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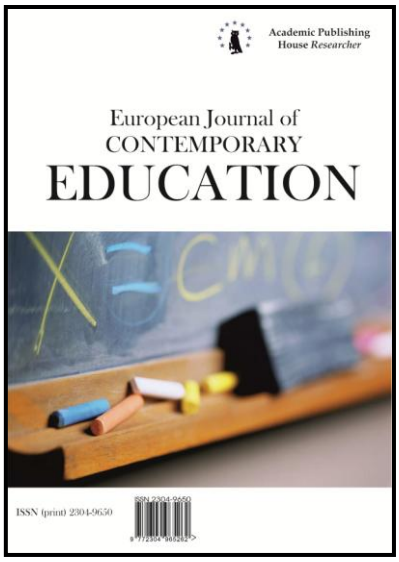

The Analysis of the Relationship between Primary Learning Styles and Learning Objects in an Online Environment

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Abstract

This study investigates the relationships between the primary learning styles of students and different learning objects presented simultaneously in an online learning environment in the context of the usage levels of these objects. A total of 103 sophomores from a Turkish State University participated in the study. Felder-Solomon Index of Learning-Styles (F-SILS) was used to determine the learning styles of the participants. Four different types of learning objects (i.e. video lecturing, audio lecturing, PDF lecturing and subject comprehension tests) were prepared for the course 'Basic database operations with MySQL'. Koper's (2003) classification model was used in selecting these learning objects. Descriptive analysis methods were used to determine the distribution of the participants according to their learning styles. Independent-Samples T-Test and the Mann-Whitney Wilcoxon test were used to test the differences between learning styles and learning objects. The usage levels of the learning objects were analysed in the context of interdimensional primary learning styles in the scale of the F-SILS. Those with sensory and visual learning styles were in the majority among the primary learning styles of participants. The study did not include the findings of students with other primary learning styles due to their small sample size. The findings of the study on the usage frequencies of subject comprehension tests and the duration of video lectures by primarily visual and sensory students demonstrated a significant difference on behalf of the primary sensory students. On the other hand, there was no statistically significant difference between students with primarily sensory styles and students with primarily visual styles in terms of the reading frequency of PDF lectures and the listening frequency of audio lectures.

Keywords: learning object, learning style, Moodle

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Introduction

Information can be transferred to students in a traditional learning environment directly by educators or in online learning environments through the various learning materials offered. It is challenging to meet the learning requirements of all students in traditional learning environments with a large number of students. Therefore, online environments may provide many advantages for educators to communicate with students [16]. However, technological learning resources presented to students in online environments may have a detrimental effect rather than a facilitating effect on their learning unless integrated to their cognitive processes [33]. Meeting the requirements of the students and providing adaptive courses and learning experiences for them are major challenges in online learning environments [16]. One way to overcome these challenges may be to design the online learning environments considering the cognitive styles of the students. In this way, preferences for students' learning styles may be affected in a positive way. In particular, cognitive styles are one important factor that affects the learning performance in the development of hypermedia-based learning [32]. Information in online learning environments can be transferred to the students not only as stable textual information but also as auditory, visual or a combination through the facilities provided by advanced information and communication technologies [6; 22]. The transfer of knowledge in these ways can contribute to the cognitive processes of the students. The learning objects with multimedia elements can be used to organise the information presented to the students in a way that addresses both visual and auditory channels.

Learning Objects

Learning objects are defined as any digital or non-digital items that can be reused or referred to throughout technology-supported learning [19]. There are various definitions and classifications of learning objects in the literature.

This study uses Koper's (2003) classification model on learning objects because this model complies with the classification definitions of the learning objects preferred frequently by lecturers in today's online learning environments.

Learning objects are classified by Koper (2003);

a) **Tool objects:** learning instruments that are used to support learning activities,

b) **Monitor objects:** learning objects that allow students to monitor their own learning and get information about learning processes,

c) **Knowledge objects:** learning objects that can be organised by the content resources such as text, audio, video and graphics [36] in order to support and ensure learning,

d) **Test objects:** learning objects used to assess learning results, learning progression or prerequisites, and

e) **Resource organisation objects:** learning objects at a lower level that contain subjects and paragraphs as well as texts and charts that can be organised within these paragraphs.

According to this classification approach, the following learning objects were used to transfer knowledge to the students in an online learning environment: audio lecturing (AL) in the category of **tool objects**, video lecturing (VL) in the **knowledge objects** category, PDF lecturing (PDFL) in the **resource organisation objects** category and subject comprehension tests (SCT) in the **test objects** category. The learning objects in the **monitor objects** category were not included in the study since tracking one's own learning and having information on the learning process do not meet the purposes of the study. Learning objects can be presented to the students in online learning environments generally in two ways. First, the lecturer uploads the learning resources to the online learning environments, and the students download these resources and study them. Secondly, students, without downloading the learning objects, interactively study the learning objects presented as animation, simulation or structured course in online environments [3]. In order to obtain reliable data on the preferences of the students for learning objects, this study utilised the second option. Students obtain and process information based on their learning styles [15]. Therefore, the availability of the learning objects that are not appropriate to the learning styles of students may have a negative impact on their learning [6]. For instance, students with a visual learning style mostly prefer visual presentations (pictures, diagrams, flow charts, movies, presentations), whereas those with verbal learning styles may prefer verbal explanations rather than visual representations [12; 13].

Learning Styles

Learning styles are the individual characteristics of students, which are reflected in their learning behaviours, such as how they learn, how they should be taught and how they interact in a learning environment [5; 25; 40; 41; 45]. Individuals may differ from each other in terms of processing, making sense and using information in new situations [13; 15; 20]. These differences play significant roles in both learning and teaching processes [21]. Each learning style contains different behavioural features that can be analysed and collected from the learning behaviour of a student [5].

Learning style models used in literature to determine the learning styles of students (e.g. [13; 17; 27; 38]) suggest different descriptions and classifications for learning styles of individuals [26]. Among them, in particular, the learning style model developed by Felder and Silverman (1988) are highly suitable for studies about learning styles in online courses, in which the information is presented by multimedia applications [4]. This model, which is highly referenced in the literature as an important conceptualiser of learning styles [40], can analyse the sizes of learning styles clearly according to a scale ranging between +11 and -11 [2]. For this study, this learning style model was used because learning objects were presented to students in an online environment. Felder and Silverman's learning style model [13] determines the learning style of an individual by scoring the nature and power of his/her learning preferences in four dimensions (perception, input, processing and understanding) [30]. The *perception* dimension describes the relationship of a student with the information type he/she prefers perceiving; the *processing* dimension describes the conversion pattern of the perceived information to understanding; the *input* dimension describes the preference pattern of the students to receive external information; and the *understanding* dimension describes the student' understanding processes [15]. Each of these dimensions contains two different student types that can make use of some specific learning approaches (perception, sensory/intuitive; processing, active/reflective; input, visual/auditory; understanding, sequential/global) [40].

In this study, it was assumed that the presentation of online learning objects that are suitable to the students' prominent learning styles rather than their additional learning styles may provide a greater contribution to their learning. In this context, relationships between the students' learning styles and their usage levels of learning were examined in the context of primary learning styles (PLS) [11; 29; 35; 39; 46]. "An empirically robust scale can measure not only one's primary learning style but additional styles with a tool to assess students' learning styles" [35]. Felder-Solomon Index of Learning-Styles (F-SILS), developed by Felder and Soloman (1994) is also included in these assessment tools [31]. PLS considered in this study were primary among all dimensions (interdimensional) of F-SILS.

Purpose of the study

The purpose of this study is to investigate the relationships between the primary learning styles of students and different learning objects presented simultaneously in an online learning environment in the context of the usage levels of these objects.

Relevant Studies

In recent years, studies conducted with the aim of personalising the online learning environments according to the students' individual needs and of determining their behaviours in these environments have considerable importance [2; 40; 16]. The majority of the studies (e.g., [1; 2; 6; 7; 8; 10; 15; 16; 24; 32; 34; 40; 43; 44; 47]) explored the relationships between learning styles and learning performances by using different learning environments/ materials and different learning style models (Table 1).

Table 1. Studies on the relationship between learning performance and learning styles

Resources	Purpose	Findings	Test Environment(s)	Learning Styles Analysed
Graf et al., 2009	They examined the relationships between the cognitive styles of students in an adaptive web-based educational environment and their working memory capacities and cognitive characteristics.	A relationship between the active/reflective, the sensory/intuitive and the visual/verbal dimensions was shown, but no relationship was found for the sequential/ global dimension.	Web-Based Educational Environments	Active/ reflective, visual/ verbal, sensory/ intuitive and sequential/ global [13]
De Boer, Kommers, and De Brock, 2011	They examined the relationship between the video viewing behaviours of the students as well as their personal characteristics such as learning styles and short-term memory.	There wasn't a primary relationship between the video viewing behaviours of the students and their current personal characteristics. However, the study found that some of the students changed their own video viewing behaviours based on their cognitive needs without causing any change in their test scores.	Instructional videos	Sequential and global [13]
Shaw, 2012	The researcher examined the relationships between the types of participants and learning styles on the education of programming language supported by an online forum.	The researcher found that learning styles and the types of participants are linked to learning outcomes and that learning satisfaction does not differentiate in a significant way by learning styles or the types of participants.	Online forum	Diverger, Assimilator, Converger and Accommodator [27]
Chen and Sun, 2012	They examined how multimedia materials affect the learning performances and feelings of the students with visual and verbal learning styles.	They concluded that video materials enable a better learning performance and a more positive feeling for those with verbal style whereas multimedia materials involving videos and animations are better than text and video materials for those with visual style.	Static text, picture and video-based and animation-based multimedia materials	Visual and verbal [13]

Ocepek et al., 2013	Researchers focused on designing adaptive learning system by relating combinations of different learning styles to preferred types of multimedia materials.	Students preferred well-structured learning texts with color discrimination, and the hemispheric learning style model was the most important criterion in deciding student preferences for different multimedia learning materials.	Animation and video- simulation and educational computer game-learning texts that have a color discrimination-well-structured learning materials-audio learning materials	Kolb's learning styles [27]
Kassim, 2013	The researcher examined the relationship between multimedia learning materials and the creative thinking and learning styles of students.	The researcher found that the use of multimedia learning tools has a positive impact on the creative thinking of the students with active, reflective, intuitive and high-degree visual styles.	Multimedia learning materials	Active, reflective, sensory, intuitive, sequential and global [13]
Mahazir et al., 2013	They focused on the relationship between the acceptance levels of technical high school students taking the Mobile AutoCAD course and their learning styles.	They found out that there is a positive and significant relationship between their acceptance levels of mobile learning and their learning styles.	Mobile learning AutoCAD course	Activist, reflective, theorist and pragmatist [18]
Feldman, Monteserin and Amandi, 2014	They suggested a new approach that can determine the sensory styles of the students by analyzing their interaction with the (puzzle games) games.	They concluded that the sensory style could be successfully estimated (with an accuracy rate of 85%) by means of the use of games.	Puzzle game	Sensory and intuitive [13]
Cheng, 2014	The researcher focused on the learning styles, behaviors and acceptances of the students towards the use of Second Life as a tool supporting the learning in higher education	While active students stated mostly that Second Life was helpful and easy-to-use, it was found that visual students are satisfied with its communication and identity properties.	Second Life	Active and visual [13]
Van Waes, Van Weijen and Leijten, 2014	They aim to investigate the effect of learning styles on the approaches of students to the writing process, and on the letters they wrote in an online environment.	They determined that reflective students were more focused than active students on the section of theory at the beginning of the task.	Online writing center	Active and reflective Kolb's learning styles [27].

Shinnick and Woo, 2014	They aimed to determine the effect of learning styles on knowledge acquisition of nursing students after using a simulated heart failure.	Whereas there was an increase in the knowledge acquisition of the students with assimilating and diverging learning styles, there was no increase in that of those with converging and accommodating styles.	Simulation	Diverging, assimilating, converging and accommodating [27]
Abdul-Rahman and Du Boulay, 2014	In programming education by means of worked-examples, they compared the active and reflective students in terms of their cognitive loads and successes.	They found that there was no difference between active and reflective students in terms of both their cognitive load and post-test performances.	Worked-examples	Active and reflective [13]
Chen and Wu, 2015	They examined the impacts of three instructional video formats on the performances of the visual and verbal students involving sustaining attention, feelings, cognitive load and learning.	They observed that verbal and visual students achieved a learning performance at the same level in three video formats (lecture capture, voice-over and picture-in-picture). The video format with voice-over was significantly better than that with picture-in-picture in terms of sustaining attention.	Instructional Video	Visual and verbal [13]
Lei et al., 2015	They examined the effects of the 100 Taiwanese fifth graders students' metacognitive strategies and verbal-imagery cognitive style on their video searches on YouTube.	Cognitive style (verbalizer and imager) could not effective on video search behaviors, search performance, and learning performance	Videos on YouTube	Visual and verbal [13]

Most of the studies shown in Table 1 (e.g. [1; 7; 8; 10; 15; 16; 24; 32; 34; 43; 44; 47]) examined the relationship between instructional materials and learning styles based on a single type of learning material, and furthermore the studies (e.g. [6; 40]) conducted on the preferences of students for multiple learning materials remained limited. Nevertheless, in these studies, the learning materials were presented to the students in different times or environments. However, it may be useful to take into account the preferences towards learning objects of students in studies aimed to investigate the relationship between learning styles and learning objects presented in online environments. In this regard, unlike the above-mentioned studies, this study attempted to find out which learning objects are frequently preferred by the students. For this reason, the learning objects with the same subject content were simultaneously presented to the students in an online learning environment.

Method

Design and Participants

In this study, the preferences of the participants towards online learning objects were analyzed in terms of their usage levels of learning objects. Therefore, the relational screening model among the general screening methods was preferred. The screening model is a research approach aiming to describe the situation existing as it is. Relational screening can be done in two ways as comparison or correlation [23]. In this study, comparative method is preferred. The participants were 103 sophomores (42 female and 61 male students with an average age of 21) of the Computer Education and Instructional Technology Department at Çanakkale Onsekiz Mart University in Turkey.

Research Questions

1. What is the distribution of all students participated in the study in terms of their preferred learning styles?

2. What is the distribution of the participants in the study according to PLSs?

3. Is there a significant difference between the usage levels of different learning objects (VL, PDFL, AL, SCT) presented simultaneously in an online environment by students with PLS?

Teaching Context

The study was performed with third-grade undergraduate students enrolled to the course of "Internet-Based Programming" in the Department of Computer and Instructional Technologies in Canakkale Onsekiz Mart University in Turkey. This course lectured in the first semester of the academic year of 2013-2014 consists of three units as "Fundamentals of Php", "Basic database operations with Mysql", and "Php-MySql Relationship". The data of this study were obtained in the weeks that the second unit was taught and the application process lasted for two weeks. The lecturer taught the first and third of these three units as face-to-face in the classroom. Students learned the second unit by studying with the four different learning objects. These learning objects are presented to students in the Moodle [37] learning environment without the support lecturer in a computer laboratory. They were free to choose what they want among this learning object. Prior to the application, the students were informed that there would be an achievement test on the relevant unit topics, which would affect the results of their final exams at a rate of 40%. The reason that the topics of relevant unit was taught via Moodle was to determine how frequently students used the learning objects. Log reports of Moodle were used to achieve this goal. The watching durations of the VLs uploaded to Moodle as SCORM package could be obtained temporally in its 2.6.2 release. Furthermore, click-through rates of PDFLs, the click/download rates of ALs and the trial quantities of the SCTs could be reported numerically.

Data Collection Tools

Felder and Silverman's Index of Learning Styles (F-SILS) developed by Felder and Soloman (1994) was used in order to determine the learning styles of the participants in the study. This index was adapted to Turkish by Samancı and Keskin (2007). The authors also performed the validity and reliability study.

Moodle Log Data and Learning Materials

In the study, PDF materials presented in Moodle environment were divided into single pages and adapted into SCORM packages. Thus, the number of hits to PDF pages by students could be obtained in this way. PDF materials were vocalized by the instructor of the course and uploaded to Moodle learning environment, and thus it was ensured that the students could follow the topic content with AL. Then, VLs with the same topic content was uploaded to Moodle as SCORM packages. At the end of each chapter, SCTs took place in order to see if the students comprehended the topics taught in that unit. Students were freed about applying or not applying these tests as well as the trial amount. Figure 1 indicates a class opened in the learning environment of Moodle and four different learning objects pertaining to each subject based on the learning preferences of the students in the class. Annex-1 presents the sample figures on these learning objects.

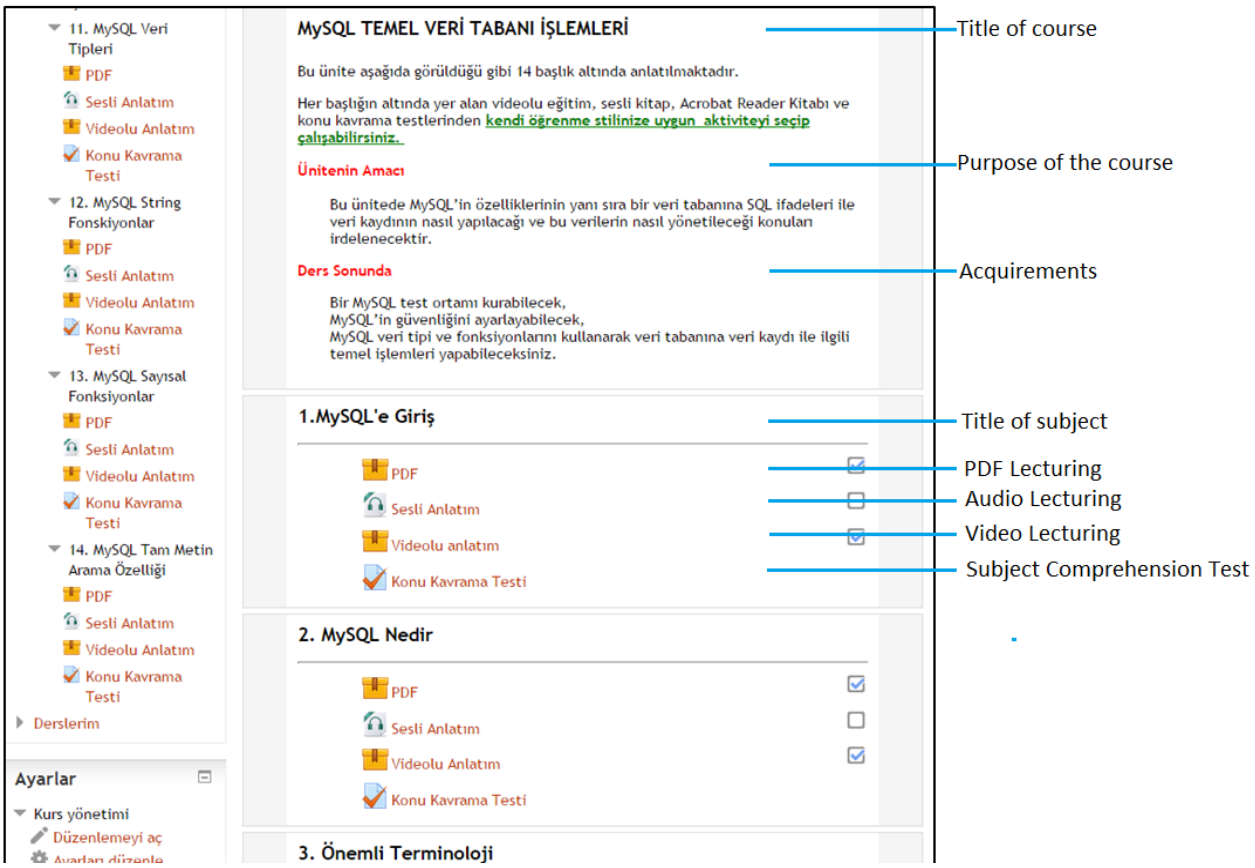

Figure 1. Online class opened in Moodle and four different type learning objects associated with each subject of the unit

In order to determine usage frequencies of students, the below-mentioned report outputs of the learning objects uploaded to Moodle learning system were used; Click-through rates of PDFL pages, Watching durations of VLs (minutes), Click/download rates of ALs and trial quantities for SCT. In order to be able to compare different data types of the report outputs with each other, these data were converted to standard scores.

Implementation Process

The implementation process lasted for two weeks. Prior to the application, F-SILS was applied in order to determine learning styles preferences of the students. Students have practiced the unit named "basic database operations with Mysql" for two weeks at the computer lab under the surveillance of the instructor, only on Moodle and by means of the different learning objects offered to their preferences simultaneously.

Data Analysis

SPSS was utilized for analysis of quantitative data. Descriptive analysis methods were used to determine the distribution of the participants according to their learning styles. In addition to this, independent-Samples T-Test and Mann-Whitney Wilcoxon test were used to test the differences between learning styles and online learning objects.

Implementation and analysis processes of the study are given in Figure 2 in a summary manner.

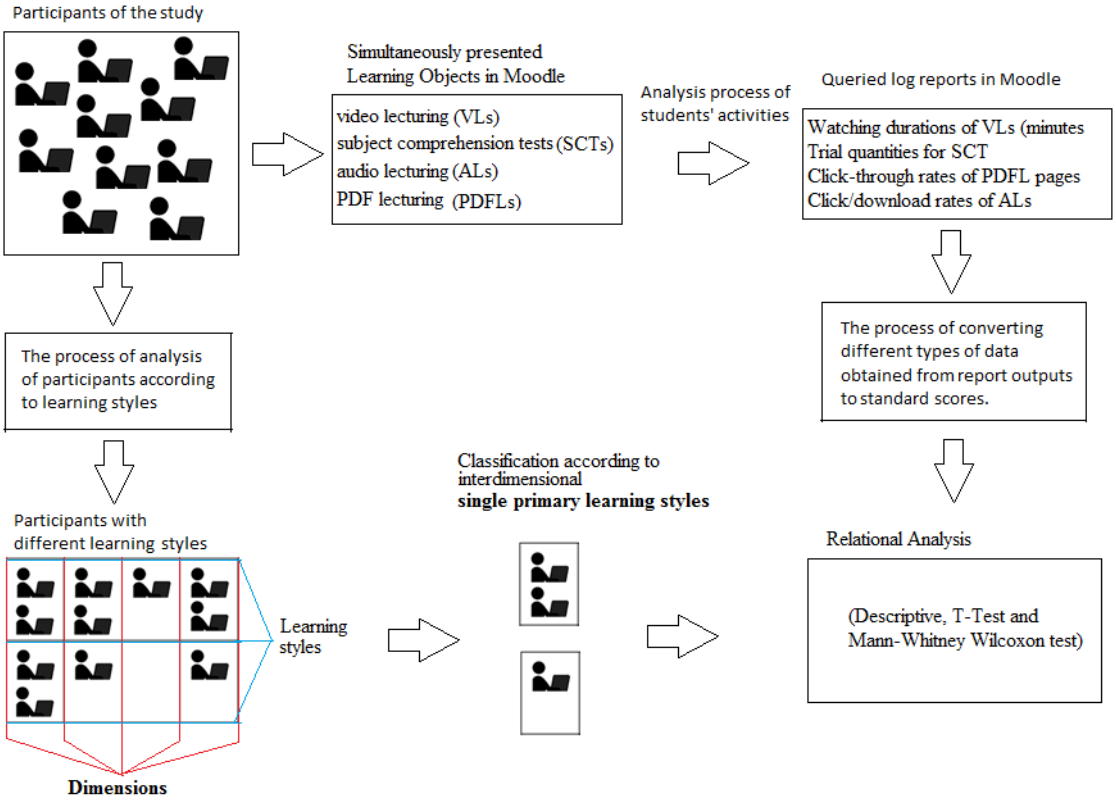

Figure 2. The implementation and analysis process of the study

Findings

What is the distribution of all students participated in the study in terms of their preferred learning styles?

There are 44 items, each of which has two different options, in the F-SILS. All of the four dimensions in the index are associated with a total of 11 statements; the "a" options refer to the active, sensory, visual or sequential pole of the relevant dimension whereas the "b" options refer to the reflective, intuitive, auditory or global pole of the relevant dimension [42]. Participants were asked to select the most appropriate option (a or b) for each of the items in F-SILS and evaluate themselves. Then, the selections were converted to the scores to be analyzed with the F-SILS Report (http://www.ncsu.edu/felder-public/ILSdir/ILS.pdf). Regarding the obtained scores, Felder and Solomon (1994) stated that 1 and 3 pointed out a balanced preference for both sides of dimension, 5 and 7 pointed out a moderate preference for one of the dimensions, and 9 and 11 pointed out a highly primary preference for one of the dimensions.

First, all of the participants were classified within only one of the styles among the dimensions stated in F-SILS (for e.g. "visual" learning style in input dimension). However, according to the Felder and Silverman's Learning Style Model [13], a student could also take place in one of two learning styles in other sub-dimensions [8] (Table 2), which means that the students may have characteristics of other learning styles as well. Accordingly, Table 2 indicates the distribution of all of the students participated in the study in terms of their learning styles.

Table 2. The distribution of all of the participates in terms of their preferred learning styles

F-SILS Dimension	Learning Style	Frequency	Percentage (%)
Perception	Sensory	63	60,19
	Intuitive	5	4,85
	Balanced on Both Style	35	34,95
	Total	103	100

Input	Visual		72	69,90
	Auditory		3	2,91
	Balanced on Both Style		28	27,18
		Total	103	100
Processing	Active		29	28,15
	Reflective		9	8,73
	Balanced on Both Style		65	63,10
		Total	103	100
Understanding	Sequential		34	33,00
	Global		11	10,67
	Balanced on Both Style		58	56,31
		Total	103	100

Table 2 shows that the mostly preferred learning style by participants is visual learning style (69.9%). This is followed by sensory (60.19%), sequential (33%) and global (10.67%) learning styles, respectively. According to that, most of the participants stated that they learned the most information when it was presented in visual formats such as images and diagrams. Auditory (2.91%), intuitive (4.85%), reflective (8.73%) and global (10.67%) learning styles are the least preferred styles by students. The distribution graph of all participates according to F-SILS dimensions is given in Figure 3.

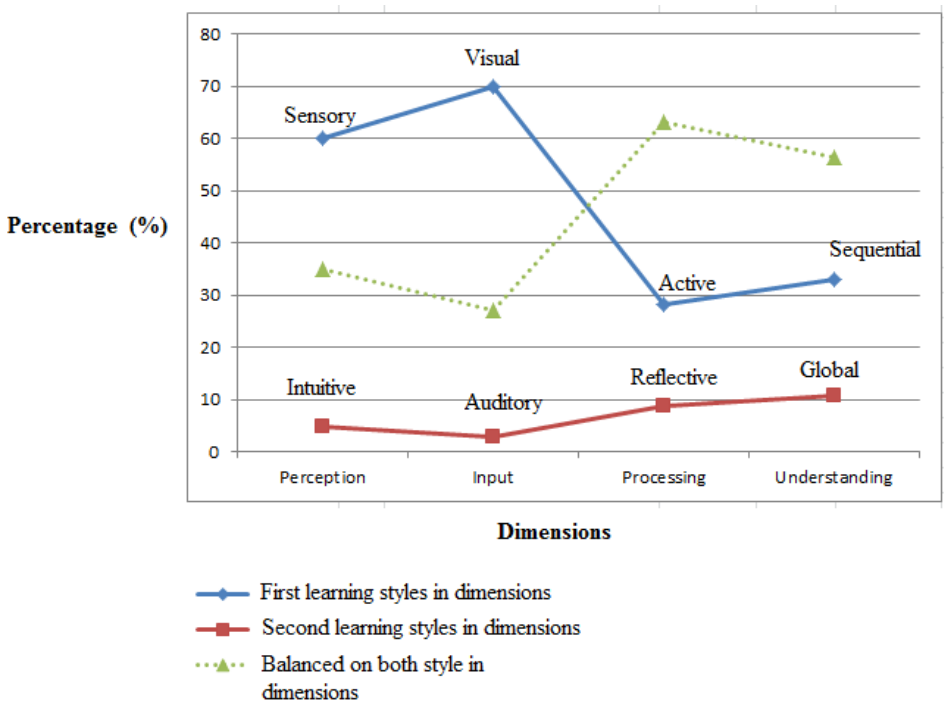

Figure 3. The distribution of all participates according to F-SILS Dimensions

What is the distribution of the participants in the study according to S-PLSs?

The data obtained on the usage levels of the online learning objects were analyzed in the context of interdimensional primary learning styles of students. In other words, when the students were being classified according to PLS, the highest score obtained in all sub-dimensions (interdimensional) in F-SILS was taken into consideration. In addition to this, just one primary, (hereinafter referred as Single-Primary or S-P) learning style was assigned for each student. For example, in Figure 4, one student's highest score is "11a" in all sub-dimensions. According to this, student' primary visual style is visual. Besides, any student may have more than one primary learning style. But, these students' data did not take place in analysis of this study. Namely they are excluded from the Single-Primary Learning Style (hereinafter S-PLS) class. This classification also allowed the creation of two independent learning style groups to perform relational analysis tests.

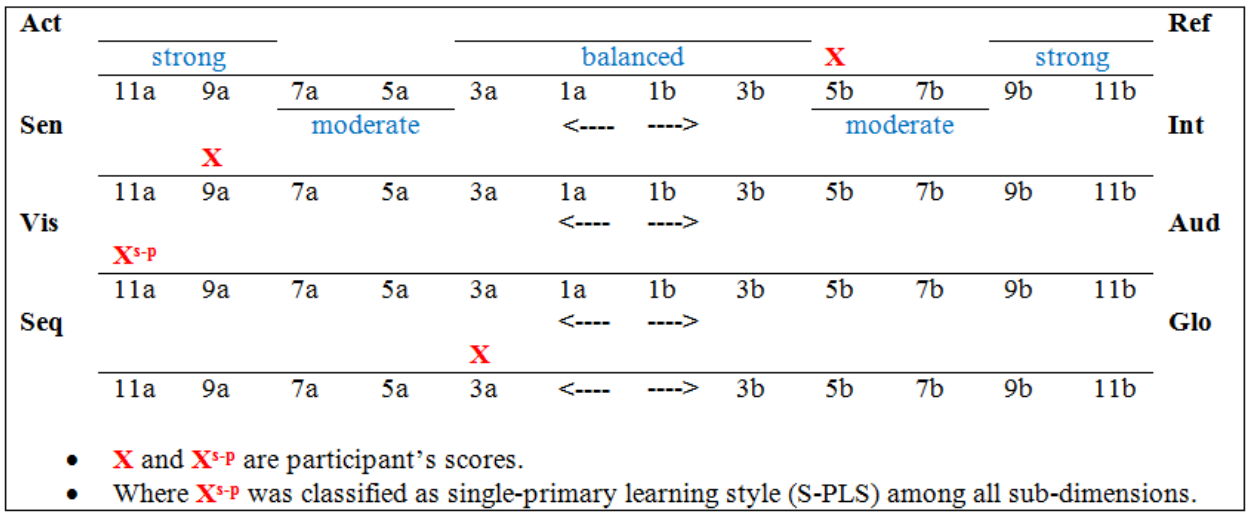

Figure 4. The F-SILS scale and the "Single-Primary Learning Style" classification approach used in study

Table 3 indicates the distribution of the participants according to their S-PLS. As it can be seen in the table, in the distribution according to S-PLSs of students, S-P visual style (34.95%) was in first order, whereas S-P sensory style (29.13%) was in second order. Since those with other S-PLSs have a small sample size and it is thought that it is not appropriate to generalize their analysis results to a larger universe, only the data of the students with S-P visual and S-P sensory styles on the second and third research questions were analyzed.

Table 3. The distribution of the participants according to S-PLSs

F-SILS Dimensions	S-PLS	Frequency	Percentage (%)
Perception	Sensory	30	29,13
	Intuitive	5	4,85
Input	Visual	36	34,95
	Auditory	0	0,00
Processing	Active	4	3,88
	Reflective	4	3,88
Understanding	Sequential	2	1,94
	Global	1	0,97
Balanced in one dimension or student has more than one primary style		21	20,39
	Total	**103**	**100**

Is there a significant difference between watching durations of VLs by students with S-PLS?

An independent-samples T-Test was performed in order to determine whether there is a significant difference between VL watching durations by students with S-P sensory and S-P visual styles (Table 4). Cohen d [9] statistics was used to calculate the effect size.

Table 4. The results of independent-Samples T-Test on the VL watching durations

PLS	N	$\bar{X}$	SD	t	P	d
Sensory	30	182.87	132.14	2.266	.028*	0.58
Visual	36	119.97	82.41			

* p<.05

As shown in Table 4, the difference between these two groups in terms of the watching durations of VLs was statistically significant (t(64)= 2.266, p<.05, d=0.58). Accordingly, it can be stated that the VL watching durations of the students with S-P sensory style (M=182.87, SD=132.14) were longer than that of those with S-P visual style (M=119.97, SD=82,41). Moreover, the difference between these two groups had a moderate effect size (Cohen's d=.58). Cohen's d values of 20, .50, .80 and 1.0 respectively refer to small, moderate, large and very large effect sizes.

Is there a significant difference between reading frequencies of PDFLs by students with S-PLS?

An independent-samples T-Test was performed in order to determine whether there is a significant difference between the reading frequencies of PDFLs of the students with S-P sensory and S-P visual styles (Table 5). According to the findings, there was no statistically significant difference between students with S-P sensory style (M=36.46, SD=25.12) and S-P visual style (M=32.35, SD=23.48) in terms of the reading frequencies of PDFLs (t (64)= 0.69, p>.05).

Table 5. The results of the independent-samples T-Test of the reading frequencies of PDFLs

PLS	N	$\bar{X}$	SD	t	p
Sensory	30	36.46	25.12	0.69	.5*
Visual	36	32.35	23.48		

* p>.05

Is there a significant difference between listening frequencies of ALs by students with S-PLS?

According to the results of the Shapiro-Wilk normal distribution test, data obtained from the listening frequency of ALs of the students with S-P sensory and S-P visual styles did not provide the normal distribution condition. For this reason, Mann-Whitney Wilcoxon test was performed for the analysis of the data (Table 6).

Table 6. The Results of U-Test on the listening frequency of ALs

PLS	N	Mean Rank	Sum of Ranks	U	p	r
Sensory	30	33.10	993.00	528.00	. 87	-.020
Visual	36	33.83	1218.00			

As it can be seen in Mann-Whitney Wilcoxon test results in Table 6, there was not a significant difference between students with S-P sensory style (Mdn=5) and S-P visual style (Mdn=1) in terms of the listening frequency of ALs (U=528.00, z= -0.167, p>.05, r= -.02).

Is there a significant difference between trial quantities of SCTs by students with PLS?

According to the results of Shapiro-Wilk Normality distribution test, the data on the trial quantities of SCTs of the students with S-P sensory and S-P visual styles did not show a normal distribution. For this reason, Mann-Whitney Wilcoxon test was performed for the analysis of the data (Table 7).

Table 7. The Results of U-Test on the trial quantities of SCTs

PLS	N	Mean Rank	Sum of Ranks	U	p	r
Sensory	30	39.18	1175.50	369.50	.025*	-.28
Visual	36	28.76	1035.50			

* p<.05

According to the results of Mann-Whitney Wilcoxon test in Table 7, there was a statistically difference between the two groups in terms of trial quantities of SCTs (U=369.50, z= -2.25, p<.05, r= -.28). Accordingly, it can be stated that the students with S-P sensory style (Mdn=11) utilized SCTs more frequently than those with S-P visual style (Mdn=4.5). Furthermore, the difference between the two groups can be considered to have an approximately moderate effect size (r= -.28).

Discussion and Conclusion

Majority of the studies in the literature investigated the relationships between instructional materials and learning styles based on a single type of learning material, whereas the studies conducted on the preferences of students for multiple learning materials remained limited. However, in studies on the relationship between the learning styles and learning objects, which are presented especially in online environments, it would be useful that students' preferences for these learning objects were taken into consideration. Therefore, in this study, four different learning objects with the same subject content were presented simultaneously to the students. Besides, the differences between the usage levels of these learning objects by the students with different learning styles were examined. In terms of all participants, the mostly preferred learning style was visual learning style, which was followed by sensory, sequential and global learning styles respectively. These findings are consistent with the findings of Cheng (2014) and Felder and Silverman (1988) reported that the students in college education had generally visual learning styles. Moreover, it is stated that sensory learning style is important due to its relation to the career preferences, skills, management styles and a variety of behavioral tendencies of the students particularly in higher education [15]. In this regard, it was concluded that the findings and interpretations in the study would be useful for the educators in the selection of learning objects to be presented to the students with these two styles (visual and sensory) during their university education.

In study, it was assumed that presentation of online learning objects which are suitable to the students' prominent learning styles rather than their additional learning styles may provide a greater contribution to their learning. In addition to this, by addressing the interdimensional prominent learning styles in learning styles models, it may be provided strong clues in relationships between learning objects and these learning styles. For this reason, the data on the usage levels of the learning objects were analyzed in the context of the S-PLSs. it is hoped that, S-PLS classification approach, which was presented in this study, will provide a contribution in the designing of the adaptive online learning environments in accordance with the various learning styles and learning objects. According to the findings of the study, the students with visual and sensory styles were in majority among the students with S-PLS (Table 3). Since it is believed that students with other learning styles in primary level were in a quite small sampling size and the generalization of the analysis results to a larger universe would not be appropriate, findings on the students with these S-PLS were not included in the analysis. Therefore, it can be said that there is need for further studies on the relationships between the learning objects and the other S-PLS which are not included in the study.

The results of the analysis indicated a significant difference between the watching times of VLs of the students with S-P visual style and those with S-P sensory style. Given the average of the two groups (Table 4), the students with S-P *sensory* style seem to spend more time on VLs than the students with S-P *visual* style in order to learn the subjects presented in online environment. According to Felder and Silverman (1988), sensory students may be careful but slow and are patient with detail but do not like complications. In this regard, that the students with S-P *sensory* style spent more time on VLs than those with S-P *visual* style learning style can be explained by the assumption that they may be careful and slow and might spend more time on the details of the subject. The reason that they spent more time on VLs may be that their desire to repeat the practices of the subject through VLs was higher than that of students with S-P *visual* style. The study revealed some promising results in providing a positive contribution to the learning outcomes of the students with two S-PLS (S-P sensory, S-P visual) most preferred by the students.

It is essential to plan and configure in-class activities and evaluation strategies by taking individual differences of students into consideration [42]. The awareness on the individual differences enables the educators (the teachers and instructional designers) to become more responsive to their teaching roles [21]. Online education environments provide prosperous

opportunities for the educators to find out these individual differences. Additionally, thanks to the developments in education technology, the learning objects structured based on students' individual differences can be quite important factors to reveal the their learning styles. Moreover "Adaptive hypermedia based on student learning styles provides the ability to individually tailor the presentation of course material to each student" [4].

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Annex-1

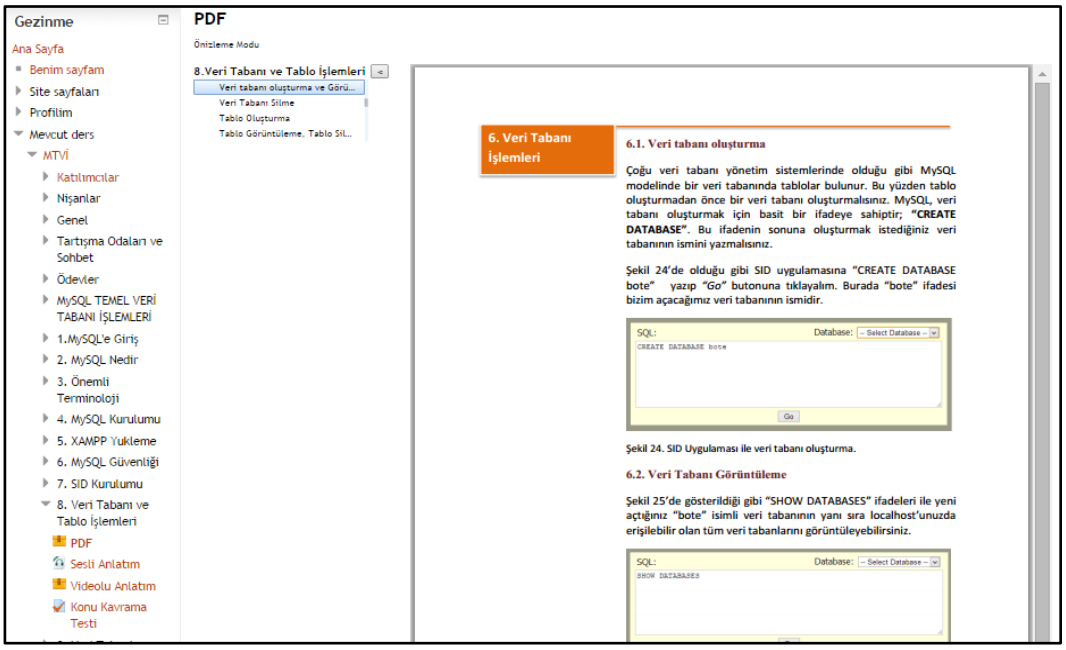

Figure 5. Example of PDF lecturing about a subject, which was uploaded to system by means of SCORM package.

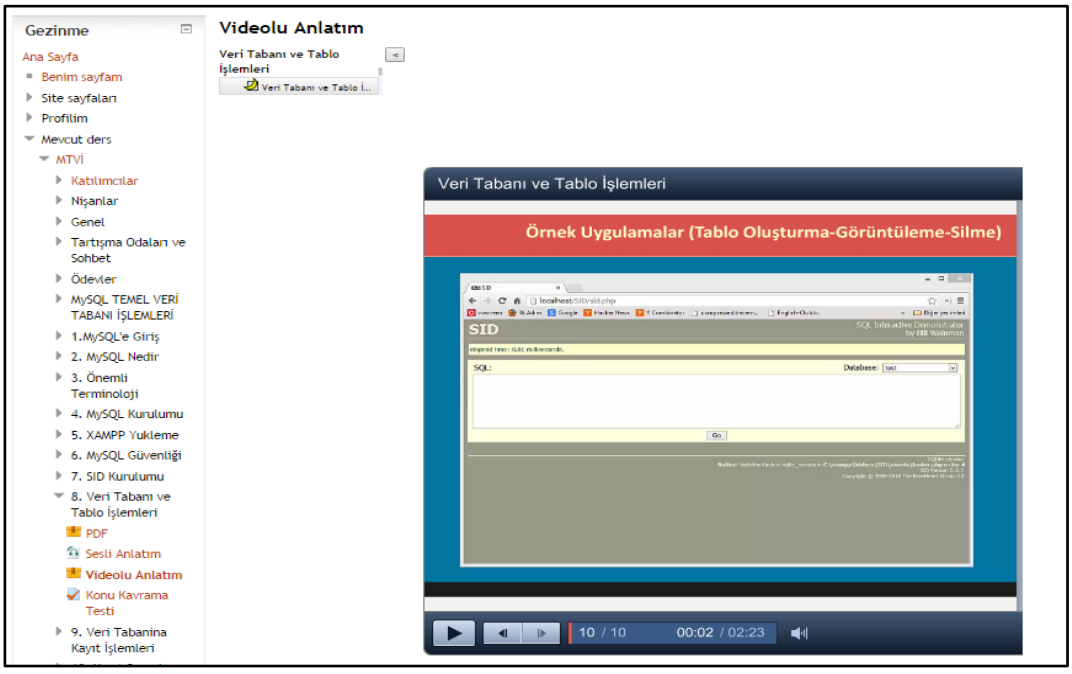

Figure 6. Example of video lecturing about a subject, which was uploaded to system by means of SCORM package.

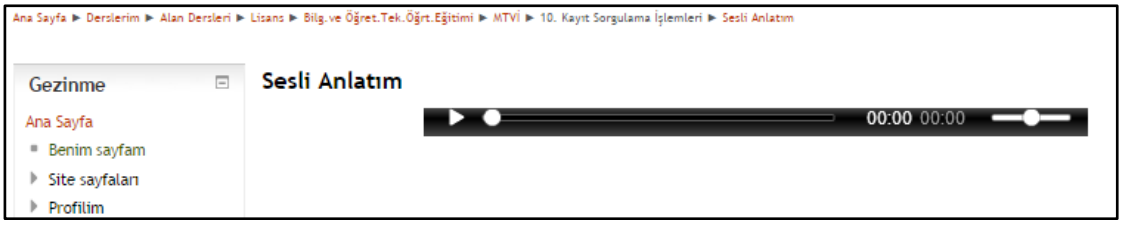

Figure 7. Example of audio lecturing about a subject

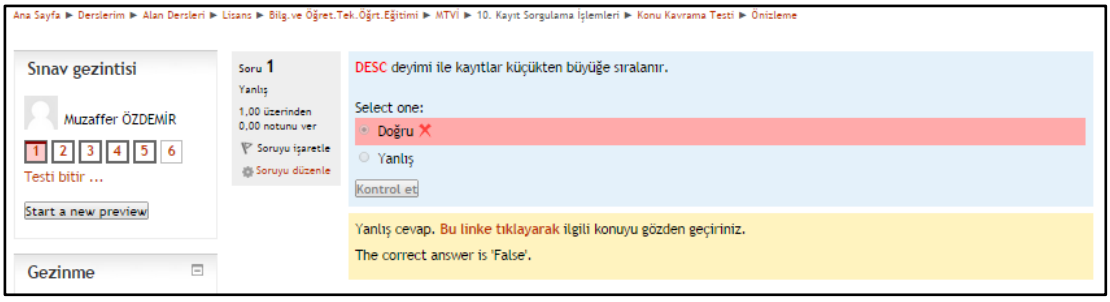

Figure 8. Comprehension test on a subject