale of 23 items was applied on 250 students. This analysis was done on the data derived to prove validity and reliability: 1.Item test correlations to prove the reliability of items. 2. Kaiser-Meyer Olkin (KMO) coefficient and Barlett Sphericity test to determine compatibility of the data to main components analysis 3. Factor analysis to prove structure validity. 3. Test-retest was done to prove reliability and Cronbach alpha (Crα) reliability was calculated.4. SPSS program was used in the analysis of the data.

3. Findings

3.1. Findings about Item analysis

In item analysis, item total, and item remainder correlations were studied in the first place. It is pointed out that, items whose total correlation is 0.30

or more, can differentiate individuals very well, items which are between 0.30-0.20 can be used if needed and items that are less than 0.20 shouldn't be used at all (Büyüköztürk, 2007). In the analysis, 13 items were decided to be taken away from the scale because their total correlation value is less than 0.30. As a result, after 13 items were taken away, the total correlations of 12 remaining items and their remainder correlations were calculated again. The remaining items were declared to have item total correlations varying between 0.37 and 0.65.

To define to what extent, the items that take place in the content differentiate the individuals, according to the scale total point, top 27% and base 27% point range T- test analysis was done for relevance of the difference between item point averages. t- Test results showed that, in all items, the item average point of top 27% group is significantly higher than points of base 27% ($p<0.001$). T-test results for differentiating quality of each item are given in Table 1.

Table 1: T-Test Results of Differentiating Quality for Each Item

Item Number	Top-Bottom 27% groups T-test Results	Item Number	Top-Bottom 27% groups T-test Results
M8	-9.406	**M15**	-7.980
M9	-9.035	**M17**	-7.988
M10	-9.592	**M20**	-9.537
M11	-12.111	**M21**	-11.781
M12	-11.008	**M22**	-11.779
M13	-7.849	**M23**	-9.682

3.2. Findings about construct validity and reliability of the scale

Factor analysis has been carried out to prove construct validity of content. In factor analysis, the compatibility of the data to factor analysis was tested by Kaiser-Meyer-Olkin (KMO) coefficient and Barlett test. When KMO coefficient is at least 0.60 and Barlett test is significantly high, shows that the date is suitable for factor analysis (Büyüköztürk, 2007; Kalaycı, 2005). In the study, KMO coefficient is .872 and Barlett test value is 950.344 ($p<0.001$). It can be said that the date is suitable for factor analysis. Once the scale is suitable for factory analysis, construct validity was maintained by using exploratory factor analysis. There is an operation in exploratory factor analysis that aims at finding factor by means of the relations between the variants (Büyüköztürk, 2007). In the assessment of factor analysis results, the items that take part in the scale are advised to have load values of 0.45 or higher, however items with load values over 0.30 can also take place in scales (Kerlinger, 1973; Tabachnick & Fidel, 1989). During factor analysis process, vertical rotation was used and factor loads were defined by using "varimax" method which is valid for more than two factors. As a result of item analysis solution and rotation operation by varimax factor analysis, three factors with eigenvalues higher than 1 are found in the scale. Rotation operation was done by using varimax method, to find the items that the factors are related with and understand them easier. In the scale with the item number increased to 12, no item that doesn't comply with the structure of the scale and provides load to more than one factor. As a result of scale development studies; a structure with 3 sub factors whose eigenvalue is higher than 1 is constructed. The factor loads of items that make up the scale vary between 0.555 and 0.847. In Table 2, factor loads of scale items can be seen. When item contents are studied, the items that are gathered under three designated factors are in coherence with each other. This allows for the factors to be named according to their item contents. So, each factor is titled accordingly. These factors are defined as; 1. Persistence of knowledge, 2. Contribution to Learning, 3. Motivation. The first factor is made up of 6 items (8,10,11,12,13,17), the second factor of 4 (20,21,22,23), and the third of two (9,15).Total variance of these three sub factors have been found as 58.413%.

Table 2: Factor Analysis Results of Scale Items

Item Number	Factor Loadings		
	Factor 1	Factor 2	Factor 3
M8	.657		
M10	.719		
M11	.600		
M12	.671		
M13	.728		
M17	.588		
M20		.555	
M21		.703	
M22		.772	
M23		.766	
M9			.743
M15			.847

In the final stage, internal consistency study of the scale was done. For every dimension of the scale and for the whole of the scale Cronbach alpha (Crα) coefficient was calculated and for all groups 100 randomly chosen students were tested again to calculate test validity. In terms of scale reliability, Crα reliability and test- retest homogeneity were calculated. Crα reliability for the whole of the scale was found 0.85, test- re-test reliability 0.76, $p<.01$, Crα related to first, second and third factors as 0.81, 0.74 and 0.63, test re-test reliability 0.73, 0.73 and 0.71, $p<.01$. All these findings have been used as a proof that the scale is satisfactorily reliable.

3.3. Findings about the correlation relation between factors

Pearson Correlation analysis was conducted between the factors to define the relation between the factors of the scale. As a result of correlation analysis, it has been found that the two dimensions of the scale are in a significantly positive relationship with each other. It can be seen that there is a positive significant relation between the total points of Students General Chemistry Computer Assisted Demonstration Experiments Effectiveness Scale.

4. Results and Suggestions

As a result of General Chemistry Computer Assisted Demonstration Experiments Effectiveness Scale validity and reliability study, in terms of utility of the scale developed; in the beginning, item total and item remainder correlations of the items of the were calculated. Item total correlations of the remainder items were found to vary between 0.37 and 0.65. The contribution of each item in the scale has been found satisfactory. In order to define to what extend the items that take part in the scale differentiate the individuals, t-test analysis was done concerning meaningfulness of the differences between item point averages. As a result of item differentiating quality analysis, items were found to have the ability to differentiate General Chemistry Computer Assisted Demonstration Experiments Effectiveness. In the studies for construct validity of the scale, the compatibility of the data to factor analysis was checked by KMO coefficient and Barlett test and according to this the data was found suitable for factor analysis. After the compatibility of the scale to factory analysis was confirmed, exploratory factor analysis was carried out for construct validity of the scale and the scale was found to have a three factors structure; Persistence of Knowledge, Contribution to Learning and Motivation. For internal consistency of the scale, for each dimension and the whole of the scale Crα coefficient was calculated and test- retest reliability was calculated. The internal consistency of the scale was found to be at a satisfactory level in terms of dimensions and the whole of the test. A significantly meaningful correlational relationship between the dimensions of the scale was found. According to the findings of the study on 250 teacher candidates, the scale prepared for General Chemistry Computer Assisted Demonstration Experiments Effectiveness was found to be a three sub dimensional valid and reliable evaluation tool. The scale was prepared as Likert type of 7 positive, 5 negative, in total 12 items. The lowest and the highest points to be scored in the scale, for the first factor 6-24 points, for the second factor 4-16 points and for third factor 2-8 points and in total 12-48 points.

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