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The Effect of Using Negative Knowledge Based Intelligent Tutoring System Evaluator Software to the Academic Success in English Language Education

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Abstract: This research was conducted to determine the effects of the using negative knowledge based Intelligent Teaching System (ITS) evaluator software in the assessment and evaluation processes (determining and correcting the misconceptions) of English Teaching as an Foreign language. Experimental design with pretest-posttest control group was used in this study. ITS software was used for the Experimental Group and it was not used for the Control Group. The study group consists of 67 students who are studying at the Vocational School of Technical Sciences located in Canakkale/Turkey. In this study, educational software based on correcting misconceptions developed by the researcher was used. At the end of the fifth week following the 4-week experimental procedure, the academic achievement of the students was determined by posttest. As a result of the research; it was found to be a significant difference [t(33)=-7.13, p.05] between the pretest scores of the experimental and control groups. There was a significant difference [t(65)=-1.15, p>.05] between the pretest scores of the experimental and control groups. There was a significant difference [t(65)=-2.25, p<.05] in posttest scores' of control and experimental group students.

Keywords: Negative knowledge, misconception, assessment, intelligent tutoring system, computer assisted instruction.

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Introduction

The widespread use of computers and access to the Internet has created many opportunities for online education, such as improving e-learning and classroom support (Latham et al., 2012). E-learning is a learning model that is the product of the developments in information technologies. This model offers the advantages of enriching the learning contents with audiovisual items and delivering them at any time, on demand, at low cost, quickly (Clark, 2016). E-learning model is used in many language education, mainly for English in Turkey (Arıcı & Karacı, 2013). The purpose of using computers to support teaching; help to learn. In this direction, educational technologies have developed rapidly and more effective teaching techniques have emerged. One of these techniques is Intelligent Tutoring System (ITS) (Burns, 2013). ITS is a computer based system that knows what to teach, who to teach and how to teach (Nwana, 1990). The application of ITS in the field of education has increased considerably due to the fact that ITS provides students with the opportunity to learn on their own, to offer individual education according to each student, to provide intelligent help and orientation, and to work independently of time and place (Dağ and Erkan, 2004; Zhiping et al., 2012).

ITS is one of the most used approaches in the field of education of expert systems, one of the applications of artificial intelligence technology. Expert System is defined as a computer program that is provided by one or more of the human experts in this area covering a very wide range of information related to that field in a given field and acts like these experts in problem solving (Wenger, 2012). The modules used by the structure of the expert system, the student can provide personalized feedback and problems. Expert system-based instructional softwares are systems based on creating a user or student model by recording the progress and user preferences of the students during the information acquisition process (Rickel, 1989; Önder, 2003). These systems organize learning and teaching processes by guiding students according to their personal characteristics. ITS; whether the student answers are wrong, whether the students answer the questions, whether they are in the right order, and so on; compares situations and directs students according to their individual needs in the teaching and learning process (Viryou, Alepis, 2005). When they are used instead of traditional teaching methods, the students give shorter and more

effective learning opportunities (Hotomaroğlu, 2002). One of the advantages provided by ITS is the ability to provide urgent explanations and feedback to the students when they need (Chen et al., 2008; Kaya and Korkmaz, 2007). Because learning mistakes can offer many opportunities for teachers to correct their learning and reconfigure the teaching process. The third principle of the evaluation process is that this process is an individualized process and that evaluation strategies are as individualized as possible (Turnbull et al., 2007). For example, using the same test for all students with disabilities is not only inappropriate, but also practically impossible. Because these individuals have individual characteristics so that it would require an individualized approach (Bransforf et al., 2009; Kargın, 2007). With the advanced assessment features that ITS has, it offers different possibilities for students with different learning abilities (Šimić et al., 2004; Rosic et al., 2006).

Although evaluation is considered the same as tests, evaluation is a process involving more than just testing and recording results (Deeks, 2001; Kargın, 2007). This process involves careful analysis of the information provided by different tools and techniques, including tests, and the results obtained should include functional and appropriate decisions. Deciding which tool and technique is appropriate will vary depending on the purpose of the evaluation (Salvia and Ysseldyke, 2001; Turnbull et al., 2007). The true and wrong answers of the students are described by the concepts of positive and negative knowledge in the evaluation process (Gartmeier et al., 2008).

Minsky (1994) divides the concept of knowledge into two parts, positive and negative, by considering it in the context of "knowing and doing". Accordingly, the positive knowledge is "knowing what a person will do" and the negative knowledge is "do not know what a person will do". Unlike positive knowledge that can be seen in behavior, it is more difficult to identify the negative knowledge obtained from mistakes and failures. Gartmeier (2008) expresses this difficulty in the form of "valuable but not applicable knowledge". Bickhard (2004) defines positive knowledge that he accepts rationally as "avoiding mistakes". Heinze (2005) defines negative knowledge as "incompatibility with previous knowledge". Tauber (2009) defines the concept of negative knowledge as "knowing what to avoid when making a decision". With these definitions, negative knowledge can be expressed as "learning from mistakes and failures". Also Positive knowledge alone may not provide the necessary opportunities to learn.

Awareness at the level of high-level learning and wisdom may not suffice for the positive knowledge alone to reach meaningful coherence and scholarly specialization. Moreover, the driving force that motivates people to find new things is not only positive knowledge. Because human history is actually filled with clues to "discover what we will not do" and to show that we know and discover new things (Barrick et al. 2011; John Walker, 2014). For example, it is known that, false information (negative knowledge) in the form of people accepting (recognizing) the world as a whole in antique ages then it lead them to think more about the universe and the world. Otherwise, at the beginning of the time everything was thougt o be complete and correct and if this idea were true, the life would probably be static and unbearable (Bhekuzulu, 2006). Similarly, it is known that many of the information we know and use today is based on mistakes and failures that are heavily priced (Akpınar and Akdoğan, 2010). Negative knowledge is about information about what is wrong and what should be avoided in a decision making process, usually through trial- (Tauber, 2009). Lambe (2006) defines negative knowledge as "the ability to learn from mistakes" by taking the concept of 'wisdom' into consideration. Because of these negative knowledge is very important in our life.

When an individual encounters something that is incompatible with his or her information, it becomes more sensitive to recognize this new condition by rethinking or waiting for actions. From this, it can be said that the previous (old) ways of thinking and knowing something (positive knowledge) prevent the individual from seeing new potentials and therefore negative knowledge is necessary in this case (Parviainen & Eriksson, 2006). From this point of view, it can be said that focusing on only positive knowledge constantly in the process of teaching-learning has the potential to prevent the individual from trying new ways of taking risks. It is also obvious that such a strategy will not help to improve the individual's entrepreneurship and creativity. This is because students start to question more when they are doing wrong when they are being directed (Montenegro, 2004). In this respect, schools should not be content with repeating only known paths leading to purpose; also there should be used negative knowledge that students can question to support their high-level learning, entrepreneurship, risk taking, and other characteristics. For this, it can be considered that in the process of learningteaching, learners should have opportunities to make mistakes in a controlling system. (Akpınar and Akdoğan, 2010) .Learners’ mistakes can give

information about their foreknowledge. Foreknowledge is one of tke key point of learning process. Because problems related to foreknowledge can cause difficulties in understanding and learning. Students may not have the necessary foreknowledge, they may not be able to benefit sufficiently from the foreknowledge, they may have incompatible or incorrect foreknowledge, or they may fail to use the information in the text. Such situations may create problems in that they can fail to understand what they read. Therefore, it is important to correct the mistakes that occur as a result of the foreknowledge.

The important thing is that the mistakes in the learning process are carried out in such a way as to prevent further mistakes. Heinze (2005) refers to this as "using the mistake as a producer". For this, it is very important that the awareness level of the individual is raised. In this context, mistakes and failures can be implemented as "feedback and corrective action" (Alpkan and Doğan, 2008), in order for schools to become "learning organizations". BDI software can provide visual and auditory richness and convenience in correcting misconceptions and misunderstandings. It is stated that the animations prepared with multimedia support on the computer makes it easy to understand complex events with collaborative applications (Milrad, 2002). Computerassisted instructional software for teaching language, as it is in the teaching of the other learning fields, provides improved possibilities in many different settings.

Purpose of the Study

Constraint-based student modelling (CSM) can provide good opportunities for learning from mistakes (Mitrovic et al., 2003; Ohlsson 1996). Because, CSM Ohlsson's theory of learning from performance mistakes can be used as an effective tool. According to this theory, "We either learn our own mistakes, or we learn when we have caught the mistake of somebody else" (Ohlsson, 1994). This theory defines learning as a two-stage process: a mistake is first detected and then corrected (Galvezet al., 2009; Woolf, 2009; Martin and Mitrovic, 2002). In CSM, field information is expressed by constraints and student mistakes are determined by using these constraints. Feedbacks on identified faults are also determined by means of constraints (Mitrovicet al., 2013). Using CSM in computer-assisted learning process can give some opportunities for learning.

It has been found out in the literature that computer-assisted English teaching is more effective than traditional methods and so that students learn better and faster with Computers. (Alsagoff et al., 2012; Chambers et al., 1980; Chapelle, 2008; Gömleksiz & Düşmez, 2005; Gündüz, 2005; Liu et al., 2010). Gömleksiz and Düşmez (2005) found that in the application of the Relative Clause in English, 28 students in the 8th class had computer-assisted instruction in their practice and that the experimental group reached the result that their students were more successful. Çetin Köroğlu (2014) has come to the conclusion that 23 university students' mistake-finding and mistake-correcting studies on article software are important in foreign language teaching. Ay et al. (2006) found that scores of students' computer and English attitude scores increased significantly after computer-assisted 'English teaching', according to a survey of including 30 people. As a result; researches on technology use in English language teaching has reached the conclusion that it positively influences students' academic achievement.

The purpose of this study is using an e-learning system that can address the needs and problems described above and determining its impact on the academic achievement of students. In this study, an ITS model was proposed for the evaluation of the "Time" teaching process within the context of teaching English as a foreign language. The content of the educational software is not based on The English teaching curriculum. The general English knowledge is taken as basis. According to the proposed model, the student learns to use the constraint-based student model (CSM) based on the mistake he made while solving the problem, and at the same time, Thus, after the student has solved all the problems, he can find out from which subheadings the wrong learnings originate. By using this data it is aimed to create a practise and an idea for designing educational softwares based on negative knowledge.

Methodology

In the study, semi-experimental design with pretest-posttest control group was used. The experimental design is defined as research designs that are used to explore cause-and-effect relationships between variables (Büyüköztürk, 2007). The purpose of the semi-experimental design is the same as the experimental design. The difference between them is that semi-experimental design, control and experimental groups are selected by measurements rather than by chance (Ekiz,

2003, Karasar, 2006). In this study, no random selection was made in the selection of the experimental and control group participants, and it was checked that the pretests of the groups were equal in terms of academic success, the dependent variable of the researcher. This research was carried out with 67 students taking English lessons at the Vocational School of Technical Sciences in Canakkale in the second term of 2016-2017 academic year. Participants are 37 girls and 30 boys. One of the 2 classes with the same level of achievement and the other group was defined as the experimental group. The content of the educational software and the tests (pre-post tests) is not based on The English teaching curriculum. The Present Perfect Tense has no similar use in Turkish grammar. For this reason, learning this topic in English is one of the biggest difficulties for Turkish learners in different age groups. Because of these general English knowledge is taken as basis. In developing and designing process of the educational software each mistake possibilities caused by grammar misconception were taken into account. In analysing process 50 students entered a gap-based test created by English teachers. After analysing these test mistakes feedback possibilities are designed and coded by software designer. Independent (t) test was used in the comparison of scores of the control and experimental groups in the comparison of the academic achievement averages of the students, and the dependent (t) test statistic was used for the pretestposttest comparisons of the control and experimental group students. The data were entered into the SPSS 16.0 program and statistical analyses were made.

Sampling

The research was carried out with an experimental research model. The gender, computer use levels, and dependent variables of the independent variable students of the study are the academic achievements of the students. Practice was carried out with 67 participants who continue their education at the Vocational School of Technical Sciences in Canakkale/Turkey. Practice was carried out with students showing a similar success in the 1th grade English lessons of the College.

Data collection tools

The data of this study were collected by "Successful Test of English Time (Present Perfect / Simple Past)". The pre-post tests were prepared by 3 teachers who are working as English Teachers in that school. It consists of 20 questions from the topics of "Simple Past" and "Present

Perfect", which are one of the topics that are mixed with each other about "times". The content of the educational software is not based on The English teaching curriculum. The general English knowledge is taken as basis. The Present Perfect Tense has no similar use in Turkish grammar. For this reason, learning this topic in English is one of the biggest difficulties for Turkish learners. Teaching software has been prepared by the researchers in the Adobe Flash program for the purpose of teaching the purposes stated in the specification table and subject matter for use in the teaching process. This software was based on individualized learning and evaluating processes including feedback for personal misconceptions. Users' also have opportunities for listing of their mistakes and missing topics. The interface screenshot of the teaching software is given in Figure 1.

Attention has been paid to the use of constructive feedback in the content design of instructional software in order to detect and correct misconceptions. In this context, evaluation was made in software to determine the readiness level of the students and to analyse the concepts that the learners had to know before the learning process and to guide the students. Instead of a multi-choice response system, a design that allows students to write their own answers is preferred. Thus, it is aimed to provide the negative knowledge environment mentioned in the introduction. A screen shot of the content design prepared for evaluation is shown in Figure 2.

In this process determined as mistake finding and correction, the user is not informed about the mistake only. Information on correct use of the incorrect answer is also provided. The correct answer of the screen display question (Figure 2) is "have broken". When the user responds to the mistake probabilities, for example "broke", the explanation of the correct use of the past time is given as an explanation. In this process, the user can learn both the right answer and the correct use of the wrong answer. As a result of the evaluation made, missing subject list students are presented. The evaluation result image is shown in Figure 3.

In this research this evaluation system was used as an analyser tool for individual learning. In designed and developed this software there is no subject explanation and teaching parts. With the evaluation process using these tools it was possible for the students to check their own learning process by listing the mistakes and incompleteness of them. Thus, individual learning and assessment is supported.

Results

The findings on 1st sub-problem

The first sub-problem of the study was expressed as “Are there any differences between the experimental group students (using ITS Software based on Negative Knowledge) and the control group students (using traditional learning processes) in the pretest scores". The t test (for independent groups) was assessed using the analysis method to determine whether there was a significant difference between the pretest scores of the experimental and control groups, and the findings are shown in Table 1.

Table 1. T-Test Results for Independent Groups Regarding Pre-test Scores of Students in Control and Experimental Groups

Groups	N	$\overline{X}$	sd	df	t	p
Control	33	52,42	8,49	65	-1,15	0,25
Experimental	34	55,74	14,20			

The result of the pretest is that there is no significant difference in the achievement scores [$t_{(655)}$=1.15, p>.05] of the experimental group students. Student pretest scores are close to each other. There is a difference of about 3 points in favor of the experimental group among them. These values shows us that groups are similar before the practise.

The findings on 2nd sub-problem

The second sub-problem of the study was expressed as "Is there a meaningful difference between the pretest and posttest scores of the students of the experimental group?" The t test (for Dependent Matched Groups) analysis method was used to determine whether there was a significant difference between the pretest and posttest scores of the experimental group and the findings are shown in Table 2.

Table 2. T-Test Results for Dependent Matched Groups Relating to Pretest and Posttest scores of Students in Experimental Group

Groups	N	$\overline{X}$	sd	df	t	p
Pretest	34	55,74	14,20	33	-7,13	0,00*
Posttest	34	65,29	15,07			

Table 2 shows that there is a significant difference in the achievement scores of the students in the experimental group as a result of the applied posttest. It is seen that there is an increase of approximately 9.5 points in the average score of the experimental group in the table contents. Using negative knowledge based intelligent tutoring system evaluator increased posttest results of the students in experimental group.

The findings on 3rd sub-problem

The third sub-problem of the study was expressed as "Is there a meaningful difference between the pretest and posttest scores of the students of the control group?". The t test (for Associated Dependent Groups) analysis method was used to assess whether there was a significant difference between the pretest and posttest scores of the control group and the findings are shown in Table 3.

Table 3. T-Test Results for Dependent Groups Related to Pretest and Posttest scores of Controlling Students

Groups	N	$\overline{X}$	sd	df	t	p
Pretest	33	52,42	8,49	32	-7,93	0,00*
Posttest	33	58,18	10,22			

Table 3 shows that there is a significant difference [t(28)=-7.93, p<.05] in the achievement scores of the control group students as a result of the pretest-posttest scores. Control group is seen to have increased by approximately 4 points in average score. This increase is not as high as the increase in the experimental group.

The findings on 4th sub-problem

The fourth sub-problem of the study was expressed as "Is there a meaningful difference between the experimental group and the control group in the posttest scores?" The t test (for independent groups) was analysed by the method of analysis to determine whether there was a significant difference between posttest scores of the control and experimental groups and the findings are shown in Table 4.

Table 4. T-Test Results for Independent Groups Regarding Posttest Points of Students in Control and Experimental Groups

Groups	N	$\overline{X}$	sd	df	t	p
Control	33	58,18	10,22	65	-2,25	0,03*
Test	34	65,29	15,07			

Table 4 shows that there is a significant difference [t(65)=-2.25, p<.05] in the achievement scores of the control and experimental group students as a result of the posttest results. It is seen that the score average of experimental group is about 7 points higher than the control group. Students in experimental group (using negative knowledge based intelligent tutoring system evaluator) got posttest results of the more than students in control groups (learning by using traditional instruction strategies).

Discussion

In the findings obtained in the research; it was seen that there was a significant difference in posttest scores of students using intelligent teaching system software compared to their pretest scores. Also it shows a significant difference between the posttest scores of the control group and

the experimental group using the negative knowledge based intelligent tutoring system evaluator software. As a result, the use of intelligent teaching system software has been found to increase the academic achievement of students. This result obtained in the research confirms the results of the application indicating that the application of ITS is successful in correcting student conceptual misconceptions (Anohina-Naumeca, 2015; Büyükkasap et al., 1998; Browning & Lehmen, 1988; Heilman et al., 2006; Karacı, 2014; Murray & Pérez, 2015; Mitrovic et al., 2013).

It is important that the teaching material address multiple senses in maintaining the permanence of the learners (Shams & Seitz 2008). In addition, it is very important to develop and use teaching activities that can motivate students' visual and intellectual structures while explaining abstract and difficult concepts (Vosniadou et al., 2001). Intelligent Tutoring System has many opportunities for this (Murray, 2003).

It is considered that more effective and instructive teaching software can be developed by including measurement evaluation systems which enable students to correct mistakes in ITS applications. Because the use of negative knowledge, which is revealed as a result of mistakes, may allow different opportunities for teaching. These opportunities can be summarized as providing an individual's depth of understanding, enhancing the ability to cope with complex situations-problem solving skills, specializing in knowledge, and supporting learning at higher levels (Akpınar and Aydoğan, 2010; Gartmeier et al., 2008; Parviainen & Eriksson, 2006). It can also limit high-level learning and creativity, as education only focuses on positive knowledge, students take risks, try new ways, interrogate and keep from seeing new potentials. Because individuals start to question more when they make mistakes and fail. This situation, which leads to mental tension, provides an important opportunity for deep learning (Cannon & Edmondson, 2005).

Negative knowledge should also be included as supplement to the positive knowledge in this education. However, when teaching mistakes are used as a learning path, care should be taken to ensure that mistakes are made to prevent further mistakes (Heinze, 2005). Thus, these mistakes should be used to produce the positive knowledge. By using ITS learners can solve and avoid the mistakes more effectively. The use of ITS is crucial in eliminating faults. Because ITS is a system

that can perceive the user's level of knowledge, psychological characteristics, learning style and speed, learning ability and strategy (Klašnja-Milićević et al., 2011).

As a result, ITS has good qualifications to provide student-centered learning environments. In software designs we generally forget to give importance to the evaluation process. Subject description part of the software's is not enough alone. Evaluation and feedback parts at least as important as subject description part is (Azmat & Iriberri, 2010). Personalization of the feedback part is very important as other educational software's parts (Kurilovas & Serikoviene, 2010) . So using negative knowledge can also support feedback and evaluation parts of the educational softwares. By using these tools learning may be more personal and comfortable for learners.

Conclusion

Softwares designed with an alternative evaluation (negative knowledge etc.) perspective are quite limited. On the other hand, the evaluation process can provide many opportunities for students to learn. An example of this is presented with this application. The use of intelligent teaching system software has been found to increase the academic achievement of students. This result is consistent with similar research results (Anohina-Naumeca, 2015; Büyükkasap et al., 1998; Browning & Lehmen, 1988; Heilman et al., 2006; Karacı, 2014; Murray & Pérez, 2015; Mitrovic et al., 2013). Literature research shows that there is a very limited number of studies on the success of educational software using negative knowledge. Identification of mistake possibilities of students' and creation of appropriate feedbacks for these mistakes are very difficult processes for educational softwares designers and developers. This situation is very important for this research.

This research is also meaningful to show to importance of the individualized evaluation process in learning process. We generally use evaluation process just for giving scores of students' achievement. In this research it was used as an analyser tool for individual learning. In designed and developed this software there is no subject explanation and teaching parts. But using negative knowledge evaluating tools in the software were affective in increasing academic achievement. With the evaluation process using these tools it was possible for the students to check their own learning process by listing the mistakes and incompleteness of the students. Thus, individual learning and assessment is supported.

Based on the findings of the research and the results obtained, the following suggestions were made:

(1) It is recommended that such a study be applied over a longer period of time and on a wider sample, and the effects on success, attitude and remembrance should be considered.

(2) This research was conducted with little context in the context of the English "Tenses" topic. For this reason, it is recommended to carry out researches that will allow testing of effectiveness in other teaching steps and in different lessons.

(3) It is recommended that a study can be applied to analyze the differences between the softwares of including classical (true/false scores etc.) evaluating system and negative knowledge evaluating based intelligent tutoring system software.

References

Akpınar, B. & Akdoğan S. (2010). Negative Knowledge Concept: Learning From Mistakes and Failures.*Western Anatolian Journal of Educational Sciences*, 1(1), 14-22.

Alsagoff, L., McKay, S. L., Hu, G., & Renandya, W. A. (Eds.). (2012*). Principles and practices for teaching English as an international language.* Routledge.

Anohina-Naumeca, A. (2015). Justifying the usage of concept mapping as a tool for the formative assessment of the structural knowledge of engineering students. *Knowledge Management & E-Learning*, 7(1), 56.

Arıcı, N. & Karacı, A. (2013). Intelligent Tutoring System For Turkish Learning (TÜRKZÖS) and Evaluation. *Turkish Studies*, 8(8), 65-87. Author. (2015).

Azmat, G., & Iriberri, N. (2010). The importance of relative performance feedback information: Evidence from a natural experiment using high school students. *Journal of Public Economics*, 94(7-8), 435-452.

Barrick, M. R., Mount, M. K., & Judge, T. A. (2001). Personality and performance at the beginning of the new millennium: What do we know and where do we go next?. *International Journal of Selection and assessment*, 9(1-2), 9-30.

Bransford, J. D., Sherwood, R. D., Hasselbring, T. S., Kinzer, C. K., & Williams, S. M. (1990). Anchored instruction: Why we need it and how technology can help. *Cognition, education, and multimedia: Exploring ideas in high technology*, 12, 1.

Bickhard, M. H. (2004). The social ontology of persons. *Social interaction and the development of knowledge*, 111-132.

Browning, M.E. & Lehmen, J.D. (1988). Identification of Students' Misconception in Genetic Problem Solving via Computer Program. *Journal of Research inScience Teaching*, 25(9), 741-761.

Burns, H. L., & Capps, C. G. (2013). of Intelligent Tutoring Systems: An Introduction. *Foundations of intelligent tutoring systems*, 1.

Büyükkasap, E., Düzgün, B., Ertuğrul, M. & Samancı, O. (1998). The Impact of Computer Assisted Science Teaching on the Misconceptions. *Kastamonu Education Journal*, 6, 59-66.

Büyüköztürk, Ş. (2003). *Handbook of Data Analyses for Social Sciences.* Ankara:Pegema Publishing.

Cannon, M. D., & Edmondson, A. C. (2005). Failing to learn and learning to fail (intelligently): How great organizations put failure to work to innovate and improve. *Long range planning*, 38(3), 299-319.

Chambers, J. A., & Sprecher, J. W. (1980). Computer assisted instruction: current trends and critical issues. *Communications of the ACM,* 23(6), 332-342.

Chapelle, C. A. (2008). *Computer assisted language learning* (pp. 585-595). Blackwell Publishing Ltd.

Chen, C. M., & Duh, L. J. (2008). Personalized web-based tutoring system based on fuzzy item response theory. *Expert Systems with Applications,* 34(4), 2298-2315.

Clark, R. C., & Mayer, R. E. (2016). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning.* John Wiley & Sons.

Çetin Köroğlu, Z. (2014). An Analysis Of Grammatical Errors Of Turkish EFL Students' Written Texts. *Turkish Studies,* 9(12), 101-111.

Dağ B., Erkan, K. & Dağ, F. (2005). User Modelling For Intelligent Tutoring System. 1. International Vocational and Technical Education Congress), Marmara University, İstanbul.

Dağ F., Erkan, K. (2004). Prolog Based An Intelligent Tutoring System. Denizli: *Journal of Engineering Sciences, Information Technology Congress,* 47-55.

Deeks, J. J. (2001). Systematic reviews of evaluations of diagnostic and screening tests. *Bmj,* 323(7305), 157-162.

Galvez, J., Guzman, E., Conejo, R., & Millan, E. (2009, July). Student Knowledge Diagnosis Using Item Response Theory and Constraint-Based Modeling. In *AIED* (pp. 291-298).

Gartmeier, M., Bauer, J., Gruber, H., & Heid, H. (2008). Negative knowledge: Understanding professional learning and expertise. *Vocations and Learning,* 1(2), 87-103.

Gömleksiz ve Serdemir Düşmez (2005), A Comparison of Computer Assisted Language Learning and Traditional Method on Student's Achievement in Teaching Relative Clauses. *The Journal of Turkish Educational Sciences,* 3(2), 163-179.

Gündüz, N. (2005). Computer assisted language learning. *Journal of Language and Linguistic Studies*, 1(2).

Heilman, M., Collins-Thompson, K., Callan, J., & Eskenazi, M. (2006). Classroom success of an Intelligent Tutoring System for lexical practice and reading comprehension. In *Ninth International Conference on Spoken Language Processing*.

Heinze, A. (2005). Mistake-Handling Activities in the Mathematics Classroom. *International Group for the Psychology of Mathematics Education, 3*, 105-112.

John Walker, S. (2014). Big data: A revolution that will transform how we live, work, and think. *International Journal of Advertising,* 33(1), 181-183.

Karacı, A. (2014). Intelligent Tutoring System Model Proposal for Teaching The Use of Punctuation Marks and Capital Letters in Turkish. *J Res Educ Teach,* 3(1):18–24.

Kargın, T. (2007). Eğitsel Değerlendirme ve Bireyselleştirilmiş Eğitim Programı Hazırlama Süreci. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi,* 8(1), 1-13.

Klašnja-Milićević, A., Vesin, B., Ivanović, M., & Budimac, Z. (2011). E-Learning personalization based on hybrid recommendation strategy and learning style identification. *Computers & Education,* 56(3), 885-899.

Kurilovas, E., & Dagiene, V. (2010). Multiple Criteria Evaluation of Quality and Optimisation of e-Learning System Components. *Electronic Journal of e-Learning*, 8(2), 141-151.

Latham, A., Crockett, K., McLean, D., & Edmonds, B. (2012). A conversational intelligent tutoring system to automatically predict learning styles. *Computers & Education,* 59(1), 95-109.

Liu, P. L., Chen, C. J., & Chang, Y. J. (2010). Effects of a computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension. *Computers & Education,* 54(2), 436-445.

Martin, B., & Mitrovic, A. (2002, December). Authoring web-based tutoring systems with WETAS. In *Computers in Education, 2002. Proceedings. International Conference on* (pp. 183-187). IEEE.

Milrad, M. (2002). Using Construction Kits, Modeling Tools and System Dynamics Simulations to Support Collaborative Siscovery Learning. *Educational Technology & Society,* 5 (4).

Mitrovic, A., Ohlsson, S., & Barrow, D. K. (2013). The effect of positive feedback in a constraint-based intelligent tutoring system. *Computers & Education,* 60(1), 264- 272.

Murray, T. (2003). An Overview of Intelligent Tutoring System Authoring Tools: Updated analysis of the state of the art. *In Authoring tools for advanced technology learning environments* (pp. 491-544). Springer, Dordrecht.

Murray, M. C., & Pérez, J. (2015). Informing and Performing: A Study ComparingAdaptive Learning to Traditional Learning. *Informing Science: The International Journal of an Emerging Transdicipline,* 18, 111.

Nwana, H. S. (1990). Intelligent tutoring systems: an overview. *Artificial Intelligence Review,* 4(4), 251-277.

Ohlsson, S. (1994). Constraint-based student modeling. In *Student modelling: the key to individualized knowledge-based instruction* (pp. 167-189). Springer, Berlin, Heidelberg.

Ohlsson, S. (1996). Learning from performance mistakes. *Psychological review,* 103(2), 241.

Parviainen, J., & Eriksson, M. (2006). Negative knowledge, expertise and organisations. *International Journal of Management Concepts and Philosophy*, 2(2), 140-153.

Rickel, J. W. (1989). Intelligent computer-aided instruction: A survey organized around system components. *IEEE Transactions on Systems, Man, and Cybernetics*, 19(1), 40-57.

Rosic, M., Glavinic, V., & Stankov, S. (2006). Intelligent tutoring systems for the new learning infrastructure. *Intelligent Learning Infrastructure for Knowledge Intensive Organizations: A Semantic Web Perspective*, 225-250.

Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. *Trends in cognitive sciences*, 12(11), 411-417.

Šimić, G., Gašević, D., & Devedžić, V. (2004). Semantic web and intelligent learning management systems. In *Workshop on Applications of Semantic Web Technologies for e-Learning*.

Salvia, J. & Ysseldyke, E.J. (2001). *Assessment.* (8th ed.). Boston: Houghton Mifflin.

Turnbull, A. P. (1995*). Exceptional lives: Special education in today's schools.* Merrill/Prentice Hall, Order Department, 200 Old Tappan Rd., Old Tappan, NJ 07675.

Virvou, M., & Alepis, E. (2005). Mobile educational features in authoring tools for personalised tutoring. *Computers & Education*, 44(1), 53-68.

Vosniadou, S., Ioannides, C., Dimitrakopoulou, A., & Papademetriou, E. (2001). Designing learning environments to promote conceptual change in science. *Learning and instruction*, 11(4-5), 381-419.

Woolf, B. P. (2010). *Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning.* Morgan Kaufmann.

Wenger, E. (2014). *Artificial intelligence and tutoring systems: computational and cognitive approaches to the communication of knowledge.* Morgan Kaufmann.

Zhiping, L., Yu, S., Tianwei, X., & Yang, L. (2012, July). The research of classical learner models in intelligent tutoring systems. In *Computer Science & Education (ICCSE), 2012 7th International Conference on* (pp. 1204-1207).

Appendix:

Figure 1. Mistake Finding and Correcting Screen Display

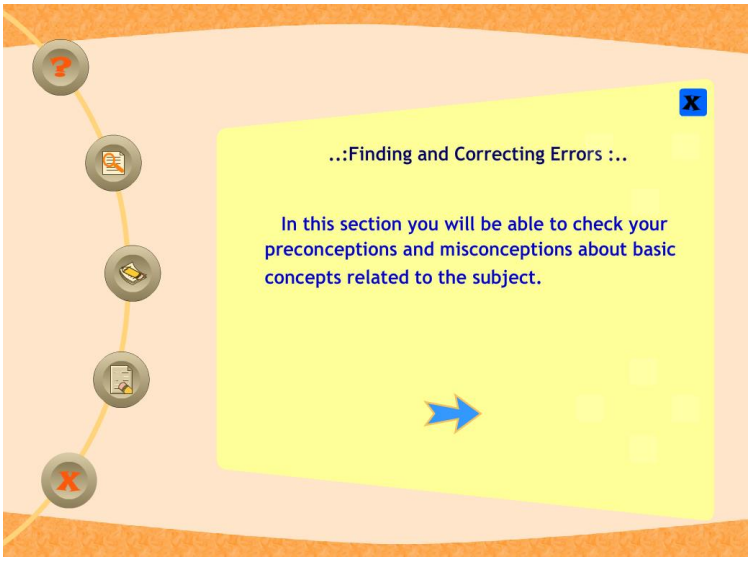

Figure 2. Wrong Answer and Feedback Screen

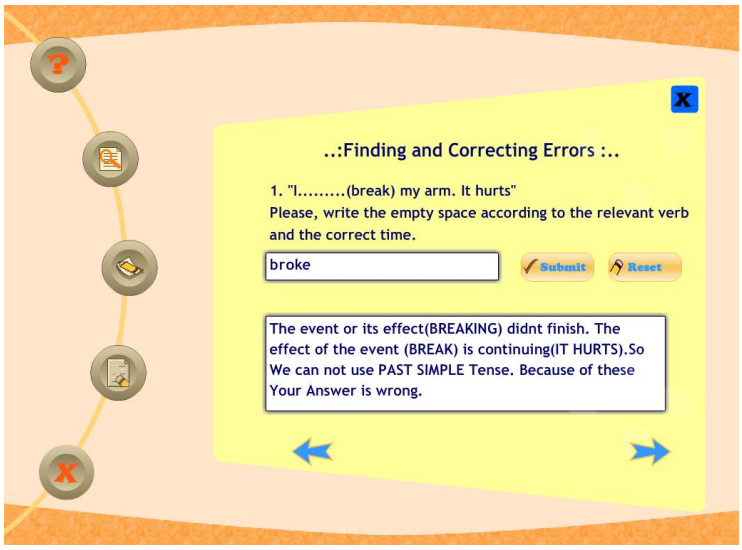

Figure 3. Wrong Answers List