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Integration into mathematics classrooms of an adaptive and intelligent individualized e-learning environment: Implementation and evaluation of UZWEBMAT

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ABSTRACT

The purpose of this study is to design an adaptive and intelligent individualized e-learning environment based on learning style and expert system named UZWEBMAT and to evaluate its effects on students' learning of the unit of probability. In the study, initially, learning objects were prepared in three different ways in relation to Visual–Auditory–Kinesthetic (VAK) learning style for each subject of the probability unit. These were appropriate for secondary school mathematics curricula. Then, they were transferred into the digital environment. Each student may follow a different course, and the solution supports s/he will get may also differ highlighting the individual learning. The sample of the study consists of 81 10th grade students from two high schools in Trabzon, Turkey. Qualitative and quantitative data were collected from students to answer research questions. Quantitative data were given as frequency distribution and percentages. Qualitative data were analyzed using qualitative data analysis methods. Results of the study indicated that opinions regarding UZWEBMAT are rather positive. Aiming at individual learning, UZWEBMAT provides the most appropriate environment for students. In addition, UZWEBMAT can be used as well to reinforce traditional classroom education.

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1. Introduction

Online education offers big and important opportunities to educators as well as students. The computer, which is a dynamic force in distance education thanks to internet and web and enables a new and interactive means of overcoming time and distance problems to reach learners, ranks first among these opportunities (Baki & Güveli, 2008; Baki & Çakiroglu, 2010; Botsios, Georgiou, & Safouris, 2008; Kim & Gilman, 2008; Wagschal, 1998; Wang, 2008). Traditional web based learning environments started to be criticized in terms of their limited aspect presenting the same content to each user under a predetermined roof (Berge, 2002; Brusilovsky, 2001). Traditional web based learning environments do not take into consideration certain different parameters such as students' learning differences, previous experiences and learning abilities. Due to this structure of traditional web based learning environment, many students cannot deal with online course requirements and take control of their learning (Berge, 2002; Picciano, 2001; Saba, 2002).

An adaptive learning system is usually a web-based application program that provides a personalized learning environment for each learner by adapting both the presentation and the wandering in content (Retalis & Papasalouros, 2005). Adaptive Educational Hypermedia Systems (AEHSs) refer to one of the approaches to adaptive learning. According to Brusilovsky (2001), Adaptive Hypermedia is an alternative to the traditional "one-size-fits-all" approach in the development of Hypermedia Systems. In a traditional web based learning environment, the same material is offered to students without taking into consideration students' pre-information, learning style or individual differences relating the topic. This is not something acceptable since individual differences, pre-information and the needs of students can be different. These differences may have an impact on their learning. Unlike traditional web based learning systems, AEHSs create a user model determining the individual differences of each student such as their knowledge levels about the topic, preferences and learning styles (Brown, Cristea, Stewart, & Brailsford, 2005; Brusilovsky, 2001; Brusilovsky & Peylo, 2003; Romero, Ventura, Zafra, & de Bra, 2009). These systems can be designed according to many parameters such as learning styles, learning speeds, needs and pre-information about the topic.

Learning process is complicated. People may learn differently (Franzoni & Assar, 2009). Many parameters such as perception of

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information by individual, his/her processing the information, learning styles, general abilities, developmental characteristics and environmental factors play a role during this process. Knowing learning styles' and designing and implementing learning activities in relation to these styles prove that many students, who used to be considered as having difficulty in learning, do not have difficulty in learning. In fact, when they are provided with appropriate environments and stimulants, they are capable of learning easily, too (Graf, Kinshuk, & Liu, 2009; Liegle & Janicki, 2006). In the broadest term, Learning Style (LS) can be defined as individual learning preferences and learning differences (Akkoyunlu & Soylu, 2008). Simplifying learning processes from complexity to simplicity is the underlying structure of LS theory. Some of the learning styles that are present in literature are Dunn and Dunn, Kolb, Felder and Silverman; Honey and Mumford and VAK (Visual–Auditory–Kinesthetic) (Akkoyunlu & Soylu, 2008; Brown, Brailsford, Fisher, & Moore, 2009; Franzoni & Assar, 2009; Graf et al., 2009). Many LSs were suggested in addition to the above-mentioned ones, and studies were conducted about them. VAK LS is a model that can be considered a basis among the said learning styles. This model appears as a LS that is based on individuals' seeing, hearing, touching and working with moving objects (Kainnen, 2009). VAK LS was designed by Sarasin (1998) and developed by Coffield, Moseley, Hall, and Ecclestone (2004). Learning styles are considered relevant for the adaptation process in the user model, and have been used as a basis for adaptation in AEHS (Brown et al., 2005; Georgiou & Makry, 2004; Karampiperis & Sampson, 2005; Manochehr, 2006; Mustafa & Sharif, 2011; Papanikolaou, Mabbott, Bull, & Grigoriadou, 2006).

1.1. Previous research

Recently, many researchers have attempted to design and develop individualized learning environments based on learning styles. Triantafillou, Pomportsis, and Georgiadou (2002) developed AES-CS. Witkin and Goodenough LS was employed in this system. Two different LSs, field dependent and field independent, were used in this system. Those who learn field dependently follow a course from general to specific while those who learn field independently follow a course from specific to general. Arthur was designed and developed by Gilbert and Han (1999). VAK LS model was taken as basis in this system, and visual-interactive, audial-voiced and text-writing based content was prepared and presented to the student. The system was developed in order to teach C++, a computer programming language. CS383 was developed by Carver, Howard, and Lane (1999). Felder–Silverman LS was employed in this system. The system was designed for "Computer Systems" course. Brown, Fisher, and Brailsford (2007) developed the system named DEUS. Felder–Silverman LS was taken as basis in this system. The system was prepared at primary school level to teach lifecycle and flowery plants subjects of biology course. eTeacher was developed by Schiaffino, Garcia, and Amandi (2008). Felder–Silverman LS was taken as basis in this system. This system was prepared in order to teach artificial intelligence course taught in the department of system engineering. iWeaver was developed by Wolf (2003). Based on Dunn & Dunn LS, this system employed the adaptive version of this style. This system was developed in order to teach Java programming course. It was enriched with style based media components and other learning instruments. Four different contents were prepared and presented according to the perceptions of individuals. ILASH was developed by Bajraktarevic, Hall, and Fullick (2003). Hsiao LS was employed in this system. This system was designed to teach "characteristics of waves" and "solar system" subjects of physics course. INSPIRE was developed by Grigoriadou, Papanikolaou, Kornilakis, and Magoulas (2001). Honey & Mumford LS was employed in this system. WHURLE-LS is built upon on WHURLE system developed by Moore, Stewart, Zakaria, and Brailsford (2003). Based on Felder–Silverman LS, this system presented visual/oral contents to students. The system was designed and applied at Nottingham University Department of Computer Sciences and IT to teach internet and www (Brown, 2007). Mustafa and Sharif (2011) developed AEHS-LS, which employed VARK (visual–auditory–read/write–kinesthetic) LS. This system was intended to teach JavaScript.

There is a lack of rigorous user evaluation in adaptive systems in the published literature. Studies tend to be fairly small in terms of sample sizes, and statistical measures of significance are rarely used (Brown et al., 2009; Mustafa & Sharif, 2011). There are no comprehensive studies for many of the systems. It is possible to encounter with comprehensive evaluation studies about this limited number of systems. Of these systems, detailed qualitative and quantitative data were obtained relating WHURLE-LS. Findings derived from quantitative data indicate that there is no significant difference between content presentation according to learning styles and the student success. The findings obtained from qualitative data show that the system was positively evaluated by the students and they liked the content presented according to learning styles (Brown, Brailsford, Fisher, & Moore, 2009; Mustafa & Sharif, 2011). Quantitative data were obtained for evaluation of DEUS system. At the end of data analysis, no statistical difference was found between content presentation according to learning styles and achievements of students (Brown, 2007). A detailed study was conducted to evaluate AEHS-LS system. Results of the study indicated that LS based learning environments positively influenced academic achievements of students (Mustafa & Sharif, 2011).

There are many studies that show the use of adaptive educational hypermedia based on learning style in teaching or learning especially for higher education (Brown, 2007; Brown, Brailsford, Fisher, & Moore, 2009; Carver et al., 1999; Gilbert & Han, 1999; Moore, Stewart, Zakaria, & Brailsford, 2003; Mustafa & Sharif, 2011; Wolf, 2003). However, a small number of studies have been conducted in high school classrooms (Brown et al., 2009; Mustafa & Sharif, 2011). It is seen that these studies are mostly about computer sciences courses (Akbulut & Cardak, 2012; Brown, Brailsford, Fisher, & Moore, 2009). From the perspective of academic level and subject, there is almost no study on secondary school mathematics subjects. In this sense, this study is expected to fill this gap in the literature. In this sense, an individualized e-learning environment named UZWEBMAT, which can be adapted by means of LS and expert system to teach the unit of probability for the 10th grade mathematics course, was designed and developed. Permutation–combination–binomial expansion and probability subjects, which are sub-topics of the unit of probability, form the content of UZWEBMAT. UZWEBMAT is an example of AEHS based on VAK LS. There are various studies in the literature indicating the difficulties encountered in teaching–learning the probability unit subjects (Fast, 2001; Gürbüz & Birgin, 2012; Kafoussi, 2004; Munisamy & Doraisamy, 1998). The lectures given in teacher centered environments, lack of appropriate educational materials, negative attitude of learners towards probability subject, and the fact that some teachers do not use effective and efficient teaching methods while teaching these subjects are some of the predominant difficulties encountered (Fast, 2001; Gürbüz, 2010; Gürbüz & Birgin, 2012; Manage & Scariano, 2010; Memnun, 2008). Such problems and other similar deficiencies make it necessary to develop and implement appropriate materials and e-learning systems to teach and learn related subjects and evaluate the results. In this sense, concretization and presentation of these subjects to learners and creating enriched learning environments to eradicate negative learner attitudes are of much importance. Main reason for selecting VAK learning style for UZWEBMAT system is that it is the most appropriate learning style for structural characteristics of the sub-

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jects constituting the content. It was considered that VAK learning style could concretize probability unit subjects in the best possible way. In addition, sub-learning areas of VAK learning styles contain the most basic form of learning style preferences. Thus, it is thought that this learning style is appropriate for designing the LOs prepared in computer environment in the most efficient way. Besides, VAK learning style is the most basic form of other learning styles. All these reasons led to adoption of VAK learning style.

Constructivist learning approach was taken as basis while creating the content of UZWEBMAT. UZWEBMAT is a student based e-learning environment. UZWEBMAT's innovations and characteristics which distinguish it from other systems can be listed as follows:

- *Content in compliance with constructivist approach*. The most distinctive feature of LOs constituting the content of UZWEBMAT system is that they were prepared in accordance with constructivist approach. All LOs were designed in such a way that learners could construct their own knowledge. The information intended to be taught to learners is not given directly. On the contrary, there are elements in LOs which allow learners to construct their own knowledge. These elements are graphic reading, filling the table and discovering the relations.
- *Innovative adaptation*. Adaptation structure in UZWEBMAT system dynamically functions based on learner performance. There are three different contents for each area of VAK learning style. If necessary, each learner is directed to secondary and tertiary learning styles at some certain decision points while s/he is taking the content of his/her primary learning style. This guidance totally depends on learner performance.
- *Intelligent solution supports*. LOs in UZWEBMAT are enriched with solution supports and tips. Solution supports and tips in LOs may change depending on the learner performance. Any of the two learners with the same learning style may encounter with different contents in accordance with their individual performances.
- *On-line and on-live visualization*. All learner activities in UZWEBMAT are monitored and recorded automatically. These activities may be listed as the current LO which learner is studying, study time, study duration, the information about guidance between different learning areas, and successful or unsuccessful completion of LOs. All these activities are reported to teacher on teacher monitoring page as a whole.

2. An adaptive and intelligent individualized e-learning environment: UZWEBMAT

Basic system architecture and content of UZWEBMAT are explained in this section.

2.1. Basic architecture of the UZWEBMAT

Basic architecture of UZWEBMAT system is explained in this section. Fig. 1 shows this architecture.

2.2. Content and expert system structure used in the UZWEBMAT

Content of UZWEBMAT comprises permutation–combination–binomial expantion and probability subjects. 53 scenarios were produced in order to teach related subjects according to the 10th grade mathematics curricula. These scenarios were transferred into digital environment as different learning objects for each sub-style of VAK LS. Main purpose of the system is to enable learners to study in accordance with their dominant learning area. To this end, the most appropriate learning objects for their dominant learning area were tried to be ensured for the interaction. Therefore, learners did not waste time with elements outside their dominant learning area, and the easiest and the most comfortable environment was tried to be created for them. Thus, LOs were designed separately for each sub-learning style. While preparing learning objects, special attention was paid to learning objects taking into consideration the characteristics of each sub LS for them to have the most appropriate structure in relation to this style. For example, figures, flow charts, pictures and animations stood out for those learning visually. Voiced instructions, warnings and feedbacks stood out for those learning audibly. Similarly, learning objects were prepared using interactive animations for those learning kinesthetically. In addition, environments which would enable students to learn by experience were created for kinesthetic learners. Since 53 Learning Objects (LO) were designed for each sub-style, $53 \times 3 = 159$ LOs were used in total within UZWEBMAT. Another point kept in mind while preparing the content forming the LOs was that these LOs should be appropriate for constructivist approach. Thus, LOs provide environments in which students can construct their own knowledge instead of directly giving information to the students. From this aspect, UZWEBMAT provides its users with constructivist environment as well as individual learning.

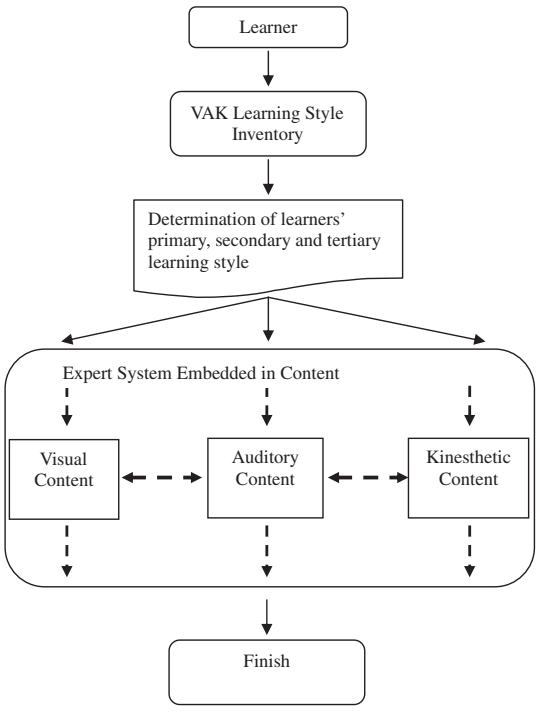

Fig. 1. Architecture of UZWEBMAT.

Contents are carefully prepared by field experts from Karadeniz Technical University, Fatih Faculty of Education. An expert system was created and integrated into content while preparing the content. This expert system has several functions, which can be listed as follows:

- Presenting the content within UZWEBMAT to the student.
- Controlling the progress of students within LOs.
- Deciding the content and solution support that students will get according to learning ability and answers of students within LO.
- Deciding on the situations in which students will be directed to the pages of other styles after obtaining the content of his/her own LS.

Thanks to above mentioned characteristics of expert system; it is possible for students with the same LS to follow different courses

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by getting different solution supports within UZWEBMAT. Therefore, educational needs of each student to progress within UZWEBMAT are taken into consideration. Thereby, highest level of individualization is tried to be achieved.

The student registering to the system takes Learning Style Inventory (LSI) first. LSI was used in order to determine the learning styles of students. At the end of literature review, we encountered many LSIs appropriate for VAK learning styles. Five point Likert type scale developed by Gökdağ (2004) was employed in the study. Cronbach Alpha reliability coefficient of the scale, which divides students into three that are visual, auditory and kinesthetic, was found as 0.74 (Gökdağ, 2004). Credibility and validity studies of the scale were conducted by Gökdağ (2004). This LSI was integrated into UZWEBMAT. The scale would not make a wrong decision about learner's learning style except from the possibility that the learner could think wrong about himself/herself. However, if that is the case, general architecture of the system will bring a solution to this problem. That is, the secondary and tertiary learning styles of learner are decided as well as his/her dominant/primary learning style. In this respect, learner is studying with the content of his/her dominant learning style. However, s/he is also directed/guided to the contents of his/her secondary or tertiary learning style. Thus, learner interaction with the content in all learning styles is ensured. This means that system directs/guides learner to the most appropriate content even if s/he is not taking the proper content.

A student who logs in UZWEBMAT encounters this LSI as a beginning. LSs of the students are determined at the end of this process. In addition to primary LS of the student, secondary and tertiary LSs are determined and recorded in the database as well. The student whose primary LS is determined is straightly directed to the content of his/her own LS automatically. Each step and progress of the student within the system is recorded. The student who takes the content of his/her own LS takes the LOs of this content and studies them. If the student cannot complete LO of his/her own LS, s/he is directed to the same LO of his/her secondary LS. The student who takes and completes LO of his/her secondary LS is returned to the content of his/her primary LS and continues with the next LO. A student who fails to complete LO of his/her secondary LS is directed to LO of his/her tertiary LS. The student who takes LO of his/her tertiary LS is returned to the content of his primary LS on condition that s/he successfully completes that LO and continues with the next LO of his/her primary LS. A student who fails in LO of his/her tertiary LS is recorded and reported to the teacher. The student who is reported to the teacher is returned to the content of his/her primary LS and continues with the next LO. A student who completes successfully LO of his/her primary/secondary/tertiary LS is automatically directed to next LO in the primary LS by the system. In addition to students who fail in activities, the courses that students who are directed to other LOs in their secondary and tertiary LSs took are recorded as well. A learner who fails in LO of a learning style makes adequate repetition about the related subject already before being directed/guided to LO of secondary/tertiary learning style. Elements like solution supports and tips in LO of secondary/tertiary learning style totally differ from the ones in other LO. Thus, it is tried to introduce different perspectives to learners regarding the same subject via different tips and solution supports. Fig. 2 shows the architecture of a student who is directed to different LOs of different styles by the system while advancing within UZWEBMAT. As a necessity of this structure, individual learning is prominent within UZWEBMAT, and different learning instruments are provided to individuals according to parameters such as their learning ability and needs.

The direction is not conducted only between learning styles in the UZWEBMAT. Learning objects are adaptive also within themselves. Expert system, which was used in the design of UZWEBMAT and integrated into content, decides on various directions within learning objects. Therefore, students working on the same LO may encounter different questions and solution supports according to their learning abilities within this object. Thus, it may be necessary for students in the same style to deal with different points. This brings the individual learning on account of individual directions within UZWEBMAT to the highest level. Fig. 3 shows the structure of a learning object used within UZWEBMAT. The same structure is present in all of the learning objects; however, the number of questions, solution supports and methods in these objects may vary.

Fig. 3 shows presentation plan of a learning object used in UZWEBMAT selected as a sample. It shows the presentation plan of the 12th LO prepared in order to teach circular permutation. There are a total of five questions in this LO. The student encounters with the third question within this LO. S/he will complete

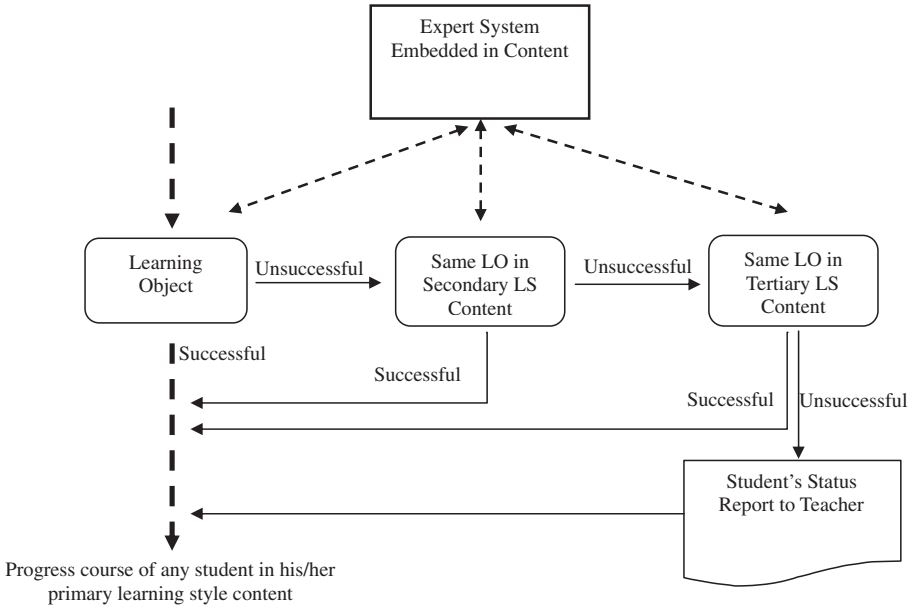

Fig. 2. Expert system supported direction architecture within UZWEBMAT.

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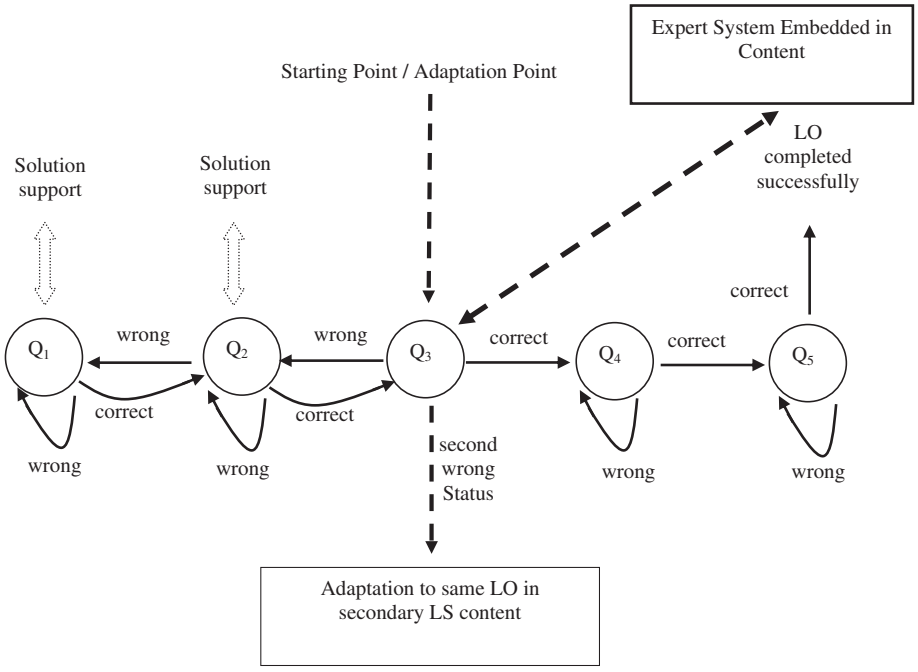

Fig. 3. Structure and function of expert system in a sample LO.

the LO on condition that s/he correctly answers the fourth and fifth questions respectively. Then s/he will be directed to the next LO. The student who fails to answer the third question correctly for the first time will be directed to the easier second question. S/he will be made to return to the first question on condition that s/he answers this question correctly. Solution support is provided to the student giving a wrong answer to the second question. If s/he fails to answer this question correctly one more time, s/he will be directed to the first question. The student who will get solution support for the first question will get enough solution support to answer this question. The student will be returned to the second question upon correctly answering this question in accordance with the same reason. S/he will be directed to the third question upon correctly answering the second question. Since it is the third question which is the introduction question of this LO, this question is accepted as the direction point for expert system. If the student fails to correctly answer the third question for the second time, s/he will be directed to LO of his/her secondary LS automatically.

2.3. A sample LO used in UZWEBMAT

In this section, screen shots of LOs from different styles that form the content of UZWEBMAT are given. Table 1 show the presentation plan and scenario of LO developed to teach counting through multiplication that is one of the subjects of permutation.

Table 1 shows LO scenario prepared for counting through multiplication and its presentation plan. There are five questions in this LO in total. First question is fixed as the introduction question and adaptation point. The student initially takes the first question and is directed either to the third or second question according to the answers given to the first question. If the student correctly answers the third question, s/he will be directed to the next question. Different solution supports are given to the student who fails to correctly answer the third, fourth and fifth questions. If student is directed to the second question, s/he gets solution support according to the answers s/he gives to this question and can be made to return to the first question. If student fails to correctly answer again, s/he will be directed to the same LO of his/her secondary LS automatically by the system. On condition that the student completes the LO of his/her secondary LS, s/he will be directed to the next LO of his/her primary LS. The student who fails with the LO of his/her secondary style will be directed to the same LO of his/her tertiary style. If student succeeds in the content of tertiary style, s/he will be directed to the next LO of his/her primary LS. The situation of student who fails also in his/her tertiary style is recorded by the system and reported to the teacher. After reporting, the student continues with his/her next LO of his/her primary LS.

Figs. 4 and 5 sample shows screen shots from this LO for visual and kinesthetic learning styles respectively. Since auditory LS content comprises voiced feedbacks solution and supported voiced instructions for all LOs, no screen shots can be used in relation to this style.

Fig. 4 shows a screen shot of LO developed for visual LS. In this LO, the student is asked to tell how many passwords s/he can write using numbers 1–4 once. If student fails to give the right answer twice, animation in Fig. 4 will be functioned step by step. By taking solution support in this way, the student will see all the possible passwords that can be written with numbers 1–4. S/he will construct his/her knowledge accordingly. This animation shows numbers that can be put in each digit using 1–4. It is shown that four numbers can be put into first digit using only one of 1–4. One of the rest three numbers can be put in the second digit. Similarly, the rest two numbers can be put in the last two digits. Finally, it is shown that four, three and two numbers can be put in digits respectively. Thus, the numbers that can be put in each digit and their count are listed in animation. Next to it, all the possible passwords that can be made up of these numbers are listed. Thanks to this animation, the student is able to see all the possible three digit passwords using 1–4. While creating the passwords, a particular attention was paid to usage of each number. General characteristics of a visual learner address to picture, schemes and flow diagrams. In accordance with that, related sample contains a scheme displaying all the possible passwords which is watched step by step by the learner. In addition, all the feedbacks that learners get in reply to their answers are visual, too. Thus, learners

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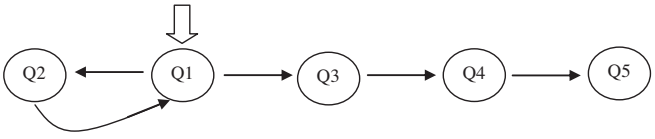
Table 1
LO scenario prepared for counting through multiplication and its presentation plan.

Pelin always complains that her brother Fikret uses her computer. One day, she learns that she can create a password in the computer and one cannot log in unless entering the right password. She goes to her computer to create the password and she configures a three-digit password. When Fikret wants to startup the computer, he sees that there is a password and wants help from his mother. Their mother says that the children should deal with it immediately. Pelin says she cannot give the password; however, she can give small tips for him to guess the password. Accordingly:

Q2. Pelin uses the numbers 1–3 while creating the password. How many different passwords can Pelin create?
Q1. Pelin uses the numbers 1–4 while creating the password. How many different passwords can Pelin create?
Q3. Pelin creates the password using the numbers 1–4, and she uses each number once. According to this, how many different passwords can Pelin create?
Q4. Pelin creates the password using 1–4, and it is a number larger than 300. According to this, how many different passwords can Pelin create?
Q5. If Pelin were to create the password using numbers 0–4 and used the numbers once, how many different passwords could she create?

Starting Point / Adaptation Point



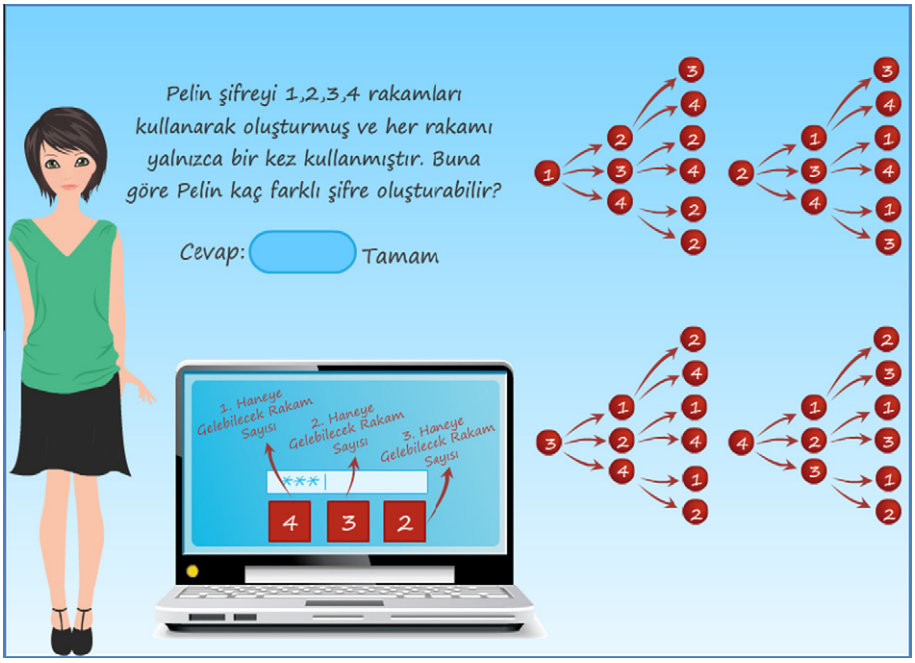


Fig. 4. Sample animation screen shot of LO prepared for visual learning style in case of failing to correctly answer the third question.

interact with visual elements. This structure is used in all learning objects of visual learning style.

Fig. 5 shows the sample screen shot of the same LO prepared according to kinesthetic LS. This screen shot displays the solution support given to the student failing in the same question. Screen shot of the version of the animation in the solution support given to the student failing to give correct answer to the third question which was worked on for a particular period time is given in the Fig. 5.

Upon completion of this animation, the student will see the number of each digit by dragging the numbers given on the screen. Here, the aim is to give prominence to characteristics of kinesthetic learning style. In other words, the purpose is to enable the student to learn by experience as if playing a game and using animations.

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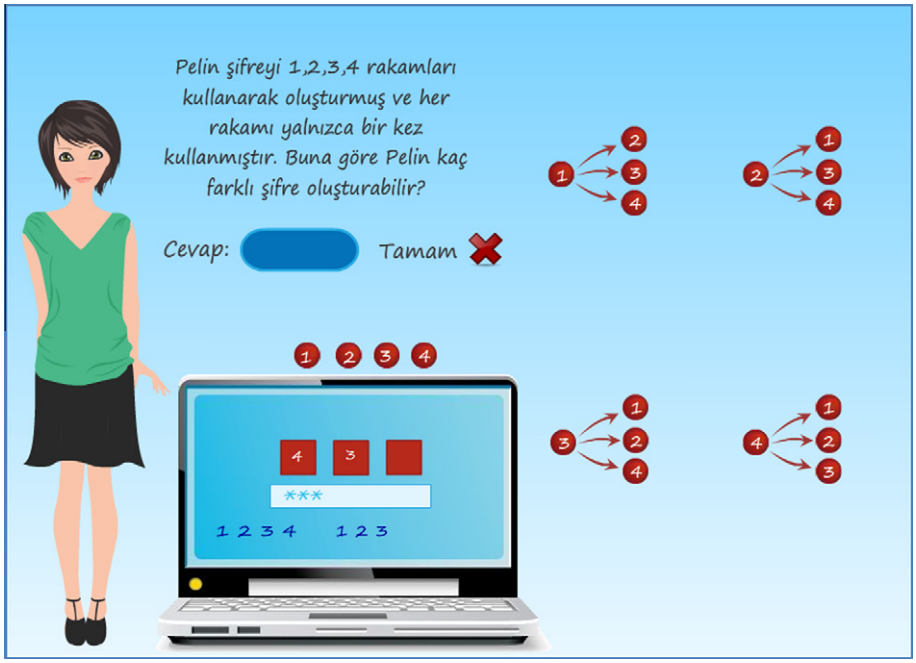

Fig. 5. Sample animation image of the LO prepared for kinesthetic learning style in the case of failing to answer the third question.

The student can drag the numbers to cells by means of drag-and-drop in order to find the numbers that should be placed in each digit. Thus, s/he is able to see which numbers are present in which digits. As the numbers for initial digits are determined, tree structure displaying all the possible passwords appears. Thanks to this solution support, the student will be able to create all the passwords that can be figured out from 1–4 and construct his/her knowledge. General characteristics of a kinesthetic learner address to motion elements which creates sense of touching like motion pictures and drag-and-drop objects. In parallel with that, related sample contains an activity which enables learner to drag-and-drop numbers to be put in digits. Thus, learner interacts with numbers while finding the appropriate passwords. As the learner drags and drops the numbers to be written in digits, a motion scheme displaying all the possible passwords is played step by step. Thus, learner interacts with tactile elements. This structure is used in all learning objects of kinesthetic learning style.

3. Research method

The purpose of this is study to design, implement and evaluate a learning style and expert system based on adaptive and intelligent individualized e-learning environment called UZWEBMAT. In this sense, the study can be examined in four steps: design, development, implementation and evaluation. In the study, initially, a system called UZWEBMAT was designed and developed. Developed system was implemented in real class environment and evaluated. The convenience sampling method was used, as random sampling was not convenient for this research (Fraenkel & Wallen, 2006). That is, users were selected in terms of their availability. This is a case study. Main research questions of the study are as follows:

- How did the students evaluate the UZWEBMAT?
- What were students' attitudes and views towards the UZWEBMAT?

The sample of this study was 81 students at 10th grade. The study was conducted during spring semester of the academic year 2010–2011 at three different classrooms in two high schools in Trabzon, Turkey. Quantitative and qualitative data were gathered from participants in order to answer the research questions.

3.1. Procedure

UZWEBMAT system was designed and developed in the first place. A content comprising permutation–combination–binomial expantion and probability subjects of the 10th grade was developed and integrated into UZWEBMAT. Before its implementation, UZWEBMAT system was introduced to students. Later, this system was applied in two different high schools for the 10th grade mathematics course in Trabzon, Turkey. In one of the high schools, two different classes of two different teachers were chosen, while in the other high school just one class of one teacher was chosen. During the application, all students were lectured in a computer laboratory with UZWEBMAT under the observation of three mathematics teachers and two researchers. The study lasted for 8 weeks in total. The students studied in computer laboratories for 32 h in total, that is to say, 4 h per week. This study schedule is given in Table 2.

3.2. Instruments

"Student Scale for Evaluation of UZWEBMAT in terms of Learning" was used as quantitative data collection tool. This scale was prepared according to Likert type. The scale comprises 13 items. Scales used for evaluation of adaptive and intelligent web based

Table 2
Distribution of 53 LOs which form the content of UZWEBMAT according to subjects and weeks.

Subject	LOs	Date	Total duration (h)
Permutation	Between 1 and 16	1st Week 2nd Week	8
Combination	Between 17 and 27	3rd Week 4th Week	8
Binomial expansion	Between 28 and 31	5th week	4
Probability	Between 32 and 53	6th Week 7th Week 8th Week	12

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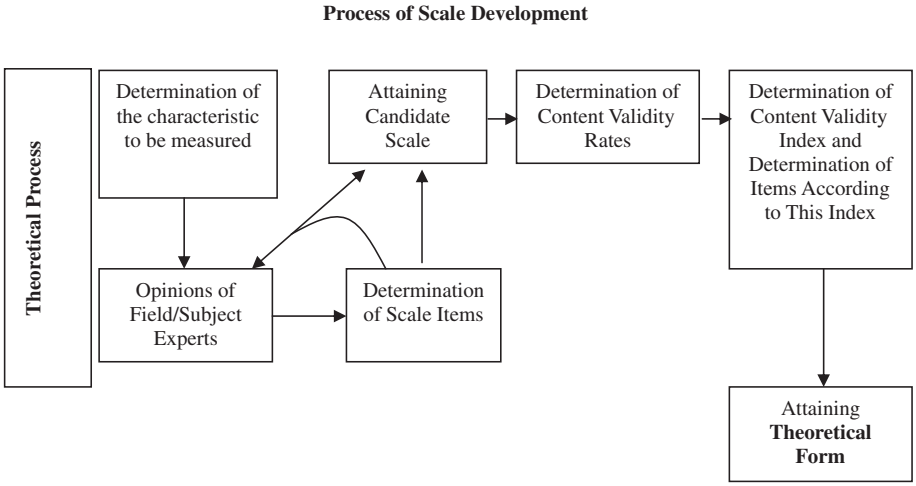

Fig. 6. Scheme of theoretical form used during the process of development of the scale.

learning environments in literature were utilized during the development process of this scale (Brown, 2007; Keleş, 2007; Mustafa & Sharif, 2011).

3.2.1. Development of scales

Development phases are usually conducted in experimental or theoretical processes during development process of the scale (Yurdugül, 2005). Since sample of pilot study comprised 81 students, it was not possible to follow the experimental process during the development of the scale. Therefore, the scale was developed according to theoretical process. Expert opinions were taken during the development phase of the scale. Operation steps of theoretical process used for development of scale were schemed by Yurdugül (2005) as seen in the Fig. 6.

Scale form was filled by researchers in the first place for the development of scale. Support was received from Department of Turkish Education in Fatih Faculty of Education of Karadeniz Technical University while writing the items of this scale. Developed Likert type scale with 5 choices comprises 14 items. They were graded as follows: "1. I strongly disagree", "2. I do not agree", "3. I am not sure", "4. I agree" and "I strongly agree".

Next phase of theoretical development of scale is determination of content validity (Yurdugül, 2005; Çakıroğlu, Güven, & Akkan, 2008). Operations below were conducted in this sense to develop theoretical scale form.

- Initially, field expert group of the study was formed. The group comprises 6 professors working in the Department of Teaching Computer and Education Technologies and Secondary School Science and Mathematics Department of Mathematics Education from KTU Fatih Educational Faculty and 8 postgraduate students studying in the same university in the department of mathematics education. These students particularly study in relation to computer and web supported education.
- Candidate scale forms comprising 14 items were prepared according to literature review and expert opinions. Experts were asked to make necessary arrangements on the items for them to be understood more clearly. These arrangements were taken into account and final versions of scale items were determined. Experts were asked to test capability of items constituting the scale in terms of meeting the factor which was intended to be measured. According to expert evaluations, all 14 items constituting the scale met the factor intended to be measured. In order to obtain Content Validity Rates (CVR) of items constituting the scale and Content Validity Index (CVI) to be obtained from these rates, Evaluation statements like "Necessary", "Beneficial but Inadequate" and "Unnecessary" were made. Experts performed the necessary grading for each item.
- All the forms filled by experts were collected and total points given to each item were calculated.
- CVR value of each item making up the scale is expressed as follows (Yurdagül, 2005):

$$CVR = \frac{N_N}{N/2} - 1 \quad (1)$$

N_N = the number of experts saying "necessary" for the item and N = the number of total experts evaluating the scale.

For 14 experts, minimum value of CVR was calculated as .51 by Veneziano and Hooper (1997) on the significance level of $\alpha = 0.05$. Since CVR values of all items in the scale comprising 14 items were bigger than .51, no item was considered to be excluded.

- After the calculation of CVR values, arithmetical mean of CVR values of each item was calculated, and CVI value of the scale was calculated. This value was calculated as .75. Since CVI value of the scale was bigger than the value of .51 fixed for 14 experts, content validity of the scale was statistically significant. In this way, final version of the scale was attained.

The scale was presented to 81 students in the form of 14 items within the scope of study. Reliability analysis of the scale was made at the end of the study. At the end of this analysis, the 12th item of the scale that reduced Cronbach Alpha value of the scale was excluded. Then, it was calculated as $\alpha = .913$. Accordingly, the scale was used with 13 items.

Qualitative data collection tools were used in the research. In order to reveal the different dimensions of the research process and its outcomes, interview guide was prepared for students.

3.3. Interview guides

Detailed views of students and teachers relating UZWEBMAT were taken in order to answer research questions. Thus, semi-structured interview guides were employed.

Interview guide prepared for students consisted of ten questions as follows:

1. How do you think studying with UZWEBMAT according to your learning style influenced your learning?

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2. When you failed to correctly answer the questions within Activities (Learning Objects-LO) UZWEBMAT directed you to a simpler question and you were provided with solution support and tips when necessary. How did this influence your learning?
3. When you failed to complete the LO of your primary learning style in UZWEBMAT, you were directed to the same content of your secondary and tertiary learning style. How did this influence your learning?
4. What do you think about learning the related concepts and principles with UZWEBMAT by means of LOs without receiving direct information?
5. According to your point of view, can learning take place independently of teachers thanks to UZWEBMAT?
6. How did LOs, tips and solution supports in UZWEBMAT influence your process of discovering mathematical relations?
7. Did UZWEBMAT influence your process of observing your weaknesses and strengths?
8. Did UZWEBMAT have an effect on your views relating mathematics?
9. What do you think about learning the related subjects either by means of UZWEBMAT or teachers?
10. Do you want to learn other subjects of mathematics via a system similar to UZWEBMAT?

3.4. Data analysis

Quantitative data were collected via scale developed for students to evaluate UZWEMAT in terms of learning. Frequency distribution and percentage rates of answers given by students in response to items were calculated. Besides, mean of each item was calculated.

Analysis of qualitative data was made according to content analysis. The purpose of content analysis is to reach concepts and relations capable of explaining the present data. Therefore, similar data are gathered together within the frame of specific concepts and themes. They are explicitly organized and interpreted (Yıldırım, & Şimşek, 2000). Data were analyzed according to the following phases respectively; encoding of data, fixing themes, defining and organizing data in relation to themes and finally interpreting the results.

4. Results

4.1. The results of the quantitative data analysis

Responses given by students to evaluation scale for the assessment of UZWEBMAT in terms of learning were analyzed through descriptive statistical techniques. Results of this analysis can be seen in the Table 3.

Average values, frequency distributions and percentage rates of each item were given in the Table 3. Taking into account all the items in the scale, it is seen that positive opinions regarding the second item (total sum of Strongly Agree and Agree) are the most positive opinions with a rate of 80.2%. In addition, percentages of positive views (I strongly agree and I agree) regarding the eighth, fourth, sixth and first items are 76.6%, 72.9%, 70.3% and 67.9% respectively. These percentages are the highest positive views among the answers in the scale.

Rates of positive opinions in relation to the fifth, thirteenth and eleventh items of the scale are 35.8%, 43.2% and 48.1% respectively. According to these values, it is clear that opinions regarding these items are predominantly neutral.

The 12th item of the scale is a negative statement. Total sum of Strongly Disagree and Disagree opinions in relation to this item is 58.7%. This value can be regarded as the rate of students not agreeing with this opinion taking into the account the fact that the question and the answers are negative. Accordingly, 58.7% of students stated that they did not agree with the opinion that learning with UZWEBMAT was boring.

Briefly, when frequency distribution of items, except for 3 of them, is examined, it is seen that positive opinions regarding UZWEBMAT are predominant (Strongly Agree and Agree). Thus, general average of items except for three items, which are predominantly neutral, is 67.17%.

4.2. The results of the qualitative data analysis

Of the 81 students who studied with UZWEBMAT, randomly selected 26 students were interviewed. Since one of the students gave conflicting answers, s/he was not included in evaluation. Student views in relation to the system are presented in the same sequence as interview questions.

Qualitative data were interpreted in the light of obtained findings. Prominent remarkable points from scale data regarding UZWEBMAT can be listed as follows:

- *Learners think that it is a positive aspect for UZWEBMAT to direct/guide them to an easier question when they have difficulty in dealing with the LOs and provide solution supports to them.*

Data obtained at the end of interviews support this view. All of the students expressed that their direction to a simpler question when they failed to answer the questions in a particular activity was effective because it took place from simple to difficult. One of the students explained the situation as follows: "*When I progress from simple to the difficult, I form an opinion for the difficult question.*" Students stated that getting solution supports and tips when necessary helped them to conclude generalizations and formulas. One of the students stated in relation to this fact, "*Tips served my purpose in terms of forming some ideas relating the answers of questions.*" One of the students suggested that tips should be increased in number by saying, "*Tips were not sufficient for some of the activities. I received aid from teacher. Some of the tips could have been better and more illuminating.*"

- *Learners think that is a positive aspect of UZWEBMAT to help them discover mathematical relations via activities, tips and solution supports.*

Data obtained at the end of interviews support this view. Most of the students stated that LOs, tips and solution supports had positive impact on their process of discovering mathematical relations. One of the students stated, "*We unwittingly discovered the formulas by solving problems, therefore I think it is really good from this aspect*". Another student mentioned, "*Instead of directly memorizing the formula and applying it to the problem, I try to figure out the formula by establishing the logic.*" Additionally, LOs, tips and solution supports aroused interest among students. One of the students expressed this with following words: "*We progress step by step. Figuring out the relations and formulas facilitated my comprehension from this aspect. Besides, it aroused interest in me. I wondered what I would get. It enhanced my ability of discovery.*" Only one student stated that s/he did not think that content had a positive effect on his/her process of discovering mathematical relations.

- *Learners consider it positive that they learn the related concepts and principles via activities with the help of UZWEBMAT which leads to a better comprehension.*

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Table 3
Student scale for evaluation of UZWEBMAT in terms of learning.

Items	$\bar{X}$	Strongly disagree 1		Disagree 2		Neutral 3		Agree 4		Strongly agree 5	
		f	%	*f*	%	*f*	%	*f*	%	*f*	%
Learning through appropriate content thanks to UZWEBMAT facilitated my learning	3.68	3	3.7	5	6.2	18	22.2	44	54.3	11	13.6
UZWEBMAT directed me to simpler question when I had difficulty in activities and provided me with solution supports when necessary. This contributed to my learning	3.98	2	2.5	8	9.9	6	7.4	39	48.1	26	32.1
In the cases where I was unable to succeed in my primary learning style, I took the same content in different learning styles. This positively influenced my learning	3.57	5	6.2	7	8.6	21	25.9	33	40.7	15	18.5
Learning the related concepts and principles via activities involving help of UZWEBMAT enabled me to understand the subject better	3.83	3	3.7	5	6.2	14	17.3	40	49.4	19	23.5
I think I will not forget the information I acquired using UZWEBMAT	3.14	8	9.9	12	14.8	32	39.5	19	23.5	10	12.3
I realized that I could learn some concepts independently of teacher thanks to UZWEBMAT	3.86	1	1.2	12	14.8	11	13.6	30	37.0	27	33.3
While studying with UZWEBMAT, I felt that I had to undertake responsibility in order to learn	3.77	1	1.2	9	11.1	18	22.2	33	40.7	20	24.7
Activities, tips and solution supports in UZWEBMAT helped me to discover mathematical relations	3.79	0	0	9	11.1	10	12.3	51	63.0	11	13.6
UZWEBMAT enabled me to see weak and strong aspects of myself	3.56	4	4.9	8	9.9	20	24.7	37	45.7	12	14.8
UZWEBMAT was a good guide for the process of learning these subjects.	3.51	3	3.7	10	12.3	19	23.5	41	50.6	8	9.9
UZWEBMAT contributed to me in terms of developing more positive attitudes regarding mathematics	3.31	7	8.6	9	11.1	26	32.1	30	37.0	9	11.1
Learning with UZWEBMAT was boring	2.41	26	32.1	24	29.6	12	14.8	10	12.3	9	11.1
I would like to use a system similar to UZWEBMAT to learn other subjects of mathematics	2.99	14	17.3	10	12.3	22	27.2	33	40.7	2	2.5

Data obtained at the end of interviews support this view. Students stated positive opinions about learning the concepts and principles related to the subject by means of LOs. 18 of the students stated that they discovered the concepts, principles and formulas thanks to tips and solution supports without taking aid from teacher. They also highlighted that they would not forget what they learnt as they experienced discovery process. One of the students explained this situation as follows: "*This method allowed me to comprehend the formula better. It enabled me to understand the origin of these formulas*." Another student said, "*It becomes permanent when I figure it out. It remains unforgotten*." S/he stated that discovery process further increased permanency. 2 students expressed that they enjoyed while learning and they did not get bored. Other 2 students denoted that this method did not have a positive impact on their learning. It would be better for them if teacher had given the lecture.

- *Learners realized that they could also learn without depending on the teacher thanks to UZWEBMAT.*

Data obtained at the end of interviews support this view. 18 of the students stated that it was possible for learning to take place independently of teacher thanks to UZWEBMAT. One of the students thinking in the same way told, "*Learning can take place even if teacher does not exist. It is no different from a teacher. That is, for me, teacher = UZWEBMAT*." Another student said, "*I think it is possible for learning to take place without the presence of a teacher. There was everything for us to learn, we were able to learn the subject without having pre-information*".

- *Learners are content that they learn in accordance with their learning styles.*

Data obtained at the end of interviews support this view. Students were initially asked about the influence of being lectured according to their learning styles and its effect on their learning. 21 of the students expressed that this facilitated their learning. One of the students stated in relation to the issue, "*My learning style is kinesthetic, I learn through practicing. I was incapable of learning aurally. While listening to the conversations, I am losing myself in thoughts. I am a million miles away and it gets more difficult for me to learn*." Another student stated, "*I must see and feel what I do to learn the subject (student with kinesthetic learning style). Thus, I would not understand via hearing. For example, I must draw the triangle for trigonometry; I must feel even if I do not see*." Apart from these, 2 other students expressed that being lectured according to their learning styles drew their attention more, and another student denoted that what he/she learnt via this approach was more permanent.

- *Learners are content that they are being directed/guided between the contents of different learning styles. Percentages of negative, neutral and positive views regarding this claim are 14.8%, 25.9% and 59.3% respectively, which was deduced from the third item of the scale. 15 learners did not experience this direction/guidance, which is thought to be the reason of high rate in hesitant examinees. It is seen that rate of negative views is rather low in comparison to all rates. Qualitative data support this case, too.*

15 of students answered this question saying, "*I was not directed to a different style*" because all of them completed all of the activities successfully. 9 students stated that they were directed to a different style. Students think that being directed contributed to their learning as it provided them with a different perspective. One of the students explained the situation as follows: "*I was directed to visual learning style, the tips there were a bit different and they enabled me to succeed*". Another student expressed told, "*Considering from different perspectives was beneficial*." 2 of the students denoted that this direction did not influence their learning.

- *Learners stated relatively positive expressions about using a system similar to UZWEBMAT for learning other subjects of mathematics. Negative, neutral and positive opinion percentages of this claim are 29.6%, 27.2% and 43.2% respectively, which was deduced from the thirteenth item of the scale. According to these rates, negative and hesitant percentages are remarkable, too.*

Data obtained at the end of interviews support this view. Most of the students think that a system similar to UZWEBMAT cannot be employed for each subject. 12 of the students expressed that the subjects easy to visualize can be lectured via a system similar to UZWEBMAT, however, the subjects which are difficult to visualize and comprehend such as trigonometry cannot be lectured in such a way. 9 of the students stated that they wanted to learn other subjects of mathematics via a system similar to UZWEBMAT.

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Table 4
Other data obtained from interviews.

Subject	Details
Student perceptions relating the effect of UZWEBMAT on students' observation of their weaknesses and strengths	7 themes were determined relating the question concerning the effect of UZWEBMAT on students' discovery of their weaknesses and strengths. These themes are as follows: discovery, learning strategy, self-esteem, learning characteristics, learning responsibility, subject, learning independently of teacher • It was stated by students that it was possible to discover mathematical relations thanks to tips and solution supports. • One of the students stated, "*I have realized that learning without memorizing formulas is better for my learning.*" • One of the students said, "*I realized that I can manage something without a teacher. I also recognized what are the things that I lack in the absence of the teacher and the things that I can do without depending on anyone. My self-esteem has improved in these terms.*" • 7 of the students expressed how they understood that they learn more easily and better thanks to system. • Students stated that the system enabled them to understand that they were responsible for their learning in order to learn the subjects and complete the LOs. • Most of the students stated that system enabled them to realize their lacks in relation to the subject. One of the students told, "*I used to know wrong things about permutation and combination. I have just learnt the true forms of them.*" • One of the students stated in relation to this fact, "*I used to say that I could not solve some problems without a teacher. However, thanks to the tips in UZWEBMAT, I realized that I could solve the problems without lectures.*"
Student perceptions relating the effect of UZWEBMAT on their views concerning mathematics	12 of students stated that UZWEBMAT did not influence their views in relation to mathematics. 11 of these students stated that they already liked mathematics and the system did not influence their views while 1 one them stated that s/he did not like mathematics and his/her view did not change after the application. 14 of the students stated that this system positively influenced their views in relation to mathematics. 7 of these students expressed that UZWEBMAT enabled them to look at mathematics from a different perspective. In relation to this, one of the students stated, "*I have actually realized thanks to the system that mathematics is entertaining.*" Another student said, "*I used to think that mathematics could not be lectured without a teacher, but now I see that some subjects of mathematics can be taught without a teacher.*" One of the students used the following statement while depicting how the system influenced his/her views in relation to mathematics: "*I used to like mathematics, now I like it more, it is because I manage to do something on my own.*"
Student perceptions relating lectures given by means of UZWEBMAT or by a teacher	Most of the students stated that they wanted to learn subjects via UZWEBMAT. 12 of the students expressed that they preferred UZWEBMAT because it provided content appropriate for individual learning characteristics, and learning responsibility belonged to them within UZWEBMAT. In relation to this, one of the students said, "*I prefer UZWEBMAT because we are responsible for the questions that are asked and our progress depends on us. It feels as if we are dominating the lecture. Everything is under our control.*" Another student stated, "*We cannot conduct activities again and again while teacher is giving lectures. Teacher repeats only once or twice utmost. But we can return and complete the activity in UZWEBMAT. We can return to the start, we can redo it.*" 6 of the students stated that they would prefer teacher because of their habits and mutual dialogue. In relation to this, one of the students denoted, "*We are bound to the computer in this system. It cannot give us more when we need, but we can ask teacher and get answers.*" 7 of the students stated that they would prefer being lectured both by UZWEBMAT and teacher

Students said that they would prefer UZWEBMAT because it provided a learning environment appropriate for individual learning characteristics, gave the control to the students, and enabled permanent knowledge as it provided an environment suitable for discovery. 4 of the students stated that a learning environment comprising both teacher and UZWEBMAT would be more beneficial.

Other data obtained from the interview are presented in Table 4.

5. Discussion

Learner attitudes and opinions regarding UZWEBMAT were tried to be revealed through quantitative and qualitative data obtained again from learners. Learner attitudes and views regarding UZWEBMAT may lead to important deductions about the place and future of AEHSs in educational system.

Learners are content that they studied in accordance with their learning styles with UZWEBMAT. According to data obtained from the scale, 67.9% of learners share this same opinion. In addition, qualitative data support this argument, too. Hence, learners stated that learning in accordance with their learning styles eased comprehension and made it fun. There are studies in literature advocating that learning that is based on learning styles increases learner satisfaction. Brown (2007), Brown, Brailsford, Fisher, and Moore (2009), Mustafa and Sharif (2011) and Schiaffino, Garcia, and Amandi (2008) revealed that learners found it satisfactory to receive the content appropriate for their learning styles. Findings of this study tally with these studies.

Learner views regarding structural characteristics such as direction/guidance between dominant/primary, secondary and tertiary learning styles, learning with LOs that were prepared according to constructivist approach, and tips and solution supports within LOs are positive, too. This is clear in the third, fourth and second items among the scale items. Thus, the percentages of positive views from learners are 59.3%, 72.9% and 80.2% for these three items respectively. Of these items, it is seen that positive opinions regarding direction/guidance between learning styles are as low as 59.3% compared to others. Neutral opinions regarding this item are 25.9%. The reason behind this can be deduced from qualitative data. Some of the interviewees stated that they had never been directed/guided. It is thought that this is reflected on the answers given to the scale. Qualitative data obtained from learners support this argument. Learners stated that being directed/guided to an easier question when they gave wrong answers to the problems within LOs helped them to comprehend the logic of the subject. Learners also stated that receiving tips and solution supports when necessary contributed them to make generalizations and discover the relations. Triantafillou, Pomportsis, and Georgiadou (2002) revealed in his study that level adaptive interactive applications in

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compliance with learners' learning styles are useful and satisfactory. Papanikolaou et al. (2006) reached to a conclusion that most of the learners regarded the solution supports presented to them by the system as positive. Results of the studies in the literature and of this study indicate that learners find tips and solution supports as beneficial for their learning.

Learners realized that they could also learn without depending on the teacher. This argument can be deduced from the fifth item in the scale. The percentage of positive opinions regarding this item is 70.3%. As for the qualitative data, 69.2% of learners stated that they realized that they could learn without depending on their teachers thanks to UZWEBMAT. These results manifest the belief of learners that learning can take place by itself. Whether or not learners are willing to study other subjects of mathematics with s a system similar to UZWEBMAT is important for the future of similar systems. This can be deduced from the thirteenth item of the scale. Negative, neutral and positive opinions regarding this matter are 29.6%, 27.2% and 43.2% respectively. Assessing these rates, it is seen that there is not an agreement among learners regarding this matter; however, the rate for those who do not want to study with a similar system is low. Qualitative data obtained from interviews sheds a light upon this variation in opinions. Thus, some of the learners think that all subjects cannot be learnt with a similar system. In addition, some of the other learners stated that they were willing to use systems similar to UZWEBMAT since it provided a learning environment appropriate for individual learning characteristics, gave the control of the lecture to learners, and created an environment of discovery. The rest of the learners stated that they wished to use these systems along with their teachers.

According to obtained data, learners expressed that making learners experience the process of discovery, providing self-confidence, discovering learning characteristics, learning independently from teacher, undertaking responsibility during learning process, realizing their strong and weak sides, being a good guide during learning process, making the environment for learning fun and permanency were positive sides of UZWEBMAT. Brown (2007) reached to a conclusion in his study that learners consider it fun and enjoyable to study with WHURLE-LS instead of conventional system. Results of the study show parallelism with this conclusion.

6. Conclusion and future work

This study deals with the development, application and evaluation of an individualized and intelligent e-learning environment named UZWEBMAT. UZWEBMAT was designed to teach permutation, combination, binomial expantion and probability subjects which are the sub-topics of the unit of probability in mathematics. UZWEBMAT is an adaptive and intelligent e-learning environment that was individualized based on VAK LS. UZWEBMAT determines learning styles of students and presents the content that is most appropriate for students' own learning styles. An expert system integrated into content was employed in UZWEBMAT. Thanks to this expert system, solution supports that students will take in LOs and the routes between pages were decided. Due to this expert system, different students with the same learning style may be subjected to different instructions according to their performances and knowledge levels. Therefore, individual learning has become prominent in web media instead of students' taking the same content. Taking this structure into consideration, it is possible to say that UZWEBMAT is a totally student centered system, and it offers choices to students in each step according to their performances. Briefly, UZWEBMAT presents what students need.

In the present study, initially, UZWEBMAT was designed and developed. Then, it was implemented during the spring semester 2010–2011. Results of the study showed that UZWEBMAT system was considered rather beneficial by students. Learning in accordance with learning styles was satisfactory for learners. Again, this kind of learning had a positive impact on their learning and eased their comprehension. Learners who studied in accordance with their own learning styles appreciated this. In addition, it was indicated by the results of the study that factors such as learning with LOs prepared according to constructivist approach and being directed/guided between contents of different learning styles eased learner comprehension and made the learning process fun. On the other hand, being able to learn without depending on the teacher, experience of undertaking the responsibility for learning, and realizing learning characteristics are some of the important achievements that learners attained in this study. All these results proved that UZWEBMAT provided an efficient and individual learning environment to learners. Dominant learning styles of learners were decided, and content appropriate to their learning style was presented to them in the present study. Future studies may involve learners' selecting their own learning style and taking the content which may be followed by a learning style inventory test. Thus, whether or not there is a relation between individual preferences of learners and their learning styles and the influence of this case on learners may be examined from different perspectives. Moreover, content corresponding to learning styles was given to learners, and the assessment was made accordingly. Future studies may involve matching different contents with different learning styles, and the effect of this system on learners may be examined.

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References

Akbulut, Y., & Cardak, C. Z. (2012). Adaptive educational hypermedia accommodating learning styles: A content analysis of publications from 2000 to 2011. *Computers & Education, 58*(2012), 835–842.

Akkoyunlu, B., & Soylu, M. Y. (2008). A study of student's perceptions in a blended learning environment based on different learning styles. *Educational Technology & Society, 11*(1), 183–193.

Bajraktarevic, N., Hall, W., & Fullick, P. (2003). ILASH: Incorporating learning strategies in hypermedia. In *Proceedings of the fourteenth ACM conference on hypertext and hypermedia (HT03)*, Nottingham, UK, 26–30 August 2003.

Baki, A., & Çakıroglu, Ü. (2010). Learning objects in high school mathematics classrooms: Implementation and evaluation. *Computers & Education, 55*(2010), 1459–1469.

Baki, A., & Güveli, E. (2008). Evaluation of a web based mathematics teaching material on the subject of functions. *Computers & Education, 51*(2), 854–863.

Berge, Z. L. (2002). Active, interactive, and reflective eLearning. *Quarterly Review of Distance Education, 3*(2), 181–190.

Botsios, S., Georgiou, D., & Safouris, N. (2008). Contributions to adaptive educational hypermedia systems via on-line learning style estimation. *Educational Technology & Society, 11*(2), 322–339.

Brown, E. (2007). *The use of learning styles in adaptive hypermedia*. Unpublished Doctoral Thesis. England: The University of Nottingham.

Brown, E., Brailsford, T., Fisher, T., & Moore, A. (2009). Evaluating learning style personalization in adaptive systems: Quantitative methods and approaches. *IEEE Transactions on Learning Technologies, 2*(1), 10–22.

Brown, E., Cristea, A., Stewart, C., & Brailsford, T. (2005). Patterns in authoring of adaptive educational hypermedia: A taxonomy of learning styles. *Educational Technology & Society, 8*(3), 77–90.

Brown, E., Fisher, T., & Brailsford, T. (2007). Real users, real results: Examining the limitations of learning styles within AEH. In *Proc. of the eighteenth ACM conference on hypertext and hypermedia (Hypertext 2007)*.

Brusilovsky, P. (2001). Adaptive hypermedia. *User Modeling and User-Adapted Interaction, 11*, 87–110.

Brusilovsky, P., & Peylo, C. (2003). Adaptive and intelligent web based educational systems. *International Journal of Artificial Intelligence in Education, 13*, 156–169.

Çakıroğlu, Ü., Güven, B., & Akkan, Y. (2008). Examining mathematics teachers' beliefs about using computers in mathematics teaching. *Hacettepe University Journal of Education, 35*, 38–52.

Carver, C. A., Howard, R. A., & Lane, W. D. (1999). Enhancing student learning through hypermedia courseware and incorporation of student learning styles. *IEEE Transactions on Education, 42*(1), 33–38.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning styles and pedagogy in post-16 learning: A systematic and critical review*. Wiltshire: Learning and Skills Research Centre.

Fast, G. (2001). The stability of analogically reconstructed probability knowledge among secondary mathematics students. *Canadian Journal of Science, Mathematics and Technology Education, 1*(2), 193–210.

Fraenkel, J. R., & Wallen, N. E. (2006). *How to design and evaluate research in education*. New York: The Mcgraw-Hill Companies.

Franzoni, A. L., & Assar, S. (2009). Student learning styles adaptation method based on teaching strategies and electronic media. *Educational Technology & Society, 12*(4), 15–29.

Georgiou, D., & Makry, D. (2004). A learner's style and profile recognition via fuzzy cognitive map. In *Paper presented at the 4th IEEE international conference on advanced learning technologies*, August 30–September 1, 2004, Joensuu, Finland.

Gilbert, J. E., & Han, C. Y. (1999). Adapting instruction in search of "A Significant Difference". *Journal of Network and Computing Applications, 22*(3), 149–160.

Gökdağ, M. (2004). *Collaborative learning, learning styles, academic achievements and gender relations in teaching social sciences*. Unpublished Doctoral Thesis. İzmir: Dokuz Eylül University, Educational Sciences Institute.

Graf, S., Kinshuk & Liu, T.-C. (2009). Supporting teachers in identifying students' learning styles in learning management systems: An automatic student modeling approach. *Educational Technology & Society, 12*(4), 3–14.

Grigoriadou, M., Papanikolaou, K., Kornilakis, H., & Magoulas, G. (2001). INSPIRE: An intelligent system for personalized instruction in a remote environment. In *Proceedings of the eight international conference on user modeling (UM2001)*, Sonthofen, Germany, 13–17 July 2001.

Gürbüz, R. (2010). The effect of activity based instruction on conceptual development of seventh grade students in probability. *International Journal of Mathematical Education in Science and Technology, 41*(6), 743–767.

Gürbüz, R., & Birgin, O. (2012). The effect of computer-assisted teaching on remedying misconceptions: The case of the subject "probability". *Computers & Education, 58*(2012), 931–941.

Kafoussi, S. (2004). Can children kindergarten be successfully involved in probabilistic tasks? *Statistics Education Research Journal, 3*(1), 29–39.

Kainnen, E. (2009). *Learning styles and e-learning*. Unpublished Master Thesis. Finland: Tampere University of Technology.

Karampiperis, P., & Sampson, D. (2005). Adaptive learning resources sequencing in educational hypermedia systems. *Educational Technology & Society, 8*(4), 128–147.

Keleş, A. (2007). *Artificial intelligence and design of web based intelligent educational system in learning-teaching process and "an application in mathematics education"*. Unpublished Doctoral Thesis. Erzurum, Türkiye: Atatürk University.

Kim, D., & Gilman, D. A. (2008). Effects of text, audio, and graphic aids in multimedia instruction for vocabulary learning. *Educational Technology & Society, 11*(3), 114–126.

Liegle, O. J., & Janicki, T. N. (2006). The effect of learning styles on the navigation needs of Web-based learners. *Computers in Human Behavior, 22*(2006), 885–898.

Manage, A. B. W., & Scariano, S. M. (2010). A classroom note on: student misconceptions regarding probabilistic independence vs. mutual exclusivity. *Mathematics & Computer Education, 44*(1), 14–21.

Manochehr, N. N. (2006). The influence of learning styles on learners in e-learning environments: An empirical study. *Computers in Higher Education Economic Review, 18*, 10–14.

Memnun, D. S. (2008). Difficulties encountered in teaching probability concepts, the reasons and solutions for not being able to learn these concepts. *İnönü University Journal of Faculty of Education, 9*(15), 89–101.

Moore, A., Stewart, C. D., Zakaria, M. R., & Brailsford, T. J. (2003). WHURLE – an adaptive remote learning framework. In *International conference on engineering education (ICEE-2003)*, July 22–25, 2003, Valencia, Spain.

Munisamy, S., & Doraisamy, L. (1998). Levels of understanding of probability concepts among secondary school pupils. *International Journal of Mathematical Education in Science and Technology, 29*(1), 39–45.

Mustafa, Y. E. A., & Sharif, S. M. (2011). An approach to adaptive e-learning hypermedia system based on learning styles (AEHS-LS): Implementation and evaluation. *International Journal of Library and Information Science, 3*(1), 15–28.

Papanikolaou, W., Mabbott, A., Bull, S., & Grigoriadou, M. (2006). Designing learner-controlled educational interactions based on learning/cognitive style and learner behavior. *Interacting with Computers, 18*, 356–384.

Picciano, A. G. (2001). *Distance learning: Making connections across virtual space and time*. Upper Saddle River, NJ: Prentice-Hall.

Retalis, R., & Papasalouros, A. (2005). Designing and generating educational adaptive hypermedia applications. *Educational Technology & Society, 8*(3), 26–35.

Romero, C., Ventura, S., Zafra, A., & de Bra, P. (2009). Applying web usage mining for personalizing hyperlinks in web-based adaptive educational systems. *Computers & Education, 53*(2009), 828–840.

Saba, F. (2002). Student attritions: How to keep your online learner focused. *Distance Education Report, 14*(4), 1–2.

Sarasin, L. C. (1998). *Learning style perspectives: Impact in the classroom*. Madison, WI: Atwood Publishing.

Schiaffino, S., Garcia, P., & Amandi, A. (2008). ETeacher: Providing personalized assistance to e-learning students. *Computers & Education, 51*(2008), 1744–1754.

Triantafillou, E., Pomportsis, A., & Georgiadou, E. (2002). AES-CS: Adaptive educational system based on cognitive styles. In *Proceedings of the second international conference on adaptive hypermedia and adaptive web-based systems (AH2002)*, Malaga, Spain, 29–31 May 2002.

Veneziano, L., & Hooper, J. (1997). A method for quantifying content validity of health-related questionnaires. *American Journal of Health Behavior, 21*(1), 67–70.

Wagschal, P. H. (1998). Distance education comes to the academy: But are we asking the right questions? *The Internet and Higher Education, 1*, 125–129.

Wang, F.-H. (2008). Content recommendation based on education-contextualized browsing events for web-based personalized learning. *Educational Technology & Society, 11*(4), 94–112.

Wolf, C. (2003). iWeaver: Towards 'learning style' based e-learning in computer science education. In *Proceedings of the fifth Australasian conference on computing education*, Adelaide, Australia, 4–7 February 2003, pp. 273–279.

Yıldırım, A., &Şimşek, H. (2000). *Qualitative research methods in social sciences*. Ankara: Seçkin Publishing.

Yurdugül, H. (2005). *Using content validity indexes for content validity in scale development studies*. XIV. Educational Sciences Assembly, 28–30 September. Denizli: Pamukkale University.

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