Cypriot Journal of Educational Sciences

Volume 15, Issue 2, (2020) 194-207

www.cjes.eu

Availability of virtual museum applications in courses based on the views of classroom teachers

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Suggested Citation:

Eguz, S. (2020). Availability of virtual museum applications in courses based on the views of classroom teachers. *Cypriot Journal of Educational Science. 15*(2), 194–207. https://doi.org/10.18844/cjes.v15i2.4501

Received September 8, 2019; revised February 12, 2020; accepted April 5, 2020.
Selection and peer review under responsibility of Prof. Dr. Huseyin Uzunboylu, Higher Education Planning, Supervision, Accreditation and Coordination Board, Nicosia, Cyprus.

Abstract

Virtual museum applications allowed individuals to access the museums that are located in distant areas and those who could not visit due to various reasons independent of time and space. The aim of this study was to determine the utilisation of virtual museum applications in life science courses based on the views of classroom teachers and the contribution of the applications to the students. This study was designed as a qualitative research based on the phenomenology method. The study data were collected using an interview form, developed by the author, in March 2019 during the 2018–2019 academic year spring semester. The study findings demonstrated that classroom teachers considered virtual museum applications important in life science courses; however, they also stated that not all curriculum topics were suitable for the virtual museum application, and the application was most frequently used in the second grade elementary school.

Keywords: Classroom teacher, life science, virtual museum.

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1. Introduction

Museums are the institutions that reflect the history of human life, culture and scientific, and technical and artistic works (Cetin, 2002). Museums that aim to collect, preserve and exhibit pedagogical, psychological, sociological and economic collections that humans produced since the ancient times (Keles, 2003) assumed the role of effective visual resources for the future generations. However, museums have certain disadvantages because the artefacts exhibited in museums are large in size, some are incomplete, it is difficult to secure, it is difficult to provide suitable environmental conditions, the need for a space, or building to exhibit the artefacts, it is difficult for the visitors to visit the museums due to economic and distance factors and the artefacts are passive (individuals could not interact easily with the artefacts) (Tsichritzis & Gibbs, 1991). The advances in network connectivity and the effective use of communication technologies play an important role in the elimination of these disadvantages. In fact, these facilities allowed the actual museums to display collections online, allowing the visitors to access these collections conveniently from their homes, workplaces, schools, libraries, etc., thus acquiring a digital dimension (Bowen, 2000; Schweibenz, 1998).

The virtual museum is the presentation of the collections in a real museum in a computer environment using image transfer and access technologies (Ermis, 2010). In recent years, virtual museum applications have become popular with the integration of traditional collections and exhibitions with modern technological systems, providing educational and entertaining experiences for online visitors (Barbieri, Bruno & Muzzupappa, 2017). For a museum to be considered a virtual museum, all the available works should be presented on the internet, special links should be provided for the visitors, and the web pages that would serve teachers, students, and field experts should be provided. In this method, the individuals without an opportunity to visit the museum could access the works and written resources in the museum using a computer, and when necessary, individuals could interact with the museum by asking questions and getting answers (Peker, 2014). Besides the virtual museum application, the technological elements such as interactive system installations, liveboard applications, three-dimensional information systems, holograms, touchscreens, digital books, thematic simulations and in-house virtual workshops (virtual ceramics and sculpture workshops) provide interactive museum experiences to the visitors and are frequently used in museum education processes (Karadeniz, Okvuran, Artar & Ilhan Cakir, 2015). Varisco and Cates (2005) categorised the learning resources available in virtual museums into eleven categories. The descriptions for these learning resources are shown in Table 1 (Varisco & Cates, 2005).

Table 1. Virtual museum learning resources

Educational resource	Description of the resource
Online instruction	Learning material should be instructed online in a comprehensible way and should include open or covert learning goals.
Learning activities	The text should include activities and games. The text should primarily provide information about the activities, and the visitors could print the texts and read offline. Activities and games should be based on a topic about an artefact in the exhibition or the collection or a conceptual theme.
Course plans	Course plans should be provided as MS word or PDF documents for both online and offline instructions in the classroom.
Online exhibits	Basic and enhanced education should include exhibitions. Basic educational exhibitions should provide minimum information on exhibitions, such as 2D static images and short interpretations. Enhanced educational exhibitions should provide more information on the existing exhibition material for the visitors.
Guided tours	A systematic method should be developed to provide functional museum content for the visitors in guided tours.

Collections	The description of each collection should include minimum of five visuals. The visuals should reflect the source of the artefact, creators, original location, artefact type and the period.
Lectures/demonstrations	Intense thematic views should be presented using video, text and sound through various media based on the visitor's experience.
Research databases	The databases should include various information such as all artefacts in the museum, special collections, artist publications, brochures, auction catalogues, books and work records.
Learning links	In general, two types of resources are labelled as 'links' and 'resources' that correspond to internal and external links in web museums. The external learning links include national and international resources, and the internal learning links include archives, publications, museum libraries and web projects.
Conversation tools	The site should include chat rooms, blogs, e-mail and bulletin boards, and online video conferencing facilities that support visitor–museum relations for interpersonal communications.
Miscellaneous other resources	This category includes all other resources that could be considered as educational sources but could not be considered in any other category such as printable guides, handbooks, whitepapers, art dictionaries and procedural instructions.

Virtual museums, as a result of the abovementioned learning resources, reduce the virtual perception by giving the impression that the visitors walk through an actual museum created in a virtual environment. Therefore, contrary to the limited physical facilities available in conventional schools, virtual museums provide students an independent learning environment. Especially for elementary school students, whose abstract thinking skills have yet to develop, it was considered that virtual museum education that provides a learning environment, which utilises the five senses, and where the students could discover, research and participate in the activities, could be more effective and permanent. However, the review of the new life sciences curriculum demonstrated that virtual museum trips were not included directly in the education program. In course instructions, it was emphasised that attention should be paid to in-school and out-of-school practices, and in particular, out-of-school activities such as oral history, local history, museum visits, nature education, introduction of public institutions and organisations and special institutions and student-centred activities should be planned (MoNE, 2018). In the life science course, frequent and functional museum visits could be conducted through the virtual museum visits. In fact, virtual museums allow the students to visit their cultural heritage, immediate and distant history, natural environment and even several museums in different countries. Thus, the competencies of the classroom teachers, who play a major role in active use of the virtual museum trips during the course, their knowledge on virtual museums, the frequency of using virtual museums during the course, their views on which class level for which achievements should the visits be conducted, the contribution of the visits to learning and productivity and the skills that these visits would develop, are important. In fact, the conditions of the period of technological advances increase the responsibility of the classroom teachers who have an important role in raising national awareness and its transformation to future generations in the life science course that aims to include the active students in the educational process. The review of studies on virtual museums in Turkey demonstrated that these studies were limited to certain fields such as fine arts and social studies (Aktas, 2017; Bingol, 2008; Canli, 2016; Demirboga, 2010; Durmus, 2012; Eguz, 2011; Ermis, 2010; Kalinci, 2015; Karakaya, 2015; Kubat, 2012; Mayda, 2014; Ozer, 2007; Peker, 2014; Uslu, 2008; Ulusoy, 2010; Ustaoglu, 2012; Yildirim & Tahiroglu, 2012). Furthermore, there are important studies in the literature that aimed to determine the views of the teachers in different fields on virtual museums and to raise awareness (Karatas, Yilmaz, Kapanoglu & Mericelli, 2016). There are also important studies on virtual museums in the international literature (Ambusaidi & Al-Rabaani, 2019; Bowen, 2000; Chadwick, 1998; Giaccardi, 2006; Hayashi, Bachelder & Nakajima, 2016; Hoptman, 1992; Huyzendveld et al., 2012; Ismaeel & Al-Abdullatif, 2016; Jones & Christal, 2002; Karoulis, Sylaiou

& White, 2006; Pescarin, 2013; Sartini et al., 2015; Schweibenz, 1998; 2012; Sylaiou, Maniab, Karoulisa & Whitec, 2010; Tsichritzis & Gibbs; 1991; Walczak, Cellary & White, 2006). However, there are no studies directly on the use of virtual museums in the life science course. Thus, this study is expected to contribute to the literature. This study aimed to determine the use of virtual museum applications in life science courses based on the views of classroom teachers and the contribution of these applications to the students. Based on this general aim, the following research problems were determined:

- What are the classroom teacher competencies required for the active use of virtual museum activities in the courses?
- Which virtual museums could be used in the life science course?
- What is the frequency of the use of virtual museums by classroom teachers?
- In which grade levels and achievements do the classroom teachers conduct virtual museum visits?
- What are the views of classroom teachers on virtual museum visits based on learning and productivity?
- The virtual museum applications used in the primary education life science course support the development of which skills in students?

2. Method

This study was designed with the qualitative research paradigm. The qualitative research entails the systematic collection, organisation and interpretation of textual material obtained with an in-depth examination of various social environments and groups or individuals living in these environments using data collection instruments such as interview or observation (Berg & Lune, 2015; Malterud, 2001).

2.1. The research model

This study was planned with the phenomenological design, a qualitative research model. The phenomenological studies usually aim to reveal and interpret the perceptions or perspectives of individuals on a particular phenomenon (Yildirim & Simsek, 2016). The aim of the phenomenology model is to provide a better understanding of a phenomenon by identifying the essence of the shared experience (Moustakas, 1994). The research process adopted in this study is shown in Figure 1.

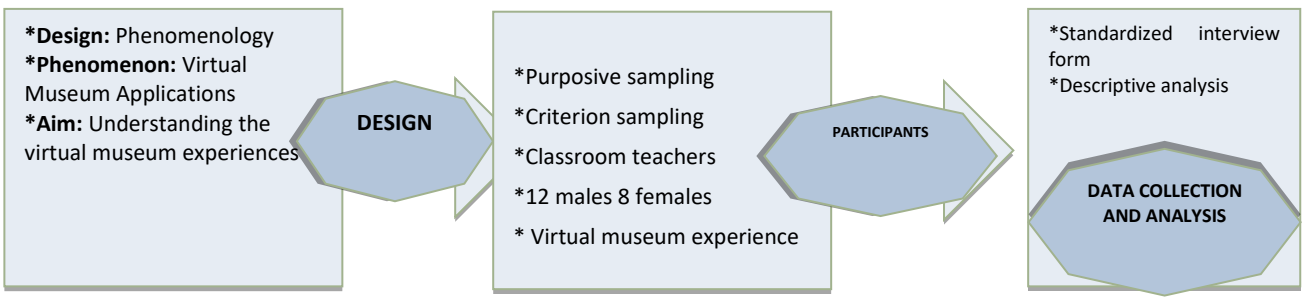

Figure 1. The research processes

2.2. The study group

In this study, criterion sampling, which is a purposive sampling method, was used. The phenomenology design generally utilises the criterion sampling method, where participants that meet predefined criteria are selected. Thus, the most significant criterion in the sample is the participants' experiences with the related phenomenon (Moser & Korstjens, 2018). The present study criteria included employment as a classroom teacher and at least one virtual museum application experience in the classroom environment. Based on these criteria, 12 (60%) male and 8 (40%) female, a total of 20

classroom teachers employed in primary schools in Battalgazi district, Malatya Province, during the 2018–2019 academic year spring semester with at least one virtual museum application experience in the classroom were included in the study group. Each participant was assigned a nickname in accordance with the ethical principles. The participant demographics are shown in Table 2.

Table 2. The demographics of classroom teachers included in the study group

Nick name	Gender	Professional seniority	Institutional seniority	Field
Ali	M	19	5	Classroom Education
Ece	F	16	2	Classroom education
Hakan	M	14	6	Classroom education
Turgay	M	8	1	Classroom education
Soner	M	21	5	Classroom education
Mehmet	M	25	8	Turkish education
Tamer	M	28	11	Classroom education
Nazli	F	6	1	Classroom education
Gizem	F	20	9	Classroom education
Esra	F	28	13	Technical education
Cem	M	9	1	Classroom education
Caner	M	13	2	Classroom education
Mehmet	M	20	4	Classroom education
Alper	M	17	5	Classroom education
Kasim	E	30	7	Classroom education
Neslihan	K	22	4	Classroom education
Tugba	K	15	3	Classroom education
Cigdem	K	12	7	Classroom education
Demir	E	21	4	Classroom education
Nil	K	10	1	Classroom education

The review of the study participants demonstrated that whilst the majority included primary school instruction graduates, there were also participants who were trained in different fields although still serving as classroom teachers.

2.3. Data collection instruments and data collection

The study data were collected with the structured and semi-structured interview forms developed by the author. Interviews are amongst the primary data collection instruments in the qualitative research. It is a good way to discover the individuals' perceptions, meanings, descriptions and their construction of reality. It is also one of the powerful methods used to understand others (Punch, 2005). Thus, interview forms were developed based on the literature review on virtual museum applications. The form included questions on the availability of virtual museum applications in the courses and the contribution of the applications to the students. The clarity, comprehensibility and suitability of the interview form questions were tested by presenting the form for an expert opinion. The validity of the interview form was determined based on the expert opinion, and it was considered to be adequate. In the reliability calculation of the research, the formula proposed by Miles and Huberman (2015) was used. (reliability = consensus / consensus + divergence * 100). Accordingly, the reliability of the study was calculated as 82%. The study data were obtained using the forms developed during March in the 2018–2019 academic year spring semester. The themes, categories and direct excerpts obtained with the written texts were presented to the participants via e-mail, and their approval was obtained as to whether the data reflected their views.

2.4. Data analysis

The study data were analysed with the descriptive analysis method. The data obtained in the descriptive analysis could be summarised and interpreted based on predetermined themes (Yildirim & Simsek, 2016), or they could be presented using the questions or dimensions adopted in the interview and observation processes (Wolcott, 1994). The data collected in this study were organised based on the themes identified by the research problems. In this study, the data were initially analysed with a holistic approach, and the categories were determined based on the whole text and research problems. Examples of the classroom teacher views were directly cited. The qualitative data analysis process includes the organisation of data, pre-reading the database, coding and organising the themes, data presentation and interpretation stages (Creswell, 2013). In the qualitative data analysis conducted in this study, after the raw data were recorded, the codes and categories were determined, the number of categories was identified, the data were sorted based on the categories and the data were presented and interpreted.

3. Findings

The study findings are presented in the sections titled 'teacher competencies required for the active use of virtual museum activities in the life science course', 'virtual museums that could be used in the life science course', 'frequency of virtual museum visits', 'utilisation of virtual museums by classroom teachers in life science classes', 'the approaches of classroom teachers towards virtual museum visits with respect to learning and productivity' and 'the contribution of virtual museum visits to the development of student skills.'

3.1. Teacher competencies required for the active use of virtual museum activities in the life science course

In the determination of the teacher competencies required for the active use of virtual museum activities in the life science course, they were asked to list the teacher competencies required for the active use of virtual museum activities in the life science course. The participant responses are shown in Table 3.

Table 3. Teacher competencies required for the active use of virtual museum activities in the life science course

Competences	Frequency *(f)*
Competency in using auxiliary technologies	15
Access to networks	13
Knowledge on virtual museums	11
Knowledge on museum types and content	7
Ability to establish the correlation between the topic, object and student	6
Planned implementation of the application	3
Development and implementation of achievement assessment activities after the virtual museum visits	2

The review of Table 3 demonstrated that classroom teachers claimed that they should mostly possess the competencies of using auxiliary technologies (f = 15) and access to network connections (f = 13) and planned an implementation of the application (f = 3) and development and implementation of achievement assessment activities after the virtual museum visits (f = 2) the least. Certain participants expressed the following views:

In order to visit a virtual museum, first, the computer use, uninterrupted internet access and selection of related museums competencies should be present (Alper).

Of course, first of all, it is necessary to use the technologies that allow us to reach the museums technically. Besides, similar planning to those we make whilst visiting actual museums would support the acquisition of the target behaviour, and the planning should be accurate (Esra).

Internet is required, information about the content of museums, as well as information on virtual museum visits, should be available (Cem).

3.2. Virtual museums that could be used in the life science course

To determine the virtual museums that could be used in the life science course, a list of virtual museums and palaces available in the official website of the Ministry of Culture and Tourism was provided to the participants, and they were asked to mark those museums that could be used in the life science course and write those that were not included in the list. The participant responses are shown in Table 4.

Table 4. Virtual museums that could be used in the life science course

Virtual museums and palaces	Frequency (*f*)
Ataturk's Mausoleum	18
Ankara Ethnography Museum	15
Ataturk's Home of Birth in Thessaloniki	11
Dolmabahce Palace	10
Ankara War of Independence Museum	8
MTA Museum of Natural History	7
Sivas Congress Museum	5
Cappadocia Outdoor Museum	4
Zeugma Mosaics Museum	2

In Table 4, it was observed that the participants preferred Ataturk's Mausoleum (*f* = 18) and Ankara Ethnography Museum (*f* = 15) the most and Sivas Congress Museum (*f* = 5), Cappadocia Outdoor Museum (*f* = 4) and Zeugma Mosaics Museum (*f* = 2) the least amongst the museums that could be used in life science courses. Furthermore, Ataturk's Home of Birth in Thessaloniki, Dolmabahce Palace, Ankara War of Independence Museum and MTA Museum of Natural History were mentioned by the participants as other virtual museums that could be used in the courses. Furthermore, it was observed that teachers did not include any international museums in their responses.

3.3. Frequency of virtual museum visits

To determine the frequency of the virtual museum visits initiated by the classroom teachers in life science courses, the question 'how often do you visit virtual museums in your class?' was asked. The participant responses are shown in Table 5.

Table 5. Frequency of virtual museum visits in the life science course

Visit frequency	Frequency/Percentage (*f*, %)
Weekly	--
Monthly	--
Every semester (1–2 times)	2 (10%)
Annually	13 (65%)
Once every two years	5 (25%)

The review of the participant responses demonstrated that 65% (*f* = 13) of the participants initiated virtual museum visits once a year, 25% (*f* = 5) initiated virtual museum visits once every 2 years and

10% (*f* = 2) initiated virtual museum visits each semester (1–2 times). The views of certain participants were as follows:

A number of difficulties, such as official procedures, due to the fact that our students are quite young and the classroom size, forced the teachers to conduct virtual museum visits. I try to conduct visits at least once every semester (Nil).

It should be 1½ or 2 years since our last visit. I would have done it more often if technological school facilities were better (Gizem).

3.4. Utilisation of virtual museums by classroom teachers in life science classes

To determine the utilisation of virtual museums by classroom teachers in life science classes, the question 'at which grade level and for which achievements you conduct virtual museum visits?' was asked. The responses are shown in Table 6.

Table 6. The grades, achievements and virtual museums that utilised virtual museums in the life science course

Grade level	Achievements	Available virtual museum	Frequency (*f*)
1	Recognises historical, natural and touristic spaces in the vicinity.	Zeugma Mosaics Museum	2
1	Has an knowledge on Ataturk's life.	Ataturk's house of birth in Thessaloniki, Dolmabahce Palace, Ataturk Mausoleum	13
1	Observes the sun, the moon and the stars.	MTA History of Nature Museum	5
2	Researches the childhood of Ataturk.	Ataturk's house of birth in Thessaloniki	14
2	Recognises the significance of national holidays.	Ankara War of Independence Museum	4
2	Researches the impact of the shape and movements of the earth on human life.	MTA History of Nature Museum	5
3	Introduces the features of historical, natural and touristic spaces in the vicinity.	Zeugma Mosaics Museum	1
3	Researches the contributions of national unity to social life.	Ankara War of Independence Museum, Sivas Congress Museum	5
3	Recognises the importance of plants and animals in human life.	MTA History of Nature Museum	1

The review of the class levels, achievements and virtual museums, where the virtual museum applications were used in the life science courses shown in Table 6, demonstrated that the participants visited Ataturk's house of birth in Thessaloniki, Dolmabahce Palace and Ataturk Mausoleum in the 'has an knowledge on Ataturk's life' achievement in the first grade the most (*f* = 13), on the second grade, the participants visited Ataturk's house of birth in Thessaloniki in the 'researches Ataturk's childhood' achievement the most (*f* = 14) and on the third grade, the participants visited Ankara War of Independence Museum and Sivas Congress Museum in the 'researches the contributions of national unity to social life' achievement (*f* = 5). In all grade levels, it was determined that the highest number of virtual visits were conducted by the participants in the second grade and the least number of virtual visits were conducted in the third-grade life science achievements. Furthermore, classroom teachers suggested that virtual museum trips were an

important application in life science courses; however, not all topics in the curriculum were suitable for virtual museum applications.

3.5. The approaches of classroom teachers towards virtual museum visits with respect to learning and productivity

The participants were asked to assess the adequacy and efficiency of corporate information, collection presentation and the ability to move within the virtual environment provided on the site based on factors such as timing, mental and affective input properties and motivation and attention to determine the participants' approach to virtual museum visits in terms of learning and efficiency. The participant approaches are presented in Table 7.

Table 7. Approaches to virtual museum visits based on learning and productivity

Learning and productivity approaches of the participants	Frequency (*f*)
For the students	
Permanent learning	17
Reinforcement of the learned information	14
Motivation	11
Raising interest	9
Development of cognitive and affective input properties	7
Timesaving	5
For the teachers	
Adequacy of technical support	15
Adequacy of collection presentation	12
Adequacy of movement in the virtual environment	10
Adequacy of institutional information	6

The review of Table 7 demonstrated that the participants assessed the visits based on the students and teachers. It was stated that these visits ensured permanent learning (*f* = 17) and reinforced the learned knowledge (*f* = 14) for the students the most, and they saved time (*f* = 5) the least. For the teachers, the participant approached to focus on the adequacy of technological support (*f* = 15) the most, and the adequacy of institutional information (*f* = 6) the least. Certain participant views were as follows:

I know that the children do not forget. When I provide information about the virtual visit that I conducted in the past, they want to talk about the things they remember. Therefore, I can say that it contributed to permanent learning. When technological support and the infrastructure that would allow us to conduct mini-tours on each topic are adequate, the life science course would be more productive (Hakan).

Of course, the presence of complete information on the virtual museum site is important. Sometimes, we cannot understand without a virtual visit. Thus, for the virtual tour to be efficient, institutional information and artefact information should be complete on the site. Although we do not provide detailed information due to the grade level, I am in favour of it (Cigdem).

It helps reinforce the previously learned knowledge (Kasim).

3.6. The contribution of virtual museum visits to the development of student skills

To determine the contribution of virtual museum visits to the development of student skills, the participants were asked to mark which skills that the virtual museum visits contributed on a table of

23 skills included in the life science course curriculum. Participant responses and their frequency are shown in Table 8.

Table 8. The student skills that virtual museums develop

Skills	Frequency (*f*)
Observation	16
Research	14
Using information and Communication technologies	13
Using resources	11
Spatial perception	9
Introduction of national and cultural values	9
Decision-making	7
Preservation of nature	5
Collaboration	2
Communication	2

From the review of Table 8 based on the participant views, it was determined that virtual museums improved observation (*f* = 16), research (*f* = 14) and using information and communication technologies (*f* = 13) skills the most, and they contributed to the development of collaboration (*f* = 2) and communication (*f* = 2) skills the least. Furthermore, certain participants proposed that virtual museum visits improved the resource use, spatial perception, introduction of national and cultural values, decision-making and preservation of nature skills.

4. Discussion, conclusion and recommendations

The preservation, presentation and transfer of cultural heritage to future generations are a long and complex process that involves various acts and methods (Surucu & Basar, 2016). Thus, the utilisation of the museums for educational purposes is not limited to the actual museum visits but should be supported by computer-assisted virtual museums and art galleries within the classroom. The study findings demonstrated that the participants considered the competences of the classroom teachers to use auxiliary technologies and access network connections the most, and their competences in the development and implementation of evaluation activities for achievements after virtual museum and in applications the least in order to use virtual museum activities effectively. It was thought-provoking that classroom teachers interviewed in this study neglected planning virtual museum visits. In fact, it is necessary for the teacher to plan the instruction to achieve the goals of all instructional activities in the classroom effectively and efficiently. Satisfaction that a planned activity in the classroom would provide motivates the teacher to plan and organise the next instructional activity (Cetin, 2019). Thus, it is important to conduct the virtual museum applications in a planned manner. In this context, Aladag, Akkaya and Sensoz (2014) emphasised the fact that certain preparations should be conducted and measures should be taken before, during and after the virtual museum visits, similar to actual museum visits, and these preparations would increase the productivity of the visit and the achievements would be acquired accurately and effectively.

A virtual museum environment should be interesting and legible to allow the visitors to interpret cultural content accurately and should encourage creative thinking, stimulate learning via fun, support inspiration and creativity and reflect individuals' curiosity and emotions (Sylaiou et al., 2010). This study participants considered Ataturk Mausoleum and Ankara Ethnography Museum as the virtual museums that could be used in the life science course the most and Sivas Congress Museum, the Cappadocia Outdoor Museum and the Zeugma Mosaics Museum as the least usable virtual museums in the course. Furthermore, the house of birth of Ataturk in Thessaloniki, Dolmabahce Palace, Ankara War of Independence Museum and MTA Museum of Natural History were also listed as virtual museums that could be visited in the course by the participants. It was stated that the museums listed

by the participants were consistent with certain achievements included in the life science course curriculum, and their use in teaching process would be beneficial. It was also observed that the study participants did not include any international virtual museums in their lists. As is known, access to virtual museums is available from all locations in the world. When it is considered that the knowledge available in a museum is global heritage and not only limited to that of the local society, it is not right to include only Turkish museums in courses.

In the study, the review of the grade levels, achievements and virtual museums, where the virtual museums were used in the life science course, demonstrated that the participants visited Ataturk's house of birth in Thessaloniki, Dolmabahce Palace and Ataturk Mausoleum in the 'has knowledge on Ataturk's life' achievement in the first grade the most, on the second grade, the participants visited Ataturk's house of birth in Thessaloniki in the 'researches Ataturk's childhood' achievement the most and, on the third grade, the participants visited Ankara War of Independence Museum and Sivas Congress Museum in the 'researches the contributions of national unity to social life' achievement. The study findings demonstrated that classroom teachers not only considered virtual museum visits as an important application in life science course but also considered that not all topics in the curriculum were suitable for the application, and they conducted virtual museum visits in second grade primary school the most and in third grade the least.

Virtual museums reflect the profile of current approaches to modern museums the best. Due to the scope of the life science course, it allows the acquisition of social science, natural science and artistic ideas and values and is the foundation of several courses that students would take in coming years; thus, it is more important to conduct the virtual museum visits in this course. The review of the participant responses in this study demonstrated that 65% of the participants visited virtual museums once a year, 25% once every 2 years and 10% visited virtual museums every semester (1–2 times). It is expected from the participants, who stated that they conducted virtual visits based on the suitability of the museums for the course achievements, to use the virtual museums more frequently in the courses, because these visits are easier to conduct, cost less and are less risky when compared to actual museum visits.

Due to the power and impact of virtual museums in the learning process, this practice has been adopted by several educational institutions in various countries as an educational method that enriches, strengthens and refines learning (Ismaeel & Al-Abdullatif, 2016). In any case, virtual museums aim to provide meaningful learning experiences, especially for visitors with educational privileges (Perry, Economou, Young, Roussou & Pujol, 2017). Learning environments for effective and permanent learning should allow students to make observations, research and discover and provide students with first-hand data using real-life and concrete objects. In this study, it was observed that the participants reported assessment both in terms of students and teachers based on learning and productivity approaches. It was determined that virtual museums provided permanent learning and knowledge reinforcement the most and time saving the least. The abovementioned findings, especially on permanent learning and knowledge reinforcement, were consistent with the findings reported by Aktas (2017), Aladag, Akkaya and Sensoz (2014), Ata (2002), Colak (2006), Ermis (2010), Peker (2014), Tepecik (2007) and Ulusoy (2010). For the teachers, it was stated that the adequacy of technological support affected productivity the most and the adequacy of institutional information the least. The fact that it is not possible to reach the officials during virtual museum visits in Turkey has led to a lack of knowledge in that field.

Virtual museums are a new communication model that creates a personalised, immersive and interactive learning environment that allows students to acquire knowledge and develop self-knowledge skills and learning approaches (Farouk & Pescarin, 2014; Ott & Pozzi, 2011). Skills such as using information and communication technologies, perception of change and sustenance, observation, recognition of national and cultural values included in the life science curriculum could also be developed with virtual museum visits. Thus, Barbieri, Bruno and Muzzupappa (2017) argued that virtual museums were a very effective solution for the communication cultural content due to

their entertaining and educational approaches. Virtual museum visits could help students develop skills such as observation, imagination and creativity, aesthetics or appreciation. In the study, it was determined that virtual museums contributed to the development of the observation, research, information and communication technologies skill the most. This finding was consistent with a report by Peker (2014). Furthermore, it was concluded that virtual museum visits improved the cooperation and communication skills amongst primary school students. Besides, the participants argued that resource utilisation, spatial perception, recognition of national and cultural values, decision-making and nature conservation skills were improved by the virtual museum visits. Considering the positive impact of virtual museums on the acquisition of course achievements, skills development, permanent learning and reinforcement, the achievements included in the curriculum should be directly associated with virtual museums to allow classroom teachers to visit both national and international virtual museums based on the curriculum requirements, and the curriculum should also include activity recommendations. Furthermore, it is known that virtual museums around the world are quite comprehensive and educational. Thus, the propagation of virtual museums and development projects should be supported and developed in Turkey, and the developments should be integrated with instruction starting from the early stages of education.

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