*Journal of Learning and Teaching in Digital Age, 2019, **4**(1), 34-40*
ISSN: 2458-8350 (online)
Research Paper

The Effect of Web-Based Instruction Designed by Dick and Carey Model on Academic Achievement, Attitude and Motivation of Students' in Science Education

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Received 21 May 2018, Revised 15 July October, Accepted 12 November 2018

ABSTRACT

Web-based applications in education seem to be increasing day by day. As in all fields of education, web-based teaching practices are being developed to make the subjects learn better in science. The web-based instruction on science education for 6th-grade students, light and sound unit, a reflection of light was designed according to Dick and Carey instructional design model. From the experimental design, a single group pre-test-post-test quasi-experimental research model is used. The study group consists of 20 students in the 6th grade of a middle school in a 2015-2016 academic year. Data obtained within the scope of the research were analysed by descriptive (frequency, percentage) and predictive (t-test of dependent samples) data analysis methods from quantitative data analysis methods. The results of the research show that the motivation levels of the students are related to the attitude and academic achievement of the students after science course. However, it is observed that the implementation is a meaningful effect on students' academic achievement on the reflection of the light, but does not make a significant difference in their attitudes and motivations. It is thought that the results of the research will contribute to the instructional design studies to be done in science education.

Keywords: *Dick and Carey model, web-based instruction, science education, academic achievement, instructional design*

INTRODUCTION

The widespread use of educational technologies in every subject and every environment strengthens the place of web-based applications in education. As in other fields, web-based teaching applications are being used to enable students to understand some subjects in science education. However, it remains superficial as it encompasses a broad subject area of teaching practice. For this reason, instructional design models should be utilized in order to be able to carry out the learning effectively and to improve the attitudes and motivations of the students with their academic achievements. Designing a web-based teaching environment for the reflection of light using the Dick and Carey model will contribute to the field of science education.

Instructional design is known as a system of procedures that are applied consistently and reliably to improve education and training programs (Gustafson, & Branch, 2002). Instructional design is generally accepted as the basis; analysis, design, development, implementation and evaluation phases. The Dick and Carey model also follows the steps of this basic instructional design model in general (Akbulut, 2007). Dick and Carey's model includes a series of events that identify the designer's learning goals and the instructional strategies needed to achieve those goals (Figure 1).

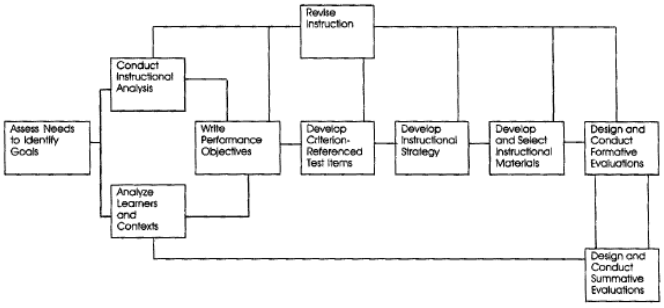


Figure 1. Dick and Carey Instructional Design Model (Dick & Carey, 1996)

In this model, steps of need analysis are assessing needs to identify goals, conduct instructional analysis, analyze learners and context, and write performance objectives. After the need analysis instructional designer should develop criterion – referenced test items, develop instructional strategy, develop and select instructional materials, design and conduct formative evaluations. Designer should revise instruction in all process of instructional design. Finally design and conduct summative evaluations in this model. Components of the instructional model that have been suggested by Dick and Carey (1996) to promote learning are objectives, practice with feedback, examples and review. Examples of Dick and Carey models include the use of one-way instructional television or video-cassettes. In the instructional design model of Dick and

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Carey, the teacher is totally the initiator and manager of communication (Atıcı, & Gürol, 2001).

Web-based instruction is a teaching program in which a meaningful learning environment is built using the characteristics and resources of the Internet in order to support and develop learning. Content development is a component of web-based instruction, multimedia components, internet tools, computers and storage devices, connections and service providers, software, servers, scanners and other applications (Khan, 1997). With web-based instruction, students can improve their learning level on any topic. However, web-based teaching supports the learning process of the students when the teaching methods applied in face-to-face education are inadequate. Simultaneous or different time learning environments are provided to the students through web-assisted instruction (Karagöz, 2010). According to Reeves and Reeves (1997), pedagogical philosophy is the dimension of web-based teaching, learning theory, goal and task setting, motivation source, teacher's role, metacognitive support, collaborative learning, cultural sensitivity and structural flexibility. These dimensions should be taken into consideration when web-based teaching is being carried out.

In science education, students are much more interested in memorizing existing information; to acquire knowledge, to comprehend what they have learned, to solve problems related to new situations they encounter and to acquire skills related to the scientific method process (Demirer, 2015). In line with this aim, there are the units mentioned in the 6th-grade science education curriculum of the secondary school (TTKB, 2016):

1. The systems in our body
2. Force and motion
3. Particle structure of the material
4. Light and sound
5. Reproduction in plants and animals
6. Growth and development
7. Material and heat
8. Electrical conduction
9. Our world, our moon and our life source sun

It has been determined that these units in the curriculum have many misconceptions about the reflection of light in light and sound units (Anıl and Küçüközer, 2010, Aydın, 2007, Demirer, 2015, Kaçan, 2008). For this reason, a web-based teaching environment was designed according to the how Dick and Carey model overcome there misconceptions about the reflection of light in this research. The answers to the following questions were searched for:

1. Is there a relationship between the academic achievements of students in the sciences course and their attitudes and motivations towards the course?
2. Does web-based teaching designed according to Dick and Carey model affect the academic achievement of students?
3. Does web-based teaching designed according to Dick and Carey model affect the attitudes of students towards science education?
4. Does web-based teaching designed according to Dick and Carey model affect the motivation of students to science education?

METHOD

In this study, where Dick and Carey instructional design model is applied, web-based instruction for 6th-grade students was prepared on reflection of light. Information on the research model, study group, data collection tools, data analysis and instructional design process are given in this section.

Research Model

In this study, one group pre-test-post-test quasi-experimental research model was used from experimental designs. In the single group pre-test-post-test quasi-experimental research model, dependent variables belonging to the same group are measured by pre-test and post-test via the same measurement (Büyüköztürk, Çakmak, Akgün, Karadeniz ve Demirel, 2013).

Study Group

The study group of this study was formed from 20 students who were studying in the 6th grade of a middle school in the 2015-2016 academic year and who volunteered to participate in the study by using appropriate sampling method. The school is located in a county of Afyonkarahisar, Turkey. For this reason, the appropriate sampling method is defined as the formation of a working group by reaching a required group (Büyüköztürk et al., 2013).

Data Collection Tools

Within the scope of the research, an academic achievement test consisting of 20 questions including the achievements of light and sound units was applied to determine the level of achievement of the students. This test was applied to all students participating in the study at the beginning and end of the study.

The attitude scale (Yanpar, Çakır and Şahin, 2000) was used to determine the attitudes of the students towards the science course. The Cronbach Alpha reliability of attitude scale was found 0.95 in 1998 (Moralar, 2012). The scale is a 27-point Likert type with positive and negative judgements. For each item, there are the

options "I fully agree, I agree, I am undecided, I disagree, I never agree". Scores of the scale were made from 5 to 1 according to the options, and in negative expressions, the scoring was reversed. This scale was applied to all students participating in the study at the beginning and end of the study.

The motivation scale developed by Tuan, Chin and Shieh (2005) and adapted to Turkish by Başdaş (2007) was used to determine the motivation of the students towards science education. Cronbach Alpha reliability of the original scale was 0.89. The Cronbach Alpha reliability of the Turkish scale was 0.83. The scale is a 35-point Likert type with positive and negative judgments. Positive expressions were evaluated as "Never Participated = 1, Participating = 2, Undecided = 3, Participating = 4, Totally Participating = 5" points. Negative expressions were scored in reverse.

Analysis of Data

The data related to the academic achievement, attitude and motivation levels obtained from the students were analyzed with descriptive (frequency, percentage) and predictive (dependent sample t-test) data analysis methods from quantitative data analysis methods. Dependent samples t-test confirms that there is no significant difference between the measurements of the subjects in the same group before and after the experiment for the dependent variable (Büyüköztürk, 2013).

Instructional Design Process

In this study, the procedures performed during the instructional design process are described in this section. The instructional design process includes the steps of assessing needs to identify goals, conducting instructional analysis, developing instrucitonal strategies and materials, formal evaluation and updating, implementation and summative evaluation.

Assess Needs to Identify Goals

In the process of needs analysis, the annual plan of the science lesson is examined. The achievements that students need to make the reflection of the 6th grade Light and Sound unit of the science education are:

Observes and reflects rays of light on smooth and rough surfaces.

The light coming from the reflection of light reflects the relationship between the reflected beam and surface normal.

Conduct Instructional Analysis

Interviews, questionnaires and success test techniques were used to determine the current situation of the learners' reflection on the light. In determining the situation, the teacher who gave the lecture was interviewed first. It was understood that the teacher gave samples to the students to attract attention and directed various questions to the students. Also, the students asked questions about past issues and made the necessary reminders to determine the level of readiness of the students.

It is stated that the course is taught through the presentation, the interactive board is actively used, and that at the end of the presentation, screening tests are performed, and the students realise the achievements. Also, the subjects are reinforced through extracurricular activities and educational games.

The expression of light reflection is processed under the heading of smooth reflection and scattered reflection; mirror, aluminium foil, wood, iron, etc. have been introduced to the class, helping to grasp the difference between the two reflection types. In addition, to realise unit gains; brainstorming, question-answer, demonstration methods were used.

In evaluating unit gains, screening tests were conducted, and classroom midterms were preferred. Questions that can not be solved by students are solved in the classroom, and the information of the students is reinforced. According to the teacher, the pupils realise the achievements at the level of knowledge and understanding, but they are having difficulty in implementing the skills at the application level such as drawing the rays.

As a result of the interviews, it was understood that mathematical success was compromised by the fact that the achievements in the light and sound units of low school students required mathematical calculations. It is stated that students should be supported with visual activities especially reflecting reflection of rays, but teachers do not have necessary knowledge and skills to design such environments.

To determine the level of achievement of the students after the interviews, a test covering the achievements of 20 students in the Light and Sound unit was applied, and it was found out that 78 out of 100 grades the students got average. This shows that the students can not achieve the gains of the Light and Sound unit adequately.

Attitudes scale (Yanpar, Çakır and Şahin, 2000) was applied to the students in order to determine the attitudes of the students towards the science education; ($x = 4.59$, $Ss = 0.32$) attitudes of the students towards the science course were found to be very good.

The motivation scale (Başdaş, 2007) was applied to the students in order to determine the motivation of the students towards science education; students were found to have the very good motivation (x = 4.41, Ss = 0.33) towards the science course.

Develop Instructional Strategy

As a result of needs analysis, it is seen that some of the students do not realise the achievement of reflection of science education. When examining the reasons for not achieving achievements, it is understood that the academic achievements of the students are closely related to the attitudes and motivations towards the lessons.

Based on this information, teaching environment; It is designed by the web-based teaching method of reflecting the reflection of the light in which the narrative technique is used, taking into account the characteristics, needs, attitudes and motivations of the students, subject content and usability.

When the content of the teaching system is determined, it has not been explained to the subject of direct light diffusion. It has been mentioned before the reflection of the light on concepts such as how the visual phenomenon is realised, how the light sources are, what the illuminated material is. After preliminary information is given according to the learning hierarchy, the reflection of the light, the types of reflection and the reflection laws are introduced. After the necessary theoretical information is given to the students, animation, matching, gap filling and game applications related to the reflection of the light are given in order to understand the subject better.

Develop and Select Instructional Material

When the learning environment is designed; attention has been paid to the cognitive load of students, visual hierarchy, balance, integrity and colour harmony. In visuals and texts, storyboards were created in such a way as to avoid the excesses and to give the subject's essence, ordered according to the learning hierarchy. Designed for students' learning needs using the Adobe Captivate 9, this learning environment is published on the researcher's website. After making the necessary preparations, the teacher informed the students about the 20 student learning environment so that the application can be started. A sample screenshot of the learning environment in which the multimedia items are used together is shown in Figure 2.

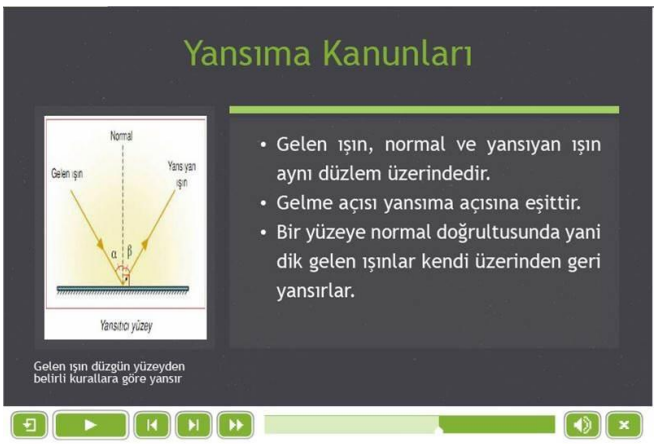


Figure 2. A screenshot from the learning environment

As shown in Figure 2, the multimedia environment has been used together in the learning environment, and attention has been paid to shape, alignment, colour scheme, font and line spacing. Thus, it has been tried to ensure that the students and their learning are permanent.

Formal Evaluation and Update

After the instructional strategies have been determined and the material development process has been completed, a formal evaluation of the application within the class has been made with a small group of students in order to evaluate the usefulness of the material developed in the process. Some formal updates have been made in practice as a result of the feedback given by the students. However, since the feedback provided is not directed at the subject content, no updates have been made to the content.

Implementation and Summative Evaluation

After a formal evaluation with a small group and the teaching material was updated, the class was applied completely. 20 students in the class have reached the application from the researcher's website. The students have carried out various activities in practice in the online environment. After the students have been practising for two weeks, the evaluation process has been completed by applying the success test, attitude and motivation scales to the students again.

FINDINGS

The Relationship between Academic Achievement, Attitude and Motivation Levels of Students

A correlation analysis was conducted to examine the relationship between students' academic achievements and the attitudes and motivations of the students after the implementation. The results are presented in Table 1.

Table 1. The relationship between academic achievement, attitude and motivation levels of students

	Academic Achievement	Attitude	Motivation
Academic Achievement	-	0.36	0.48*
Attitude		-	0.75**
Motivation			-

* p<0.05, ** p<0.01

When Table 1 is examined, it is seen that the academic achievements of students in science education are related to motivations (r = 0.48, p <0.05) in moderate and positive direction. There is, however, a high level and positive relationship between the attitudes and motivations of students towards science courses (r = 0.75, p <0.01). There is no significant relationship between the academic achievement and attitudes of the students (p> 0.01). For this reason, it is thought that the motivation of the students is closely related to the development of positive attitude towards the science education and the achievement of the goals.

Effect of Implementation on Academic Achievement of Students

The dependent sample t-test was applied to examine whether the students' academic achievement levels differed after the implementation. The results are presented in Table 2.

Table 2. Academic achievement levels of students

		N	x	Ss	t	η^2
Academic Achievement	Pre-Test	20	78	19.36	-2.17*	0.20
	Post-Test	20	87.5	10.20		

* p<0.05

When Table 2 is examined, it is seen that there is a significant difference between the results of the academic achievement made before and after the application made to the students about the light reflection [t (19) = - 2.17, η2 = 0.20, p < 0.05]. According to this, it is understood that the students' academic achievement (x = 87.5, Ss = 10.20) was higher than that before (x = 78, Ss = 19.36). This is a broad and positive directional effect on the level of academic achievement of web-based instruction, explaining 20% of the total variance. This suggests that web-based teaching has an important role in enhancing the academic achievement of students.

Effect of Implementation on the Attitudes of the Students

The dependent sample t-test was applied to examine whether there was any difference in post-implementation attitudes of the students. The results are presented in Table 3.

Table 3. Attitudes of students

		N	x	Ss	t	η2
Attitude	Pre-Test	20	4.59	0.32	-1.58	-
	Post-Test	20	4.67	0.29		

* p<0.05

When Table 3 is examined, it is seen that there is not a significant difference between students' attitudes towards science education before and after the implementation of web-based instruction (p > 0.05). According to this, it is understood that the attitudes of the students towards the post-implementation science course did not change according to the preliminary. For this reason, it is considered that the web-based instruction made does not have an effect on the attitude level of the students.

Effect of Implementation on Students' Motivation Levels

The dependent sample t-test was applied to examine whether the motivation levels of the students were different after the application. The results are presented in Table 4.

Table 4. Motivation levels of students

		N	x	Ss	t	η2
Motivation	Pre-Test	20	4.41	0.33	-0.43	-
	Post-Test	20	4.44	0.36		

* p<0.05

When Table 4 is examined, it is seen that there is no significant difference between students' motivation towards science education before and after the application of light reflection (p > 0.05). According to this, it is understood that the motivation of the students towards the science course after the implementation has not changed according to the previous one. For this reason, it is considered that the web-based instruction has no effect on the level of motivation of the students.

CONCLUSION AND DISCUSSION

The results of the research show that the web-based instructional design on the reflection of light contributes to the academic achievement of the students and that there is no effect on the attitude and motivation levels of the students. Demirer (2015), a simulation of the concept of light and sound, has shown that students improve their academic achievements in light and sound units and those students who learn by simulation are more successful than students in the control group as a result of the applications made. It is seen that web-based teaching material prepared by Keles (2007) for the force and movement unit contributes positively to the academic achievements of the students and does not contribute to the attitudes towards the science course.

The results of the experimental study on mathematics education designed by Akay (2017) according to the Dick and Carey model indicate that the instructional design practices increased the academic achievement of students. Kwon and Block (2017) use Dick and Carey instructional design model to provide three sources of self-efficacy, mastery experience, vicarious experience, and social persuasions. As a result of research pre-service physical education teachers' perceived self-efficacy improved after taking the e-learning supplement. Carlton, Kicklighter, Jonnalagadda and Shoffner (2000), design, develop, and formatively evaluate a computer-based multimedia nutrition education program for adults based on the Dick and Carey instructional design model. They conclude that dietetics professionals should use instructional design models, such as the Dick and Carey model, to design effective nutrition education programs for the public.

The results of the study and similar studies show that web-based teaching designed by Dick and Carey model in science education affects the academic achievement of students positively. However, to improve the attitude and motivation level of students towards science education, it is necessary to design different teaching environments. It is thought that the work to be done in this context will contribute to the fields of science and instructional technology.

REFERENCES

Akay, Y. (2017). The efficiency of implementations based on instructional design created in primary school 4th grade mathematics lesson. Unpublished doctoral dissertation, Balıkesir University, Instutite of Social Sciences.

Akbulut, Y. (2007). Implications of two well-known models for instructional designers in distance education: Dick-Carey versus Morrison-Ross-Kemp. *Turkish Online Journal of Distance Education-TOJDE 8* (2) 62-68.

Anıl, Ö., & Küçüközer, H. (2010). Ortaöğretim 9. sınıf öğrencilerinin düzlem ayna konusunda sahip oldukları ön bilgi ve kavram yanılgılarının belirlenmesi. *Türk Fen Eğitimi Dergisi, 7*(3), 104-122.

Atıcı, B., & Gürol, M. (2001). *Nesnelci öğretim yaklaşımlarından oluşturmacı öğrenme yaklaşımlarına doğru internet tabanlı uzaktan eğitime yönelik gelişimsel bir model önerisi.* BTIE 2001. Bilişim Teknolojileri Işığında Eğitim. Bildiriler Kitabı. Ankara 2001. 177-183.

Aydın, S. (2007). *Eliminating the misconceptions about geometric optics by conceptual change texts.* Unpublished doctoral dissertation, Atatürk University, Instutite of Natural Sciences.

Başdaş, E. (2007). *The effect of hands-on science learning method in the education of science in primary school on the science process skills, academic achievement and motivation.* Unpublished master dissertation, Celal Bayar University, Instutite of Natural Sciences.

Büyüköztürk, Ş. (2013). Veri analizi el kitabı.(18. Baskı). Ankara: Pegem Akademi.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz Ş., ve Demirel, F. (2013). Bilimsel araştırma yöntemleri. Ankara: Pegem Akademi Yayınları.

Carlton, D. J., Kicklighter, J. R., Jonnalagadda, S. S., & Shoffner, M. B. (2000). Design, development, and formative evaluation of "Put Nutrition Into Practice" a multimedia nutrition education program for adults. *Journal of the American Dietetic Association, 100*(5), 555-563.

Demirer, G. M. (2015). *The effect of simulations on the elimination of misconceptions: Light and sound unit sample.* Unpublished master dissertation, Kırıkkale University, Instutite of Natural Sciences.

Dick, W., & Carey, L. M. (1996). The systematic design of instruction. (4. edition) New York: HarperCollins.

Gustafson, K. L., & Branch, R. M. (2002). What is instructional design? In R.A. Reiser & J. A. Dempsey (Eds.), *Trends and issues in instructional design and technology* (pp.16-25). Saddle River, NJ: Merrill/Prentice-Hall.

Kaçan, B. (2008). *Applications towards overcoming misconceptions about light.* Unpublished master dissertation, Gazi University, Institute of Educational Sciences.

Karagöz, F. (2010). *The effect of web-based teaching method in science and technology lesson at primary schools.* Unpublished master dissertation, Eskişehir Osmangazi University, Instutite of Natural Sciences.

Keleş, E. (2007). *Developing and assessing effectiveness of web supported instructional material based on brain based learning for 6th grade force and motion unit.* Unpublished doctoral dissertation, Karadeniz Technical University, Instutite of Natural Sciences.

Khan, B. H. (1997). Web-based instruction (WBI): What is it and why is it. *Web-based instruction,* 5-18.

Kwon, E. H., & Block, M. E. (2017). Implementing the adapted physical education E-learning program into physical education teacher education program. *Research in developmental disabilities, 69*, 18-29.

Moralar, A. (2012). *The effect of problem-based learning approach on academic success, attitude and motivation in science education.* Unpublished master thesis, Trakya University, Instutite of Natural Sciences.

Reeves, T. C., & Reeves, P. M. (1997). Effective dimensions of interactive learning on the World Wide Web. *Web-based instruction,* 59-66.

TTKB (2016). *Fen ve Teknoloji Dersi (6-8.Sınıflar) Öğretim Programı.* http://ttkb.meb.gov.tr/program2.aspx?islem=1&kno=25

Tuan, H. L., Chin, C. C., & Shieh, S. H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639-654.

Yanpar, T.Ş., Çakır, Ö.S., & Şahin, B. (2000). *İlköğretim 6. Sınıf Öğrencilerinin Fen Bilgisi ve Sosyal Bilgiler Derslerine Karsı Tutumları, Akademik Benlik Kavramları ve Bilişsel Öğrenme Düzeyleri.* MEB EARGED Projesi, Ankara.