Available online at www.sciencedirect.com

ScienceDirect

ELSEVIER

Procedia Social and Behavioral Sciences 2 (2010) 5619–5624

Procedia Social and Behavioral Sciences

WCES-2010

Comparison teaching strategies of videotaped and demonstration experiments in inquiry-based science education

Songul Sever[a], Kemal Yurumezoglu[a] *, Ayse Oguz-Unver[a]

[a]*Faculty of Education, Mugla University, Mugla, 48000, Turkey*

Received November 12, 2009; revised December 2, 2009; accepted January 22, 2010

Abstract

The purpose of this study was to transfer some experimental activities designed by the researchers in line with the curriculum on light-matter interaction into audio-visual mediums that can be used in schools with insufficient laboratory facilities, in this way providing needed support for educational materials, offering guidance for teachers and contributing to student academic achievement. The study was conducted with second-year student teachers (n:148) in the format of demonstration experiments or videotaped experiments. The results showed no significant difference in the effectiveness of the demonstration or videotaped experimental format that means videotaped experiments could be alternative for demonstration experiments.

Keywords:; Videotaped experiments; demonstration experiments; inquiry-based science teaching; light-matter interaction; educational materials.

1. Introduction

The concept of the educational method of "learning by doing" as opposed to memorization, which appeared at the start of the twentieth century through the work of the famous American philosopher John Dewey (TUBA, 2009), has maintained its currency in education and become even more widespread. The structure of the attempt to learn, which is carried out simultaneously both by our senses and our mind, is completed in the mind through inquiry. Inquiry not only helps to diversify the data that reaches our senses but also serves to process and arrange that data in the mind. Inquiry leads the individual to discovering the qualities of an object, allowing us to better conceptualize the role of the object and relations between objects in each case. An inquiring attitude not only triggers curiosity in the individual but also draws the individual into the process. Individuals who play a role in the process of an experimental activity determine the effective variables in a phenomenon and uncover the relationships between these variables. Later, they comprehend and attach meaning to the cause-and-effect relationships of variables that take part in processes. Discovering cause-and-effect relationships in existing processes of phenomena serves to foster scientific understanding in the classroom. Expanding this understanding throughout the class, however, is made possible through participatory work and a high level of scientific communication in the classroom.

Teachers have recognized the effectiveness of experimental activities in learning environments in which the philosophy of inquiry-based learning is well-established and participation is high. Despite this, however, effectiveness may sometimes be compromised because of practical difficulties encountered in the classroom. The

* Kemal Yurumezoglu. Tel.: +90-252-211-1840; fax: +90-252-223-8491
E-mail address: k.yurumezoglu@mu.edu.tr

1877-0428 © 2010 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.sbspro.2010.03.916

fact that the teacher by himself cannot be fully equipped with the the entire span of knowledge, skills and time needed to perform and moderate these activities may lead to the partial or full abandonment of this method. It is for this reason that it is of great importance to integrate methods of learning by inquiry and by doing/participating and create new strategies to make this possible. A diversity of strategies in presenting experimental activities will provide alternatives for teachers and students of differing intellectual capacities. This is turn will help to diversify the science-based production of the many unique minds that make up the class.

Approaching the essence of scientific knowledge requires continuity and diversity in reasoning. Diversity in reasoning is possible in classroom environments where participation is high and students interact intellectually between themselves and with the teacher. The effectiveness of this interaction can be enhanced through the creation of innovative and creative strategies in educational research and by transferring these strategies to learning environments. This is in fact the starting point of the present study. The study has been carried out using a series of activities with previously proven validity that provide a means of learning through an inquiry-based, learning-by-doing method that promotes hypothetical-deductive reasoning (Robardet, 1990).

1.1. The use of demonstration and videotaped experiments in the teaching of scientific concepts and phenomena

Since teaching science is generally based on concepts, experiments and observations should be made a part of the classroom so that students can visualize these concepts in their minds. Experiments serve to lead students to question the contradictions they form in their minds and in this way attach meaning to concepts (Gunstone & Champagne, 1990). In other words, students become aware of phenomena occurring in nature, question these and experiment to test their way into finding solutions (Bulunuz, Erbaş, & Ergul, 2002). Demonstration experiments, which are one of the most common forms of experimentation used in teaching, are preferred by teachers because of time factors, material limitations and students' lack of required skills. In crowded classrooms, however, and especially in long experiments, the use of a different strategy becomes imperative because of the tendency of students to lose their concentration, the fact that teachers may not be equipped with the necessary skills and due to the flaw that the demonstration experiment may be not be supported by appropriate questions. Technology inevitably enters the teaching environment at this point.

The advance of information and communication technologies in today's world necessitates the use of different teaching materials in the teaching environment (Peraya, 1998). Some studies in science education have set forth that using information and communication technologies in teaching scientific concepts and science subjects will enhance learning (e.g., Dhingra, 2003; Gabel, 1999; Goedhart, van Keulen, Mulder, Verdonk & de Vos, 1998; Laroche, Wulfsberg & Young, 2003; Mayo, Sharma & Muller, 2009; Morgil, Arda, Secken, Yavuz & Oskay, 2004; Ozmen & Ayas, 2003;Yalcınalp, Geban & Ozkan, 1995). In the world of information and communication technologies, videotapes have been used in teaching environments for the last 50 years (Depover, Giardina & Marton, 1998). The benefits of using video in science education have been described as the ease of demonstrating a phenomena, eliminating the shortcomings of failing to observe the changes in fast-moving scientific events, being able to readily explain phenomena that are difficult to explain by only oral narration, and the opportunity to be able to show students what the teacher is explaining verbally (Robles, 1997). During the process of preparing a video as teaching material, the concepts in the subject to be taught and the parts which may be difficult for students to comprehend should be determined; the video should be prepared and presented in the light of what has thus been established. Although classrooms today are equipped with video-players, teachers should also be equipped with the skills needed in using video equipment (Kearney, 2004). In addition, videos should not take the place of the teacher and should only be used as a teaching aid (Pekdağ, & Le Maréchal, 2007).

Therefore, this study's objective was to provide an audio-visual environment for four experiments (Can there be colored shadows? Is outer space light or dark? Why is the sky blue? Why are the seas blue?) developed by the researchers in the context of the curriculum subject of interaction between light and matter and to support learning with the use of materials, offer teachers guidance in their teaching and contribute to the cognitive achievement of students.

2. Method

2.1. Sample

The study was conducted at a four-year public university located in the Mediterranean region of Turkey with second-year students teachers (n=148) enrolled in the department of primary school teaching. The study was undertaken within the scope of the course curriculum of "Science and Technology Laboratory Practices-I." Two of the four classes participating in the study comprised the experimental group; the other two made up the control group.

2.2. Content of the experiment

The experiments within the scope of the study were formulated on the subject of the interaction of light and matter and comprised four progressive/consecutive stages: *Is the space light or dark? Can a shadow be colored? Why are the seas blue?* and *Why is the sky blue?* The experiments were designed by using simple materials on the basis of an inquiry-based, learning-by-doing/participatory method of teaching that promotes hypothetical/deductive reasoning. Validity of the experiments had been tested in previous experimental work (Yurumezoglu & Oguz, 2009; Yurumezoglu, Sever & Oguz, 2008). The experiments to be presented on video were videotaped by the researchers. Montage was completed with the *Microsoft Windows Movie Maker* program in such a way as to allow questions to be asked. The required sound effects and text were added.

2.3. Presentation of the experiments

The students in the experimental group were presented the experiment in the videotaped format and the students in the control group dealt with the experiment in the form of a demonstration. The classes were held in the presence of a faculty member in both the experimental and control groups and with the cooperation of three research assistants. The only variable in the experiments was the manner of presentation—demonstration or video. Apart from the presentation strategy, the lesson was an inquiry-based activity that was conducive to hypothetical-deductive reasoning and in line with the conceptual/theoretical foundation of the experiment. While no specific material was used in the classroom where the video was shown, students in the demonstration experiment group did use specific materials in their work.

2.4. Data Collection

Students in both the experimental and the control groups were questioned before and after the activity in the form of individual evaluation tests. The students answered the individual evaluation tests using a ball-point pen and the tests remained with the students for the duration of the experimental exercise. The objective here was to offer the opportunity to observe the changes in the responses of the students over the course of the activity.

3. Results (Findings)

The statistical data obtained from each experimental exercise have been presented and interpreted in the tables below.

3.1. First experimental exercise: Is the space light or dark?

The pre- and post-experiment paired sample t-test results for the groups watching the demonstration showed a significant difference: $t(146)=-10.858$, $p<.05$. In the same way, the pre- and post-experiment results also showed a significant difference in the groups that watched the video experiment: $t(146)= -12.192$, $p<.05$.

Independent t-tests were used pre- and post-experiment in the groups watching the demonstration and the video. There was a significant difference between the evaluation test results of the demonstration and video experiment groups prior to the experiment: $t(146)=-2.003$, $p<.05$. There was, however, no significant difference in the post-tests: $t(146)=-.644$, $p>.05$. Due to the significant difference found compared to the pre-experiment data, the group pre-tests were used as covariants and a covariance analysis was carried out. When the pre-tests of the students in the demonstration group and those of the students watching the video were used as covariants, it was found that there was no significant difference in impact on the groups [F (1.117)=.029, p=.865] (Table 1).

Table 1. Descriptive statistical data on the experiment "Is the space dark or light?"

Groups	Demonstration Experiment		Video Experiment	
	Pre- Experiment	Post- Experiment	Pre- Experiment	Post- Experiment
N	78	78	70	70
Mean	4.29	7.78	4.96	8.00
Standard Deviation	1.981	2.294	2.039	1.753

3.2. Second experimental exercise: Why are the seas blue?

The pre- and post-experiment paired sample t-test results for the groups watching the demonstration showed a significant difference : t(146)=-22.996, p<.05. In the same way, the pre- and post-experiment results also showed a significant difference in the groups that watched the video experiment t(146)= -16.666, p<.05.

Independent t-tests were used pre- and post-experiment in the groups watching the demonstration and the video. There was no significant difference in the evaluation test results of the demonstration and video experiment groups prior to the experiment: t(146)=-.960, p>.05. No significant difference could likewise be seen in the groups after the experiment: t(146)= .463, p>.05. Since a significant difference did not occur in the demonstration and video groups before the experiment, no need was seen to carry out covariance analysis (Table 2).

Table 2. Descriptive statistical data for the experiment "Why are the seas blue?"

Groups	Demonstration Experiment		Video Experiment	
	Pre-experiment	Post-experiment	Pre- Experiment	Post- Experiment
N	78	78	70	70
Mean	3.19	8.78	3.50	8.56
Standard Deviation	1.788	2.214	2.111	2.573

3.3. Third experimental exercise: Why is the sky blue?

The pre- and post-experiment paired sample t-test results for the groups watching the demonstration showed a significant difference : t(146)=-18.412, p<.05. In the same way, the pre- and post-experiment results also showed a significant difference in the groups that watched the video experiment: t(146)= -12.930, p<.05.

Independent t-tests were used pre- and post-experiment in the groups watching the demonstration and the video. There was a significant difference between the evaluation test results of the demonstration and video experiment groups prior to the experiment: t(146)=-2.402, p<.05. There was, however, no significant difference in the post-test: t(146)= .455, p>.05. Due to the significant difference in the pre-experiment data in the evaluation test, the group pre-tests were used as covariants and a covariance analysis was carried out. When the pre-tests of the students in the demonstration group and those of the students watching the video were used as covariants, it was found that there was no significant difference in impact on the groups [F (1,117)=.919, p=.339] (Tablo 3).

Table 3. Descriptive statistical results for the experiment on "Why is the sky blue?"

Groups	Demonstration experiment		Video Experiment	
	Pre- Experiment	Post- Experiment	Pre- Experiment	Post- Experiment
N	78	78	70	70
Mean	4.15	8.86	5.00	8.67
Standard Deviation	2.033	2.226	2.252	2.749

3.4. Fourth experimental exercise: Can a shadow be colored?

The pre- and post-experiment paired sample t-test results for the groups watching the demonstration showed a significant difference: t(146)=-20.431, p<.05. In the same way, the pre- and post-experimint results also showed a significant difference in the groups that watched the video experiment: t(146)= -10.781, p<.05.

Independent t-tests were used pre- and post-experiment in the groups watching the demonstration and the video. There was no significant difference in the evaluation test results of the demonstration and video experiment groups prior to the experiment: t(146)= .124, p<.05. There was, however, a significant difference after the experiment: t(146)= 3.231, p>.05. Due to the significant difference in the post-experiment data in the evaluation test, the group post-tests were used as covariants and a covariance analysis was carried out. When the post-tests of the students in the demonstration group and those of the students watching the video were used as covariants, it was found that there was no significant difference in impact on the groups [F (1,117)=2.714, p=.102] (Tablo 4).

Table 4. Descriptive statistical results of experiment on "Can a shadow be colored?"

Groups	Demonstration experiment		Video Experiment	
	Pre-Experiment	Post-Experiment	Pre- Experiment	Post- Experiment
N	78	78	70	70
Mean	4.38	9.05	4.34	7.71
Standard Deviation	1.723	1.441	2.352	3.324

4. Discussion

A review of the findings showed that although there was a minor difference in the achievement of the groups, the differences in the individual evaluation tests prior to the experiments were not statistically significant. It was also seen that after the experiment, academic achievement in the individual evaluation tests increased in both groups; it was observed that in the second, third and fourth experiments, the achievement of the groups watching the demonstration experiment was higher, albeit minimally. It can thus be seen that there was no significant difference between the experimental and control groups in terms of their performance on the individual evaluation tests before and after the experiments. It was determined that in both groups, academic achievement after the experiment was higher than prior to the experiment. On the basis of these findings, it can be said that the difference seen between the first pre- and post-experiment tests and the last pre- and post-experiment tests shows that students gradually improve their scientific thinking skills as experiments are presented to them.

While there are studies in the literature on inquiry-based science education and activities in video format (e.g., Teker, 1990; Rüzgâr, 2005) there have been limited examples of comparative studies that explore different strategies. In this sense, the present study might take its place among the initial research attempts in this area.

The results attained suggest that video experiments may be used in place of demonstration experiments in schools where facilities are lacking or classrooms are overcrowded. In this way, the problems encountered in demonstration experiments (inability of students to see the experiment in crowded classrooms, lack of materials, etc.) may be avoided. In addition, a presentation in video format may offer the teacher the opportunity to prepare before coming to class, chose teaching strategies in the classroom and be guided in the preparation of questions. In fact, instead of presenting pre-prepared material, the teacher may thus have the chance to change and improve the material according to specific needs and the level of the students in the class.

5. Conclusion and Recommendation

The basis for the experiments treated in this study was a series of questions encountered in daily life. In this context, while students tried to find answers to these questions through their experiments in the classroom, they rearranged the knowledge they already had in their minds about the topic of light. By reviewing light-matter interaction using four different phenomena using an inquiry-based approach, the students were better able to understand and conceive the subject. With explanations that integrated concepts with nature, students were able to apply their knowledge to their daily lives. In addition, it was seen that the consecutive experiments presented on the theme of light-matter interaction facilitated students' perception and comprehension in that each experiment became easier to comprehend than the preceding one.

Repeating and expanding this study with different groups and different subjects will support the data in the present study and also reinforce the applicability of different strategies in inquiry-based science education.

References

Bulunuz, N., Erbaş, S., & Ergul, R. (2002). *İlköğretim fen bilgisi laboratuar etkinlikleri.* Bursa, Ekin Kitabevi.

Depover, C., Giardina, M. & Marton, P. (1998). Les environnements d'apprentissage multimédia: Analyse et conception**.** Education et formation, Ed. Pari L'Harmattan.

Dhingra, K. (2003). Thinking about television science: How students understand the nature of science from different program genres. *Journal of Research in Science Teaching*, *40*, 234-256.

Gabel, D. (1999). Improving teaching and learning through chemistry education research: A look to the future. *Journal of Chemistry Education*, *76*, 548-553.

Goedhart, M.J., van Keulen, H., Mulder, T.M., Verdonk, A.H. & de Vos, W. (1998). Teaching Distillation Knowledge: A video film bridging a gap between theory and practice. *Journal of Chemical Education*, *75*, 378-381.

Gunstone, R. F., & Champagne, A. B. (1990). Promoting conceptual change in the laboratory. In E. Hegarty-Hazel (Ed.), *The student laboratory and the science curriculum.* Routledge: London.

Kearney, M. (2004). Classroom use of multimedia-supported predict-observe-explain tasks in a social constructivist learning environment. *Research in Science Education, 34*(1), 427–453.

Laroche, L.H., Wulfsberg, G. & Young, B. (2003). Discovery videos: A safe, tested, time-efficient way to incorporate discovery-laboratory experiments into the classroom. *Journal of Chemical Education*, *80*, 962-966.

Mayo, A., Sharma, M. D. & Muller, D. A. (2009). Qualitative differences between learning environments using videos in small groups and whole class discussions: A preliminary study in physics. *Research in Science Education, 39*, 477-473.

Morgil, I., Arda, S., Secken, N., Yavuz, S. & Oskay, O.O. (2004). The influence of computer-assisted education on environmental knowledge and environmental awareness. *Chemistry Education: Research and Practice*, *5*, 99-110.

Ozmen, H., & Ayas, A. (2003). Students' difficulties in understanding of the conservation of matter in open and closed-system chemical reactions. *Chemistry Education: Research and Practice*, *4*, 279-290.

Pekdağ, B. & Le Maréchal, J.F. (2007). Bilimsel filmlerin hazırlanması. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 1*(1), 57-84.

Peraya, D. (1998). Image(s) et cognition. *Recherche en Communication, 10*, 7-19.

Robardet, G. (1990). Enseigner les Sciences physiques a partir de situations problemes. *Bulletin de l'Union des Physiciens*, *720*, p. 17.

Robles, A. (1997). *La vidéo comme support didactique en physique*. Université Claude Bernard Lyon I, Lyon.

Ruzgar, B. (2005). Bilginin eğitim teknolojilerinden yararlanılarak eğitimde paylaşımı. *The Turkish Online Journal of Educational Technology, 4*(3).

Teker, N. (1991). Video ve egitimde kullanılması. *Ankara Universitesi Egitim Bilimleri Fakültesi Dergisi, 24*(2), 423-446.

TUBA, Türkiye Bilimler Akademisi. Bilim Eğitimi Projesi (2009). Retrieved from http://www.tuba.gov.tr/userfiles/file/files_tr/projeler-calismagruplari/bilimegitimilinkleri/link%201.pdf.

Yalcınalp, S., Geban, O., & Ozkan, I. (1995). Effectiveness of using computer-assisted supplementary instruction for teaching the mole concept. *Journal of Research in Science Teaching*, *32*, 1083-1095.

Yurumezoglu, K., & Oguz, A. (2009). Tendency of children's and adults' scientific thinking processes regarding to hypothesis-test procedure. *Hacettepe University Journal of Education, 36*, 340-350.

Yurumezoglu, K., & Oguz, A. (2009). The darkness of space: A teaching strategy. *Science Activities: Classroom Projects and Curriculum Ideas, 46*(4).

Yurumezoglu, K., Sever, S., & Oguz, A. (2008). Purposing a simple activity about the reflection of light: is the space dark or light? *XIII. IOSTE Symposium*, Izmir.