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Reflections from a Mathematics Instruction Conducted With Individualized Adaptive and Intelligent e-Learning Environment *

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Abstract

Purpose of this study is to produce a qualitative evaluation of reflections from the learning environment created by UZWEBMAT (Adaptive Intelligent WEB based MAThematics Instruction) which was developed to teach/learn sub-topics of probability unit. The study was a case study. It was conducted during 2010-2011 academic term in Trabzon, Turkey. The case study was carried out with tenth grade students from three different classes in two different Anatolian high schools. Eighty one students and three teachers participated in the study in total. Interview forms were employed as data collection tools. These forms were for collecting qualitative data from teachers and students. Qualitative data collected from the examinees were analyzed via content analysis. Reflections derived from the study were divided into two categories which were positive and negative. It was decided that there were positive reflections from the mathematics instruction environment created by UZWEBMAT such as individual learning, exploring mathematical connections and formulas, and taking the responsibility of learning. In addition to these positive reflections, there were negative reflections such as concern of failing in central exams and the impossibility/possibility of teaching other subjects of mathematics with a similar system.

Keywords

Adaptive and intelligent e-learning environments
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Introduction

The domain of education is experiencing many changes and transformations as information-communication technologies have been a part of daily life recently. In this sense, there is a gradual increase in the number of developed computer supported learning/teaching environments. The use of these environments is becoming more frequent as well (Doğan, 2009). The terms for teaching services with computer support can be listed as "Computerized Teaching", "Teaching via Computers", "Computer Based Teaching" and "Computer Supported Teaching (CST). Baki (2002) defines CST as student's recognition of his/her lacks and performances, control over one's learning through feedbacks, and benefiting from computers for education process in order to raise interest towards the course by means of graphics, audio and animations. CST can be used effectively for mathematics instruction as well as various domains of education (Baki, 2002; Ersoy, 2005).

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Advancements in internet technologies led to diversification in CST environments. This diversification created a phenomenon named as "ubiquitous learning" (Wagschal, 1998). This phenomenon involves electronically learning in the broadest terms. However, it is also known as web based education, web based learning and web based teaching (WBT) (Alper & Deryakulu, 2008). WBT brings important opportunities to both educators and students in terms of creating new and interactive learning environments and accessing to learning environment regardless of time and place (Baki & Güveli, 2008; Botsios, et al., 2008; Wagschal, 1998). WBT environments differs from one another according to the users, content, level and the way they are used. All of the students gather in the "same virtual class" in web based learning environments. However, everyone has "different characteristics" in the real world. Traditional WBT environments were harshly criticized since they provided the same content to all students who may possess different learning objectives and styles. As a matter of fact, this situation presents an important lack: to take into account individual learning differences (Brown, 2007; Brown et al., 2009; Cabada, Estrada, & Garcia, 2011; Tseng, et al., 2008). This led to the emergence and generalization of a new approach: adaptive and e-learning environments. These learning environments takes into account individual differences of students. Thus, they offer an individualized environment for students with different learning strategies and sources, solution supports and interfaces (Brown, 2007; Brusilovsky & Peylo, 2003; Mustafa & Sharif, 2011).

The most important concept in the individualization of adaptive and intelligent e-learning environments is the selection of characteristics for individualization and the way they are used. In this sense, learning styles, which were regarded as the preference of receiving, using and storing information, guide the process (Brown, 2007; Brown, et al., 2007; Latham, et al., 2010; Wolf, 2003). According to the results of many previous studies, e-learning environments employing a certain learning style became more effective and efficient for students. Also, they provided a higher satisfaction level and reduced the time for learning (Mustafa & Sharif, 2011; Papanikolaou, et al., 2003; Popescu, 2009; Popescu, 2010; Sangineto, et al., 2008; Triantafillou, et al., 2003; Wang, 2008). Therefore, learning styles can be deemed as parameters to create a user model in the design of adaptive intelligent e-learning environments (Brown, 2007; Conlan, et al., 2002; Latham, et al., 2010; Sangineto, et al., 2008; Wang, 2008).

Relevant Studies

It is possible to come across with adaptive and intelligent e-learning environments in the literature which were designed to teach various subjects. Prominent ones among them are listed in Table 1 in detail.

Table 1. Individualized and Intelligent E-Learning Environments Based on Learning Styles

Sequence	System Name	Topic	Level	Learning Style
1	ADAPTAPlan	Object-oriented programming	University	Felder-Silverman
2	AES-CS	Multimedia technology systems	University	Witkin and Goodenough
3	AES-LS	JavaScript programming	University	VARK
4	APeLS	SQL subject	University	VARK
5	CIMEL-ITS	Independent	Unspecified	Felder-Silverman
6	DEUS	Reproduction in magnoliophyta	Primary	Felder-Silverman
7	Diogene	Independent	University	Felder-Silverman
8	EDUCA	Independent	University	Felder-Silverman
9	INSPIRE	Independent	University	Honey and Mumford
10	iLearn	Independent	Unspecified	VARK
11	iWeaver	Java programming language	University	Dunn and Dunn
12	Lecomps	Independent	Unspecified	Felder-Silverman
13	İMANIC	Introduction to networks	University	VAK
14	MOT	Independent	Unspecified	Kolb
15	OPAL	Independent	Unspecified	VARK
16	OSCAR	SQL subject	University	Felder-Silverman
17	SACS	Independent	University	VARK
18	TSAL	Mathematics	Secondary	Keefe
19	WELSA	Artificial Intelligence	University	Karma

There is no assessment study on ADAPTAPlan, CIMEL-ITS, Lecomps, iLearn, MOT, and OPAL in literature (Brown, et al., 2009; Mustafa & Sharif, 2011). Though not so comprehensive, there is a study conducted on AES-CS (Triantafillou, et al., 2003) with a small sample consisting 10 people. According to the relevant results, the system was satisfactory for students in terms of its adaptivity according to learning styles. Also, changing of appropriate interactive applications based on levels was deemed helpful. In relation to AES-LS (Mustafa & Sharif, 2011), an experimental study was carried out based on different learning styles and their effects on students' academic achievements. As indicated by the results of the study, students who received adaptive content based on learning styles were more successful than students who received the same materials traditionally. APeLS (Conlan, et al., 2002) conducted an experimental study with more than 500 students in order to evaluate the system. Based on the data analysis obtained from students, performances of students with no or little experience on online learning were positive in final exams. DEUS (Brown, et al., 2007) system was used in primary school level. It was an e-learning platform used by children whose ages ranged from 9 to 11. The results of the study indicated that there was no significant difference between sequential and global learning styles (based on statistical comparisons via ANOVA test). With Diogene (Sangineto, et al., 2008) system, a study was conducted in relation to instruction of information and communication technologies with 137 university students. According to the results of the study, 70% of students stated that their user profiles defined their learning habits in the best way. 72% was satisfied with the system since it offered learning objects which were appropriate to their learning styles. With EDUCA (Cabada, et al., 2011) system and compiler design, a study was carried out to make an introduction to computer sciences and to teach maya language. Results of the study were simply demonstrated in column chart. When these graphics were interpreted briefly, it was possible to say that students preferred "I agree" and "I definitely agree" choices for interface, ease of producing intelligent teacher, the time spent for learning how to use the system and adaptive course organization. A study was carried out to teach memory management hierarchy subject of computer architecture course with INSPIRE (Papanikolaou, et al., 2003). According to study results, most of the students had positive reflections on the adaptivity structure used within INSPIRE and the supports provided to them by the system. iWeaver (Wolf, 2003) system was implemented and evaluated for java programming course. According to the results of the study, media selection created a significant difference on learning outcomes and motivations of students

with "low level of experience". However, there was not a statistically significant difference between the pleasure taken from the course and perceived learning process. In order to evaluate iMANIC (Stern, 2001) system, a small scale experimental study was carried out. Limited as they were, one of the most important results of the study was the fact that computer instructor successfully estimated student preferences however, it needed to be adapted until the most appropriate selection was detected. An experimental study was conducted with OSCAR (Latham, et al., 2010) system. According to the results, performances of students who received content appropriate to their learning styles were higher compared to those who did not. A study was conducted with three sub-topics of artificial intelligence via SACS (Wang, 2008) system. A limited evaluation to assess the system was also carried out. As indicated by the study, both students and academicians shared the same opinion that SACS system was helpful. An experimental study was carried out to evaluate TSAL (Tseng, et al., 2008) system. TSAL was one of the rare systems in literature developed for mathematics course. It was designed to teach subjects of progression, arithmetic progression, calculation of progression and the middle member of progression. According to the results of the study, students in experimental group were instructed more efficiently. An experimental study was conducted with 64 students to evaluate WELSA (Popescu, 2009; Popescu, 2010) system. As indicated by the results, there was a substantial difference between matched and unmatched groups. Besides, there were also differences between adaptive and non-adaptive approaches. According to statistical comparison carried out with Mann–Whitney U-test, in all of the aforementioned six items, there was a statistical difference between matched and unmatched groups.

At the end of the literature review, 19 studies were examined in total. There was not any evaluation study in relation to 6 of the systems. Evaluation studies of 13 systems were published. Majority of these studies (n=11) were for university education while the number of studies for primary and secondary education was quite limited (n=12). In terms of subject content, there were many studies on various domains, however, those pertaining to the domain of mathematics were limited. As a matter of fact, there was only a study conducted at secondary education level. In this sense, adaptive e-learning environments were frequently implemented at university level while it was a fact that there is a lack in this domain at high school level (Brown et al., 2009; Mustafa & Sharif, 2011). Therefore, design, implementation and evaluation of adaptive intelligent e-learning environments at high school level for different courses, particularly for mathematics, may contribute substantially to literature. This study dwells on reflections from the integration of UZWEBMAT, adaptive and intelligent e-learning environment integrated into high school mathematics classes, into real class environments. To this end, research questions can be organized as follows:

- What are the views and opinions of students and teachers in relation to learning environment created by UZWEBMAT?

Method

A learning environment was created by UZWEBMAT in the study. UZWEBMAT is an adaptive and intelligent e-learning environment individualized on the basis of visual-auditory-kinesthetic learning styles. UZWEBMAT's content was prepared in accordance with constructivist approach. There are 53 learning objects in total within UZWEBMAT in relation to permutation, combination, binomial expansion and probability. These are 16, 11, 4 and 12 in number respectively. Many details such as the structure and architecture of UZWEBMAT, structure of the learning objects within the system, and adaptivity methods can be accessed from literature (Özyurt, Özyurt, & Baki, 2013). The study employed case study method. In order to reveal the effects of integration of adaptive and intelligent e-learning environments into real classes, it was decided that views and opinions of the examinees would be received in relation to learning environment created by UZWEBMAT.

Sample

This study was conducted during 2010-2011 academic term in Trabzon. Two different Anatolian high schools were selected. The sample consisted of three different tenth grades from these schools (two classes from one high school and a class from the other). 81 students (51 males, 29 females) in total and three mathematics teachers (a teacher for each class) constituted the sample of the study. At the end of the study, randomly selected 26 students from these three classes (16 males and 10 females) and three teachers were interviewed.

Procedure

UZWEBMAT was introduced to students and teachers in 4 hours prior to the implementation. Students took a look at the activities within UZWEBMAT and received general information regarding the system. Afterwards, the study was conducted with three classes in computer laboratory with a computer for each student. The study lasted for 8 weeks with 4 hours per week. That made 32 hours of instruction in total. Total length of the study conducted with three different classes was 96 hours. During the implementation, all students were individually instructed with UZWEBMAT. Students individually received the learning content offered by UZWEBMAT. They did not interact with their friends. The study was organized taking into account ordinary teaching periods of these subjects within the curriculum. Class teachers and a researcher were present in the computer laboratory throughout the study. The intention was to help students with the problems they may encounter regarding the system. In other words, teachers did not intervene in students in the laboratory environment directly or indirectly. They only ensured that the process was running smoothly. Schedule of this study is given in Table 2.

Table 2. The Distribution of 53 Activities Constituting the Content of UZWEBMAT Based on Subjects and Weeks

Subject	Activities	Period	Total Hours
Permutation	Between 1 and 16	First two weeks	8
Combination	Between 17 and 27	Third and fourth weeks	8
Binomial Expansion	Between 28 and 31	Fifth week	4
Probability	Between 32 and 53	Last three weeks	12

Data Collection Tool

In the study, structured interview forms were employed to evaluate the learning environment created by UZWEBMAT. These forms were developed by researchers in accordance with expert views. Questions in these forms were prepared in such a way that they would reveal the views and opinions of students and teachers regarding the environment.

Interview form prepared for students consisted of ten questions:

1. What kind of an effect do you think that UZWEBMAT has on your learning with its instruction based on learning styles?
2. When you gave an incorrect answer within the activities, you were directed to a simpler question by UZWEBMAT. You were also provided with solution supports and tips whenever needed. How did these affect your learning?
3. While being instructed in your primary learning style, you were directed to the same activity in your secondary and tertiary learning styles upon failing the activity. How did this affect your learning?
4. What do you think about learning concepts and principles via UZWEBMAT without being directly dictated?
5. In your point of view, is it possible that learning occurs automatically without a teacher (thanks to UZWEBMAT)?

6. How did learning objects, tips and solution supports within UZWEBMAT affect your experience of exploring mathematical relations?
7. Did UZWEBMAT affect your process of observing your weaknesses and strengths?
8. Did UZWEBMAT have an effect on your views regarding mathematics?
9. What do you think about learning with the assistance of UZWEBMAT/teacher?
10. Would you like to learn other subjects of mathematics with a system similar to UZWEBMAT?

Interview form prepared for teachers consisted of eight questions:

1. How do you think that instruction via UZWEBMAT based on learning styles affect students' learning?
2. When students gave incorrect answers to the questions of learning objects, they were directed to a simpler question by UZWEBMAT. They were provided with solution supports and tips when needed. How do you think that this affected their learning?
3. Do you think that UZWEBMAT was effective on students' learning when they were directed to the same content of their secondary and tertiary learning styles upon failing in the content of their primary learning style?
4. What do you think about learning concepts and principles via UZWEBMAT without being dictated (with the assistance of learning objects)?
5. In your point of view, is it possible that learning occurs automatically without a teacher (thanks to UZWEBMAT)?
6. How did the learning objects, tips and solution supports within UZWEBMAT affect students' experience of exploring mathematical relationships?
7. Did UZWEBMAT assisted students to make them see their weaknesses and strengths?
8. What do you think about teaching other subjects of mathematics via a system similar to UZWEBMAT?

Analysis of Data

Audio recordings saved via recorders during the interviews were transcribed and analyzed via content analysis. In order to analyze separate interviews of students and teachers, each interview given by students and teachers were repeatedly read. Thus, based on the answers given to each question, encoding process was carried out. Phases of the analysis process can be listed as data encoding, determining the themes, defining and organizing data in accordance with the themes, and interpretation. While presenting data, both positive and negative situations which were prominent during the interviews were taken into consideration. At the end of the study, 26 students, from whom data was collected, were encoded as Stu1, Stu2, …, Stu26 while the teachers were encoded as A, B, and C.

Results

This section deals with the findings in detail obtained from the analysis of data collected via interviews from students and teachers. Findings of the study can be categorized under two divisions which are positive reflections and negative reflections.

Positive Reflections from the Learning Environment Created by UZWEBMAT

According to findings of the study, positive reflections from the learning environment created by UZWEBMAT were collected under four themes. Table 3 shows positive reflections from the study under the titles.

Table 3. Positive Reflections from the Learning Environment in Which UZWEBMAT Was Used

Items	Main Themes	Frequency (Student)	Frequency (Teacher)
a)	Facilitation of learning	23	3
b)	Permanent Learning	21	3
c)	Exploring mathematical relationships and formulas	20	3
d)	Independent Learning	18	1

In addition to presentation of main themes derived from data analysis, content of each theme is given in detail below.

a) Facilitation of Learning: One of the positive reflections obtained from student and teacher interviews was the facilitation of learning via UZWEBMAT based on the content appropriate to their learning styles. As a matter of fact, data obtained from student and teacher interviews was in parallel with this outcome. Generally speaking (n=23) students thought that learning based on learning style facilitated their learning. Statements of a student on this issue is given below:

> *Stu7: "…My learning style is kinesthetic, I learn through experience. I could not learn by hearing. Sometimes I used get lost in thoughts while listening to the conversations. My mind drifts away and it makes it difficult for me to learn. I have such problems in classroom environment as well. In this sense, I think learning based on learning styles facilitated learning process for me …"*

Similarly, all of the teachers believed that learning based on learning styles via UZWEBMAT was beneficial for students. One of the teachers expressed his/her views on facilitation of learning with the following words:

> *A: "…Since students learn the content by interpreting it based on their learning styles, I think this system facilitated learning process for them …"*

Majority of students (n=21) stated that shifting between learning styles within UZWEBMAT facilitated their learning as well. Students believed that being guided between styles offered a different perspective. Thus, it contributed to their learning. Student views on this issue are as follows:

> *Stu13: "…My learning style was auditory. When I failed in auditory activities, I was guided to visual ones. Tips in that section were a little different. They helped me to comprehend better …"*
>
> *Stu19: "… Being guided to another style and viewing from a different perspective was beneficial…"*

Teacher views on this issue correspond to student views. As a matter of fact, all of the three teachers stated that being guided to the same activity in secondary or tertiary learning style upon failing to complete an activity was positive. This guidance provided a different perspective to students. Thus, it was thought that it facilitated learning. A teacher thinking thus expressed his/her ideas as follows:

C: "… Receiving contents differently led students to reach the conclusion by gaining different perspectives…"

All the teachers regarded being guided to a simpler question and provided with solution supports and tips when needed by UZWEBMAT upon giving incorrect answers to the questions within activities as beneficial. It had a positive effect on their learning. Teachers also stated that they also employed the method of guiding to a simpler question upon giving incorrect answers and it was a method facilitating the learning. In relation to the issue, a teacher gave his/her opinions;

B: "… We also employ this in our classes. When a student does not get a question, we try to help him/her by simplifying that example. This system employed this method as well. This was really beneficial and positive for students. I think this structure facilitated their learning…"

***b) Permanent Learning**:* Students (n=21) denoted that studying with UZWEBMAT was really good for them. Acquiring concepts and principles by themselves without being dictated was regarded as positive by students. There were opinions that learning via UZWEBMAT would be more permanent by its very nature. It gives control to the student by creating a learning environment appropriate to individual characteristics. It enables permanent learning by providing an environment for exploration. Thanks to these features, students expressed their wish to use UZWEBMAT (n=19). Some of the student views are given below regarding the issue:

Stu3: "…It is more permanent since I explore it myself. It is not to be forgotten. So, it was good to study in these environments…"

Stu21: "…I studied with UZWEBMAT and received an instruction appropriate to our characteristics. I made deduction on principles and concepts without being dictated by means of activities. To me, it was more permanent and different from classroom environment. For example; I will not forget the relationship between combination and permutation or its formula. …"

These views were supported with the data obtained from teachers. In this sense, views of a teacher on this issue are as follows:

C: "…Self-study of students and individual learning as well as entrance into a different learning environment are all distinct from traditional class environments. In this sense, the most outstanding characteristic of UZWEBMAT is its instruction for all students, one way or another. Different tips and solution supports within activities and shifting between styles when needed are the most prominent characteristics. Thanks to this structure, I think student knowledge will be more permanent…"

***c) Exploring mathematical relationships and formulas**:* Most of the students (n=20) positively commented on learning concepts and principles of the relevant subject via UZWEBMAT and activities. In this type of learning, students expressed that they learnt and explored concepts, principles and formulas without receiving assistance from the teacher through tips and solution supports. Views of two students on this issue are as follows:

Stu9: "…This method enabled me to comprehend the formula better. It allowed me to understand where formulas come from…"

Stu15: "...While studying with this system, no formula was dictated to me. Instead, the subjects were instructed via activities. We explored the formulas and relationships within the activities. This helped us to understand where these formulas come from. It is a different and nice structure..."

Similarly, majority of students (n=20) expressed that tips and solution supports in the activities had a positive effect on exploring mathematical relationships and formulas. Student views on this issue are as below:

> *Stu2: "…By solving the problems in the activities again and again, we made up the formula. I think it was good from this perspective…"*
>
> *Stu13: "…Instead of memorizing the formula and implementing on the question, I try to figure out the formula by reasoning. Thus, it affected this process positively …"*
>
> *Stu24: "…We progressed step by step. Exploring relationships and formulas in this respect made it easier for me to learn. Besides, it raised my curiosity, like, what will I acquire and so on. UZWEBMAT raised my exploration skills…"*

Teachers also agree with the idea that learning concepts and principles relevant to the subject without giving direct information (through activities) assisted students to explore mathematical relationships and formulas. Making reference to constructivist approach, teachers emphasized the fact that new curriculum employed the same approach as well. Also, it was highlighted that this method enabled students to explore concepts and principles. Opinions of two teachers were given below in relation to this issue:

> *A:"…New curriculum aims at making students to explore and make conclusions on concepts and principles on his/her own as well. In this sense, activities such as making a whole from the parts (via activities), making mind exercises, forming certain concepts in their minds are our objectives, too. UZWEBMAT has this structure and it is quite beneficial…"*
>
> *B: "…Presence of tips and solution supports which assist you to explore concepts, principles and formulas on your own, are pretty effective on students' learning. Exploring mathematical relationships, concluding those formulas were particularly appropriate for this subject…"*

d) Independent learning: Majority of students (n=18) stated that it was possible to experience learning independent from teachers after being instructed in the learning environment created by UZWEBMAT. Views of students who thought accordingly are as below:

> *Stu7: "…It is possible to learn without a teacher. It is just like a teacher. I think teacher means UZWEBMAT…"*
>
> *Stu14: "…I think it is possible to learn independent from teachers. There was everything we need to learn, we were able to learn without even having prior knowledge on the subject…"*
>
> *Stu16: "…I used to say that I would not solve certain problems without teacher. Thanks to tips within UZWEBMAT, I understood that I could solve the problems without being lectured…"*
>
> *Stu25: "…I realized what I could do without a teacher or what kind of weaknesses I had in absence of the teacher as well as the things I could manage without needing anyone. In this sense, my self-confidence grew. That is to say, teacher is not irreplaceable for learning…"*

One of the teachers was of the opinion that learning occurs without a teacher thanks to UZWEBMAT. However, two of them expressed that "no single system is adequate on its own". These teachers stated that human factor in learning environments is too important to be ignored. However, they also asserted that UZWEBMAT would be a substantial contribution to courses. View of a teacher regarding the issue is as follows:

> *A: "…I do not think that a single instruction system on its own would be beneficial on students. In addition, a teacher on his/her own is not adequate either. I believe that the use of both will be more beneficial for education. In this sense, UZWEBMAT system might be beneficial for students, yet a teacher has to create a learning environment for students over this system…"*

Negative Reflections from the Learning Environment Created by UZWEBMAT

In accordance with the findings of the study, negative reflections from the learning environment created by UZWEBMAT were divided under two main themes. Table 4 shows negative reflections from the study under the titles.

Table 4. Negative Reflections from the Learning Environment Created by UZWEBMAT

Items	Main Themes	Frequency (Student)	Frequency (Teacher)
a)	Concern for central exam	17	3
b)	The possibility of implementation for all subjects of mathematics	13	1

In addition to presentation of main themes derived from data analysis, content of each main theme was given in detail below.

a) Concern for Central Exam*:* Most of the students (n=19) and all of the three teachers believed that exam system and question types in the schools were not compatible to this kind of learning environment. Thus, this became the leading main theme of the negative reflections. Examinees stated that exam types in the schools and question types in university entrance exams (which they will be obliged to take for higher education) made them worried. Some of the student views on this issue are as follows:

> *Stu4: "… It was fun to study with UZWEBMAT system. It is quite different from the classroom environment. We learnt on our own and individually. However, there is the possibility of encountering different questions in the exams. In this sense, it would be wrong to say I do not worry. I worry about the exams..."*

One of the teachers pointed out to the fact that exams and question types must be prepared based on this method in order to achieve full efficiency from this method. It is expressed as follows:

> *C: "…Question types in the exams must be organized in such a way that they would enable reasoning…"*

In this sense, concern for central exam system was considered negative reflection.

b) The impossibility/possibility of implementation for all subjects of mathematics*:* Another negative reflection in relation to learning environment created by UZWEBMAT was the difficulty or impossibility of learning all subjects of mathematics via a system like this. Majority of students (n=15) stated that subjects which were easy to visualize and comprehend could be instructed with a system similar to UZWEBMAT. However, they believed that subjects which were difficult to visualize and comprehend could not be instructed. Negativity on this issue was also felt in the statements of teachers. As a matter of the fact, two of the teachers stated that it was not possible to instruct other subjects of mathematics with a system similar to UZWEBMAT. Statements of a teacher on this issue are as follows:

B: "…Each subject has a structure of its own. I do not think that this method can be employed for all subjects. It can be employed for many subjects however, there are such subjects that it is impossible for a student to experience part to whole learning and exploration processes..."

Discussion, Conclusion and Suggestions

Purpose of the study was to reveal reflections from the learning environment created with the integration of UZWEBMAT, which was designed as an adaptive and intelligent e-learning environment, into real class environment. In this sense, a study was conducted with 10th grade students. In order to reveal views and opinions of the examinees, qualitative data was obtained from students and teachers. This data was analyzed via content analysis. Recommendations in accordance with the results of the study can be briefly expressed as below. The findings were evaluated under two categories which were student views and teacher views as well as positive and negative reflections. Positive and negative reflections obtained from the findings of the study are substantially important since they were in parallel with student and teacher views. As a matter of the fact, experiences during the study and post-study interviews showed that all the positive reflections were regarded positive and all the negative reflections were regarded negative both by students and teachers alike.

Positive reflections derived from the study can be discussed separately in terms of students and teachers. Students particularly emphasized that learning based on their learning style facilitated their learning. In this sense, it was possible to say that UZWEBMAT environment was an appropriate learning environment for them. Shifting between learning styles and leveled questions within activities as well as solution supports contributed much to students in terms of exploring mathematical relations and deducing formulas. One of the most distinguishing aspects was permanent learning. In fact, majority of students thought that they learnt by exploration through tips and solution supports. Thus, they believed them to be permanent and not to be forgotten. Another point indicated by students who studied with UZWEBMAT was the possibility of learning independent from teacher. Considering these evaluations, it is clear that they correspond to the findings in literature which suggest that e-learning environments based on learning styles are appreciated by students and students prefer such environments (Triantafillou, et al., 2003; Brown, et al., 2009; Cabada, et al., 2011; Mustafa & Sharif, 2011). The concept of learning independent from teachers was not regarded as substitution or replacement of teachers by UZWEBMAT. Purpose of this type of question was to observe limitations of UZWEBMAT. That is because the purpose of the study was to thoroughly determine student views, who were instructed without a teacher (instructed individually), regarding self-learning processes. In this sense, UZWEBMAT is not a teacher but a supplementary tool and assistant to teacher. Its purpose is to enrich the learning environment. To teachers, receiving appropriate content based on learning styles, shifting supports between learning styles, solution supports and tips within activities were quite beneficial for students as well. Structure and content of UZWEBMAT facilitated students' learning, enabled them to learn through exploration, construct their own knowledge and ensure permanent learning. Hence, it was revealed that it would be considerably beneficial for students.

Considering negative reflections of the study, it was seen that these were divided into two. These were concerns on central exams and the difficulty of instructing all subjects of mathematics with a system similar to UZWEBMAT. These were also shared by both students and teachers. They were regarded as problems stemming from exam type enforced by the educational system and the nature of mathematics. Thus, it is clear that this situation is not directly related to UZWEBMAT. In other words, it was clear especially from the statements of the teachers that characteristics of UZWEBMAT, which seemed negative, were indeed based on educational system. Effective integration of individual learning and constructivist approach into real class environments may remove the so-called negativities.

Addressing the findings of the study as a whole, correspondence of teacher and student views and their being positive to a great extent increases the implementability of UZWEBMAT. This supports the belief in literature that it will contribute to the studies devoted to the development and generalization of e-learning environments based on learning styles (Schiaffino, et al., 2008; Mustafa & Sharif, 2011).

As indicated by the results of the study, UZWEBMAT was regarded as beneficial both by students and teachers to a great extent. UZWEBMAT contributed to students particularly in terms of facilitation of learning, permanent learning, learning through exploration and individual/independent learning processes. By its very nature, UZWEBMAT can be both employed as an individual learning tool and a tool for assisting students in real classroom environments. UZWEBMAT is also a good teaching tool for teachers. Taking this into account, extending the use of learning environments similar to UZWEBMAT and their integration into real classroom environment are really important in this domain. Besides, enriching the content of UZWEBMAT and extending it to cover different subjects can turn it into an important tool for teaching mathematics.

There were negative results at the end of the study which were concerns for central exam and the possibility of implementing such an environment for all subjects. Considering negative aspects of the study, concerns of central exam require important changes. Among these changes, the most important one is the frequent employment of learning environments where individual differences are taken into account or learning styles are integrated. As advocated by new curriculums, constructivist or student centered approach must be attached more importance and practiced more. Similarly, exam systems, particularly question types in written exams given in schools, must be diversified. Developing such systems for other subjects of mathematics and their integration into real class environments may assist to create the perception that these kinds of environments can be employed to learn/teach different subjects and to generalize such systems.

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