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Content Analysis of Studies Conducted on Adaptive Educational Hypermedia Environments in Turkey *

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Abstract

The purpose of this study is to analyze various studies on adaptive educational hypermedia environments, regarded as a new field of research and application, in a comprehensive way. To this end, all postgraduate thesis studies conducted in Turkey, articles in the journals whose scope covers educational sciences and which published in Turkey, and articles with Turkey address in the international journals indexed in SSCI were reviewed and content analysis was employed. The study will present current situation of this field and also, inform those who are interested in adaptive educational hypermedia environments concerning deficiencies in the field in the light of similar studies conducted abroad.

Keywords

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Introduction

Despite the fact that today emerging technologies bring about several opportunities, growing amount of information and changes in learning needs of individuals have altered perspectives regarding learning environments (Somyürek, 2008). It is observed that 'one size fits all' approach in traditional hypermedia does not currently meet the demands (Graf & Kinshuk, 2014). In this approach, although needs and characteristics of each individual are different, all learners are regarded as equal in traditional hypermedia environments. This is not effective pedagogically and leads to many learning problems (Akbulut & Çardak, 2012; Brusilovsky, 2001; Jonassen & Grabowski, 1993). In this case, use of adaptive educational hypermedia environments is offered as a solution (Brusilovsky, 2004; Schiaffino, Garcia, & Amandi, 2008).

The terms *adaptive learning system, adaptive educational hypermedia system, personalized learning system, intelligent tutoring systems* are used exchangeable in the literature review. All these terms emphasizes that learning can be personalized by considering individual differences and thus, learning can be more effective. While intelligent tutoring systems focus on the use of artificial intelligent techniques so as to support learner, adaptive learning systems focus on how to present different learning activities and materials for different learners (Brusilovsky & Peylo, 2003; Graf & Kinshuk, 2014). The term adaptive educational hypermedia will be used throughout this article.

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Adaptive educational hypermedia systems offer a learning environment taking form in accordance with learners' needs and preferences during learning process (Brusilovsky & Peylo, 2003). Related studies in literatures show that such a learning environment affects learners' performance positively (Chen & Duh, 2008; Mampadi, Chen, Ghinea, & Chen, 2011; Yang, Hwang, & Yang, 2013), makes learning process easier (Graf, 2007; Papanikolaou, Grigoriadou, Magoulas, & Kornilakis, 2003; Popescu, 2010; Tseng, Chu, Hwang, & Tsai, 2008) and increases learner satisfaction (Mampadi et al., 2011; Papanikolaou et al., 2003; Popescu, 2010; Yang, et al., 2013).

Advantages of adaptive educational hypermedia systems emphasize the necessity of such systems and raise the issue of variables taken into consideration so as to improve these systems. Although variables such as learners' knowledge level and difficulty of learning content are important to improve adaptive systems (Graf & Kinshuk, 2014; Jonassen & Grabowski, 1993), researchers also point out that individual preferences should be taken into consideration (Hsu, Hwang & Chang, 2010; Tseng, et al., 2008). The first question to be answered in designing an adaptive system is "what are learners' characteristics in present?"(Gonzalez, Burguillo, & Llamas, 2006). Some of characteristics of learners are static and some are dynamic. Jeremic´, Jovanovic´ and Gasevic (2012) suggest that static variables such as e-mail, age, language are determined before learning process starts. Dynamic information obtained during the interaction between system and learner should be updated. First of all, learners' current characteristics should be determined in order to set a learner model. These characteristics are listed by Chrysafiadi and Virvou (2013) as knowledge level, learning style, learning preference, cognitive abilities, motivation, affective abilities, meta-cognitive features and misconceptions.

In adaptive learning environments, how such adaptation should be realized (user modeling) is another issue to consider. User modeling is employed to diagnose users and see needs of users truly. In order to set a user model, it is necessary to answer questions such as "which data should be taken into consideration for user modeling, how much data should be collected, how this data should be updated and how this data should be used for adaptation?" (Millán, Loboda, & Pérez-de-la-Cruz, 2010; Nguyen & Do, 2009). Process of user modeling is the most important part in developing adaptive systems. The quality of adaptation is ensured by the quality of data used in user modeling (Brusilovsky, 1996). User modeling can be static or dynamic. Static user model is generally set once he is first signed in adaptive educational hypermedia. Dynamic user model is permanently updated in accordance with data gathered on his behaviors and motions on system. The studies in the literature prove that dynamic user modeling provides near real and consistent results (García, Amandi, Schiaffino, & Campo, 2007; Graf, 2007). Based on user characteristics and needs, a lot of user modeling approaches such as overlay model, stereotype model, perturbation model, bayesian network model, fuzzy logic model are identified in the literature.

The next step after obtaining data on learner in user model is the choice of adaptation type. Brusilovsky (2001) divides adaptation types into two as adaptive navigation and adaptive presentation. The aim of content adaptation is to determine content based on learner needs and characteristics. Hypermedia systems may not contain merely textual data and therefore, both text and multimedia content should be adaptive (Brusilovsky, 2001). Content-based adaptive characteristics are adaptation of presentation type, adaptation of multimedia and adaptation of text. Adaptation of text is also realized in two ways. These are natural language adaptation and adaptation of text's parts. There are different techniques for text adaptation. These techniques are inserting/removing fragments, sorting fragments, altering fragments, dimming fragments and stretch text (Brusilovsky, 2001). Brusilovsky (2007) classifies adaptive navigation techniques such as direct guidance, link ordering,

link hiding, link annotation, link generation and map adaptation. Some or all of these adaptation techniques were employed in many studies in literature.

There are various studies regarding classification of adaptive educational hypermedia environments. According to framework of research, Alessandro (2006) lists four groups as "theoretical aspects", "authoring tools", "architectural refinements" and "adaptive learning systems". Studies presenting conceptual views focus on new trends in adaptive educational hypermedia environments, theoretical comparison of alternative learner modeling techniques and conceptual information about these environments. Design of authoring tools covers design and developing of authoring tools using alternative adaptation techniques on various subjects. Studies focusing on systems improved architecturally involve elaboration of necessary data on subject area and user modeling, and testing of new models regarding adaptation techniques. Studies in the last group are studies examining influences of developed adaptive learning system on learning process.

Inan, Flores and Grant (2010) classify developed adaptive educational hypermedia environments based on level setting. This is classified as "Pseudo Adaptive Web-Based Learning Environments", "Naive Adaptive Web-Based Learning Environments", "Advanced Adaptive Web-Based Learning Environments" and "Ultimate Adaptive Web-Based Learning Environments". The first level, so-called adaptive web-based learning environment, is the basic level for adaptation. At this level, user modeling is not made. Users are supposed to make use of materials according to their individual preferences. Rather than individualized learning environment, these environments are designed to balance individual differences by presenting several options. Individualization begins at second level called 'basic adaptive environment'. Different adaptive methods for each individual characteristic are applied in environments in this level. But, number of variables in this level is limited. Basically, the system matches each individual difference variable with an adaptive method. At the third level called 'advanced level adaptive web-based learning environment', the system considers more than one characteristics of a learner for modeling. Besides, it offers more than one navigation and content adaptation. Many adaptive web-based learning environments exist at this level. However, the systems at this level are not developed in accordance with learner's progress and motions. In the last level called 'adaptive systems', user model is totally dynamic and updated based on learner's motions and progress by monitoring their errors. Additionally, new technologies (eye tracking etc.) and methods are employed to evaluate affective states of learners in environments at this level.

In the literature exits many compilation studies which have been conducted on adaptive hypermedia environments considering different evaluation criteria at various times. Researchers generally aim to introduce current trends in designing adaptive educational hypermedia environments by focusing on questions such as "which individual characteristics are considered, which modeling approach are preferred, which type of adaptation is applied".

In their study, Triantafillou, Georgiadou and Economides (2006) examined adaptive variables employed in adaptive hypermedia environments. Variables used in user modeling are categorized as "user dependent" and "user independent". User dependent variables are defined as user foreknowledge, experience, preferences, interest, individual characteristics, personal data, ability/disability status, social group. User independent variables are current task, environmental conditions and position. These variables and available modeling approach are elaborated in the study.

Vandewaetere, Desmet and Clarebout (2011) conducted a compilation study on the contribution of learner characteristics to the development of adaptive education environment. PsycINFO, ERIC and Web of Science were reviewed according to the specified key words by the researchers. Results of the review were limited to empirical studies on efficacy of adaptive learning environment, studies giving detailed information about learning environment and studies on modeling focusing on learner characteristics. Studies not in English, book chapters and compilation studies were excluded. Studies were divided into three different themes as "source of adaptive instruction", "target of adaptive instruction" and "pathways of adaptive instruction". When studies were analyzed in terms of the first component, it was indicated that similar learner characteristics were taken into consideration to set learner model. Many research referred in this study focused on the integration of learner behavior and learner characteristics. However, the relation between parameters of this integration was based on assumptions. Therefore, it suggests to do research on the relation between learner behavior and learner characteristics for further research. When studies were analyzed in terms of the second component, adaptation was applied considering combination of content adaptation and navigation adaptation in most of the studies but content adaptation was applied in a few studies. When analyzed in terms of last component, techniques such as Bayesian networks, fuzzy logic and neural network were prominently used as new approaches in learner modeling, and it was highlighted that studies testing pedagogical efficacy of these techniques in learning environments were needed.

Chrysafiadi and Virvou (2013) reviewed research on learner modeling conducted between the years of 2002 and 2013 in literature. In this study, they elaborated on the issues regarding which learner differences were considered in which modeling approach in learner modeling process. They focused on learner knowledge level, learner style, misconceptions, affective characteristics, motivation, meta-cognition features and preferred modeling approaches for modeling these characteristics in modeling process. It was found out that overlay model was preferred to determine learner foreknowledge and stereotype model was employed in learner preferences and styles. perturbation model was employed so as to determine misconceptions, machine learning to determine motivation and Bayesian networks to determine meta-cognitive features. It was stated that fuzzy logic and Bayesian networks were employed increasingly in recent years in order to realize effective learner modeling and to overcome ambiguity in learner modeling process.

Akbulut and Çardak (2012) reviewed the literature between the years of 2000 and 2011 with keywords "adaptive/ adaptable e-learning", "adaptive/adaptable hypermedia", "adaptivity", "adaptation", "adaptability", "personalized e-learning" and "learning styles". They reviewed 70 studies in total. The results briefly are as follows: most of them are articles (67.14%), they mostly focus on learner style-based adaptation (81.43%), variable used for adaptation is learner style (%55.71), Felder-Silverman model is the most preferred learner style model (50%), static modeling is more preferred in learner modeling (60%), instruments used in modeling are scales and indexes (52.86%), monitoring is used for dynamic modeling (39.29%), researches mostly conduct in higher education (80.43%), most of participants are students (91.3%). Mostly used data collection tool is learning style scales (71.74%) and it is followed by achievement tests, questionnaires and observation.

In literature review done by Şahin and Kışla (2013), studies from different databases were listed under three titles as "individualized learning environment development studies", "development and evaluation studies of individualized learning environment" and "studies on features necessary for design of individualized learning environment". The reviewed studies were summarized in brief. It was examined in the related studies that most of the studies were web-based developed, individual characteristics were determined via questionnaire when first signed up for the system and according to the data given, students were directed towards different content. Additionally, it was determined that students from secondary school and higher education were generally chosen as sample.

So as to determine trends in adaptive educational environments and gaps in the literature, a range of year is first identified and categorization is made according to parameters like, titles, objectives, method, results. The data at hand is analyzed descriptively and interpreted. This type of studies gives an idea about overall changes and development in years. Unfortunately, it does not provide detailed information. In other words, this type of studies gives sight of forest but not trees. However, it is important and more beneficial for researchers who are interested in this field to examine studies in its theoretical structure in a detailed way.

Although there are some studies on adaptive educational hypermedia environments in the literature, there exists no comprehensive study elaborating on postgraduate thesis and articles in this field in Turkey. This study attempts to reveal present situation of Turkey. In addition to this, it is aimed to find out the relation between individual differences and adaptation model used in user modeling process in the studies conducted in Turkey by examining user modeling process and adaptation model of each study. In this way, it is aimed to compare similar studies in the literature and those conducted in Turkey, and reveal possible variables regarding the issue. Lastly, issues such as which methodology were used in the studies in Turkey and which results were reached in accordance with the methodology will be summarized.

Purpose of this study is to examine the studies conducted on adaptive educational hypermedia environments in a holistic and comprehensive way. To this end, all postgraduate thesis studies conducted in Turkey, articles in the journals whose scope covers educational sciences and which published in Turkey, and articles with Turkey address in the international journals indexed in SSCI were reviewed and content analysis was employed. In this context, the current study seeks to answer the following research questions:

1. Adaptive educational hypermedia environments in Turkey:
    a. How is the distribution when classified by the nature of study?
    b. How is the distribution when classified by the nature of developed adaptive educational hypermedia environment?
2. In studies on adaptive educational hypermedia environments in Turkey:
    a. How was the process of user modeling?
        i. Which individual differences were considered in user modeling?
        ii. Which modeling type was employed in user modeling?
        iii. Which sources of data were employed in user modeling?
        iv. When data employed in user modeling was updated?
    b. Which type of adaptation was used?

3. In studies on adaptive educational hypermedia environments in Turkey:
   a. Which research methods were employed and which dependent or independent variables are used in experimental studies
   b. Which sampling type was preferred?
   c. Which data collection instruments were used?
   d. Which data analysis method was used?
   e. What conclusions were reached?

Method

Content analysis method was employed to analyze the studies on adaptive educational hypermedia environments. Content analysis is basically a systematically summarizing and reporting process of analysis which focuses on textual data and messages conveyed by this textual data (Cohen, Manion, & Morrison, 2007). Çalık and Sözbilir (2014) states that content analysis can be carried out under three sub-domains such as meta-analysis, meta-synthesis and descriptive content analysis. In this study, meta-synthesis method was preferred since it examines the issue at hand critically and interprets in depth.

Data Collection Period

As a data collection instrument "Classification form for Publications on Adaptive Educational Hypermedia Environments" was prepared by the researchers and used in this study. In building this form, literature review studies were examined by considering theoretical framework. As a result of this, the framework presented in Appendix-1 was designed in accordance with evaluation criteria in the similar literature review studies. The studies obtained were classified in two different ways such as nature of study (Alessandro, 2006) and characteristics of developed adaptive learning environment (Inan et al., 2010). User modeling and parameters used in adaptation process of each study which developed adaptive learning environment were examined as well. Lastly, all studies in the scope of this paper were examined in terms of methodology.

Postgraduate thesis studies (both master and doctorate) published in national thesis center, articles with Turkey address in the international journals indexed in SSCI, refereed journals in the field of education in Turkey listed in Appendix-2 (8 journals), journals published by universities' education faculties (26 journals), online journals with the same scope (19 journals) were analyzed. Information regarding the studies handled in this research is presented in Table 1. The current study is limited to the studies obtained from the literature review conducted in July, 2014.

Table 1. Publications on Adaptive Educational Hypermedia Environments

Publications	Frequency
National thesis center	
Master	6
Doctorate	6
Journal in SSCI indexed	
Articles with Turkey address in the international journals	5
Field of education in Turkey	
Journals (Appendix-2)	9

In determining the studies handled in the current research, the researchers identified some measures and the review was carried out within these measures. In reviewing the literature, "Adaptive Educational Hypermedia" "Adaptive Systems", "Adaptive Hypermedia/", "Adaptive Learning" was used as keywords. However, studies focusing on "adaptive test" were excluded since it refers to a different issue. A total of 12 postgraduate thesis studies (6 masters and 6 doctorates) were reached in national thesis center. A total of 14 articles (5 articles with Turkey address in the

international journals indexed in SSCI, 9 articles in the journals in educational sciences listed in Appendix-2) were reached. Detailed information on these studies is given in Table 2.

Table 2. The Studies Reviewed

No	Reference	Type	Published
1	Somyürek (2008)	Doctorate Thesis	National Thesis Center
2	Serçe (2008)	Doctorate Thesis	National Thesis Center
3	Uysal (2008)	Doctorate Thesis	National Thesis Center
4	Eryılmaz (2012)	Doctorate Thesis	National Thesis Center
5	Özyurt (2013)**	Doctorate Thesis	National Thesis Center
6	Çetinkaya (2013)	Doctorate Thesis	National Thesis Center
7	Sezer (2011)	Master Thesis	National Thesis Center
8	Polat (2013)***	Master Thesis	National Thesis Center
9	Hopcan (2013)***	Master Thesis	National Thesis Center
10	Cesur (2013)	Master Thesis	National Thesis Center
11	Demirören (2013)	Master Thesis	National Thesis Center
12	Çelebi (2014)	Master Thesis	National Thesis Center
13	Somyürek (2009)*	Article	International Journal of Informatics Technologies
14	Inan et al.(2010)	Article	Contemporary Educational Technology
15	Akbulut and Çardak (2012)	Article	Computers & Education
16	Eryılmaz (2011)*	Article	Educational Science and Practice
17	Polat, Adıgüzel and Akgün (2012)*	Article	Educational Sciences: Theory & Practice
18	Özyurt, Özyurt, Baki, Güven and Karal (2012)*	Article	Expert Systems with Applications
19	Şahin and Kışla (2013)	Article	Journal of Research in Education and Teaching
20	Kara and Sevim (2013)	Article	Contemporary Educational Technology
21	Özyurt, Özyurt and Baki (2013)*	Article	Expert Systems with Applications
22	Özyurt, Özyurt, Baki and Güven (2013)*	Article	Computers in Human Behavior
23	Özyurt, Özyurt, Güven and Baki(2014)*	Article	Computers & Education
24	Somyürek and Yalın (2014)*	Article	International Journal of Human Sciences
25	Demirören (2014)*	Article	Educational Science and Practice
26	Eryılmaz and Şimşek (2014)*	Article	Education and Science

* The article was produced from the author's thesis.
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All the studies handled in current research were examined in a detailed way. Since some articles were produced from thesis studies, they were excluded in analysis section so as to avoid repetition.

Data Analysis

The studies on adaptive educational hypermedia environment were analyzed according to the research studies identified. The researchers gave utmost attention to consensus in defining thematic codes in order to ensure validity and reliability. An adaptive educational hypermedia environments classification form which covered the titles presented in the framework of the current study was formed and presented in Appendix-1. The studies gathered and analyzed in depth were coded by the researchers on their own. After coding process, the researchers came together and examined the consistency among their codifications. The coders examined and coded the studies once again as any inconsistency was observed among the coders. Each study's theoretical framework, user modeling method and research method were analyzed in detail, summarized and presented in findings section.

Results

It was seen that the studies on adaptive educational hypermedia environments in Turkey were started in 2008. In analyzing the studies conducted from then on, the number of publications on the issue is on the top in 2013. Findings of all these studies reviewed are presented in accordance with research questions respectively.

Classification of The studies on Adaptive Educational Hypermedia Environments in Turkey

The analysis of the studies on adaptive educational hypermedia environments was carried out according to the classification considering nature of study made by Alessandro (2006). The related findings are presented in Table 3.

Table 3. The Classification of Available Studies According to Nature of Study

Classification	**The studies on adaptive educational hypermedia environments in Turkey**
Theoretical aspects	Akbulut and Çardak (2012), Çetinkaya (2013), Inan et al.(2010), Kara and Sevim (2013), Polat (2013), Şahin and Kışla (2013)
Authoring tools	Serçe (2008), Sezer (2011)
Architectural refinements	-
Adaptive learning systems	Cesur (2013), Çelebi (2014), Demirören (2013), Eryılmaz (2012), Hopcan (2013), Özyurt (2013), Somyürek (2008), Uysal (2008)

As shown in Table 3, most of the thesis studies focus on "influences of adaptive learning systems on learning process" and articles mostly on "conceptual views". There exist no studies focusing on the issue of improving systems architecturally.

In classification proposed by Inan et al. (2010) the use of user model in improved system, the number of variable in user modeling, updating method of user model, variables used in adaptation process and methods are taken into consideration. The studies aiming to develop adaptive educational hypermedia were reviewed and examined according to this classification. Table 4 presents concerning findings:

Table 4. The Classification According to Nature of Adaptive Educational Hypermedia Developed in Available Studies

Classification	**The studies on adaptive educational hypermedia environments in Turkey**
Pseudo Adaptive Web-Based Learning Environments	-
Naive Adaptive Web-Based Learning Environments	Cesur (2013), Çelebi (2014), Demirören (2013), Eryılmaz (2012), Hopcan (2013), Polat (2013)
Advanced Adaptive Web-Based Learning Environments	Özyurt (2013), Serçe (2008), Sezer (2011), Somyürek (2008), Uysal (2008)
UltimateAdaptive Web-Based Learning Environments	-

In this kind of classification, it is certain that there should be a developed adaptive educational hypermedia environment since the classification is made according to the features of this environment. Therefore, the studies which did not develop such kind of an environment were not included in Table 4. The findings in Table 4 indicate that there is no study on overlay and perturbation adaptive learning environments. Since there is no user modeling and adaptation in overlay adaptive learning environment, no study on overlay adaptive learning environment is available in the context of this study. Keyword like adaptive might not be used in such kind of studies. The studies on perturbation adaptive learning environments require use of new technologies so as to evaluate students' affective status and monitor their motions constantly. Besides, it is necessary for perturbation nature of developed application to have educationalist, instructional technologists and computer scientists in research team. In the current study, no study could be reached as reviewed in literature. Studies focusing on basic or advanced level adaptive learning environments were more popular in the international related literature.

Process of Adaptive Educational Hypermedia Environment Development in Turkey

User modeling process is an integral part of development of adaptive educational hypermedia environment in order to estimate students' needs accurately. Adaptation is made in accordance with inference made in user model. Table 4 presents information on which individual differences are considered, which modeling type is preferred, what the source of data is, when data is updated and what type adaptation is made with such a data in hand.

Table 5. User Modeling and Adaptation Process of Adaptive Educational Hypermedia Environment Development in Turkey

Reference	User Modeling				Type of adaptation
	Individual Differences	Modeling Type	Data sources	Data updating	
Somyürek (2008)	• Prior knowledge	Bayesian Network	• Log files • Achievement Tests	Dynamic	• Adaptive navigation • Adaptive presentation
Serçe (2008)	• Prior knowledge • Learning style	Stereotype	• Log files • Index of Learning Styles	Dynamic	• Adaptive navigation
Uysal (2008)	• Prior knowledge • Learning style	Rule-based*	• Log files • Index of Learning Styles Achievement Tests	Static	• Adaptive presentation
Eryılmaz (2012)	• Prior knowledge	Rule-based*	• Achievement Tests	Static	• Adaptive navigation • Adaptive presentation
Özyurt (2013)	• Prior knowledge • Learning style	Stereotype	• Index of Learning Styles Achievement Tests	Dynamic	• Adaptive presentation
Sezer (2011)	• Prior knowledge • Learning style	Rule-based*	• Log files • Achievement Tests	Dynamic	• Adaptive navigation • Adaptive presentation
Polat (2013)	• Prior knowledge	Rule-based*	• Achievement Tests	Static	• Adaptive presentation
Hopcan (2013)	• Prior knowledge	Rule-based*	• Achievement Tests	Static	• Adaptive presentation
Cesur (2013)	• Prior knowledge	Rule-based*	• Achievement Tests	Static	• Adaptive navigation • Adaptive presentation
Demirören (2013)	• Prior knowledge	Rule-based*	• Log files • Achievement Tests	Dynamic, static	• Adaptive navigation • Adaptive presentation
Çelebi (2014)	• Prior knowledge	Rule-based*	• Log files • Achievement Tests	Dynamic	• Adaptive navigation • Adaptive presentation

* In these studies, there is no specific information on the use of modeling approach. They give information on circumstances necessary for realization of adaptation. These studies are defined as rule-based.

As observed in Table 5, user modeling is generally based on prior knowledge (n=11). Additionally, there are some studies integrating learner style, one of the most important individual differences, into user modeling process (n=4). It was seen that as a variable, learning styles do solely not exist in setting user model but with prior knowledge. When the studies focusing on both variables were examined, it was found out that user data was dynamically updated and learners were directed dynamically according to their learning preferences and replies to questions on the system. Also, there is a rule-based (if…then…) modeling type which is different from the modeling types in literature (n=8). Apart from these studies, stereotype model is used in two of the studies and Bayesian networks in one of the study. It was seen that data updating in the studies preferring Bayesian networks and stereotype model were dynamically done. In addition to this, data in some rule-based user modeling was updated dynamically. However, rule-based user modeling were preferred in all of user models,

having no feature of data updating, built according to results of questionnaire or tests only at the beginning. Since prior knowledge is considered in user modeling process, achievement tests are mostly used in data collection period. Questions addressed to students in the system are defined as achievement tests. Students are directed to pages appropriate to their knowledge level according to the answers. Learner style indexes were stated to use as sources of data in learner-style-based studies. In addition to these sources of data, it is seen that navigation log records such as duration of navigation, number of clicks etc. were used as sources of data in some studies. As studies are examined according to data update in user modeling, in almost half of the studies modeling are static and in the other half is dynamic. Both content and navigation adaptations (n=6) are used as a type of adaptation in most of the studies. They are followed respectively by content adaptation (n=4) and navigation adaptation (n=1).

Methodologies and Conclusions of Studies on Adaptive Educational Hypermedia Environment in Turkey

This section is devoted to statement of research method, sampling, data collection instruments and method of data analysis in studies reviewed. Secondly, it presents on experimental studies in terms of dependent or independent variables and conclusions with the aim of determining efficacy of developed adaptive educational hypermedia environments in available studies. Among all studies, literature review compilation studies and application studies (employed a sample group) were chosen and their choice of methodology was summarized and presented in Table 6. Except from the studies aforementioned, research methodology and results of the studies by Inan et al.(2010), Kara and Sevim (2013), Serçe (2008) and Sezer (2011) were summarized.

Table 6. Methodologies of Studies on Adaptive Educational Hypermedia Environment in Turkey

Reference	Research Methods	Sampling of Research	Data Collection Instruments	Data Analysis
Somyürek (2008)	Experimental Design	67 Undergraduate students	• Achievement test • Motivated strategies for learning questionnaire • Disorientation scale • Revisitation rates • Rate of content map use as navigation tool • OpinionForm	*Quantitative* • Frequency, percentage ANOVA/ANCOVA *Qualitative* • Descriptive analysis
Uysal (2008)	Experimental Design	130 Undergraduate students	• Learning style index • Achievement test • Expert interview form	*Quantitative* • Frequency, percentage • Mean, standard deviation • Mann Whitney U • Kruskal Wallis H
Eryılmaz (2012)	Experimental Design	120 Undergraduate students	• Achievement test • Cognitive load scale • Satisfaction scale	*Quantitative* • Frequency, percentage • t-test • ANOVA/ANCOVA • Factor analysis

Table 6. Continue

Reference	Research Methods	Sampling of Research	Data Collection Instruments	Data Analysis
Özyurt (2013)	Experimental Design	108 secondary school students	• Achievement test • Scale for evaluating system • Interview forms	*Quantitative* • Frequency, percentage • t- test • Mann Whitney U • Kruskal Wallis H *Qualitative* • Content analysis
Çetinkaya (2013)	Relational Screening Model	90 experts	• Open ended questions • Questionnaire (Likert)	*Quantitative* • Frequency, percentage • Mean, standard deviation • Correlation *Qualitative* • Content analysis
Polat (2013)	Development / Design	4 students who have specific learning disabilities	• Expert interview form • Elementary school teachers and parents survey • Learner analysis form • Expert evaluation form • Sample activity	*Quantitative* • Frequency, percentage *Qualitative* • Content analysis
Hopcan (2013)	Experimental Design	6 students who have specific learning disabilities	• Pre-test and post-test forms • Evaluate the paper-pencil activities • Evaluating form of educational software • Evaluating form of interface • Observation form • Experimental process form	*Quantitative* • Frequency, percentage • Mean, standard deviation • Wilcoxon *Qualitative* • Descriptive analysis
Cesur (2013)	Experimental Design	39 Undergraduate students	• Cognitive styles scale • Cognitive load scale • Disorientation scale	*Quantitative* • Frequency, percentage • t-test • Mann Whitney U
Demirören (2013)	Experimental Design	38 Undergraduate students	• Achievement test • Log files	*Quantitative* • Frequency, percentage • Mann Whitney U • ANOVA/ANCOVA
Çelebi (2014)	Experimental Design	88 elementary school students (5-8)	• Log files • Disorientation scale	*Quantitative* • Frequency, percentage • ANOVA/ANCOVA • Mann Whitney U • Kruskal Wallis H
Akbulut and Çardak (2012)	Literature Review	70 publication	• Document review form	*Qualitative* • Content analysis
Şahin and Kışla (2013)	Literature Review	24 publication	• Document review form	*Qualitative* • Content analysis

Table 6 indicates that experimental method is preferred in most of studies on adaptive educational hypermedia environment. Apart from this method, it was determined that the study by Polat (2013), Serçe (2008) and Sezer (2011) was development/design; the study by Akbulut and Çardak (2012), and Şahin and Kışla (2013) is literature review; the study by Inan et al. (2010), and Kara and Sevim (2013) is theoretical study on adaptive educational hypermedia environments in nature. As the sample group studies were examined, it was seen that undergraduate students were mostly preferred in the studies. As they are examined in terms of sampling, it is seen that bachelor students are mostly preferred. Primary, secondary or students with special educational needs are also available as sample in some studies. The size of sample ranges from 4 to 130. Achievement tests are mostly used as data collection instruments. In addition to this data collection tool, it is seen that scales are frequently used to find out learners' psychological characteristics and various feedback forms so as to get students' views. As the studies were analyzed in terms of data analysis methods, it was seen that quantitative methods were mostly preferred. Additionally, as the studies examining users' view and document analysis studies were examined, it was determined that content analysis was preferred in general.

Among all studies with no sample group, the studies by Serçe (2008) and Sezer (2011) were identified as developmental study on adaptive hypermedia environment. Serçe (2008) developed a system with an acronym MODA (A Multi-Agent Adaptive Learning System for any LMS) which can be integrated into learning management system so as to present more efficient learning environment via distance education for learners having different characteristics. This system basically comprises modules such as learner profile, adaptive content and learning management system. Learner profile is formed in accordance with features such as user behaviors, information and characteristics. The system has 30 different type of content. These contents are categorized according to Felder and Silverman learner style model. Value of normalized Euclidean distance was employed in matching learner characteristics with content. The developed system was integrated into open source learning management system successfully. There is no study regarding the efficacy of such a system.

Sezer (2011) developed a system combining facilities of both adaptable (by user) and adaptive (automatic by interaction between system and user) systems. The system named Ax2ELS (Adaptable-Adaptive English Learning Support) was developed for foreign languages by using Iterative, Incremental Framework adaptation method. The system has basically three layers as interface, adaptation and registration. The system monitors users' motion on system and updates users' information accordingly. The system asks users' view on seeing annotations and keywords, link ranking, link explanation and direct guide adaptation, and they can use such features if they wish. As signing up, the system asks for the data on their learning style, interface and adaptation preferences. Later on, users sit on a pre-test and according to their level; they start on an appropriate level. The system was developed by the researcher but efficacy of the system was not tested. Only it was evaluated by information technology and English specialists, and it was stated that it can aid individual learning.

It was seen that the studies by Inan et al.(2010), and Kara and Sevim (2013) were about theoretical framework of adaptive learning environments. Inan et al. (2010) made suggestions about effect of various adaptive methods on system design, categorization of experimental studies examining efficacy of adaptive systems and ideas for adaptive systems which will be designed in future.

Kara and Sevim (2013) elaborated on changes in learning environments from past to today. First, concepts of learning machines and adaptive learning systems were compared and discussed differences and similarities between them. Second, they gave suggestions to designers by giving information on strengths of learning environments.

Table 7 shows the findings on experimental studies determining influences of independent variable(s) on dependent variable(s).

Table 7. Experimental Studies

Reference	Dependent Variable	Independent Variable	Result
Somyürek (2008)	• Academic achievement • Perception of disorientation • Rate of return • Rates of content map use	• Learning environment (adaptive and traditional)	• No significant difference in terms of academic achievement. • Low perception of disorientation • Low return in navigation • High rate of use of content map as navigation tool
Eryılmaz (2012)	• Academic achievement • Satisfaction • Cognitive load	Learning environment (content adaptation, navigation adaptation, no adaptation) • Repeating Measurements (pretest-posttest)	• High academic achievement level in adaptive environments • High satisfaction in adaptive environments • Low cognitive load in adaptive environments
Uysal (2008)	• Academic achievement	• Computer-based instruction (task-based and traditional) • Computer-assisted training method (learner style adaptive and traditional)	• Higher level of academic achievement intask-based • No affect of learner style on academic achievement
Cesur (2013)	• Cognitive load • Disorientation	• Learning environment (adaptive and none-adaptive) • Cognitive Style (Field dependent and field independent)	• Less cognitive load and disorientation problems in adaptive environments • Field independent students in adaptive learning environment feel less cognitive load and disorientation problem
Hopcan (2013)	• Type of Specific Learning Difficulty • Level of Special Education	• Learning environment (adaptive learning activities)	• Less performance problems • Less time in performing related skills
Demirören (2013)	• Academic achievement • Duration of Material completion • Efficiency of environment	• Sustainability of adaptation (static, dynamic)	• No significant difference in academic achievement, duration of material completion, efficiency level in both environment
Çelebi (2014)	• Duration of navigation • Visited links • Perception of disorientation	• Learning environment (adaptive and none-adaptive) • Navigational strategies	• No significant difference in duration of navigation, number of visited links, perception of disorientation in students in both adaptive and none-adaptive environments • Duration of navigation and number of visited links do not differ in any environment but perception of disorientation is higher in adaptive environment.
Özyurt (2013)	• Academic achievement	• Learning environment (adaptive and traditional classroom)	• Experimental group are more successful than control group. • Students' and teachers' views on environments are greatly positive.

The data presented in Table 7, independent variable in almost all of the experimental studies is "learning environment" and most popular dependent variables are respectively "academic achievements, disorientation, cognitive load, duration of navigation, number/rate of connection, satisfaction, efficacy and type of specific learning difficulty". In addition to "learning environment" as an independent variable, there exists some studies researching influences of "cognitive style, navigation strategy and computer-assisted training method" on dependent variables. Most of experimental studies are designed in a way that students in experimental group study in adaptive educational hypermedia environment while those in control group study in none-adaptive (traditional) educational hypermedia environment. There is a study (Özyurt, 2013) researching efficacy of education in adaptive educational hypermedia environment as compared to traditional classroom. There is also another study (Demirören, 2013) examining influences of adaptation sustainability in adaptive educational hypermedia environment on different dependent variables.

As for the results of available experimental studies, although some studies prove that adaptive educational hypermedia environment affects academic achievement positively (Eryılmaz, 2012; Özyurt, 2013; Uysal, 2008), some conclude that there is no effect of such environments on academic achievement (Somyürek, 2008). A study examining effect of educational hypermedia on perception of disorientation by Somyürek (2008) and Demirören (2013) shows that perception of disorientation decreases in adaptive learning environment conflict with another study by Çelebi (2014) which shows that students in adaptive educational hypermedia environments have more feeling of disorientation. Eryılmaz (2012) and Cesur (2013) found that adaptive educational hypermedia environments reduces cognitive load. Demirören (2013) developed two adaptive educational hypermedia environments according to adaptation sustainability. There is no difference in both of the environments in terms of efficacy, academic achievement or duration of navigation. The results of the studies in general indicate that adaptive educational hypermedia environments increase student satisfaction (Eryılmaz, 2012) and decrease performance problems (Hopcan, 2013). There is no significant difference of adaptive educational hypermedia environments on duration of navigation and number of visited links (Çelebi, 2014). The other studies reviewed apart from experimental studies are summarized and presented below.

Conclusion and Recommendations

In this section, results in accordance with research questions were compared and contrasted with results in the similar studies in literature review, and also provided suggestions. Also, apart from the research questions, the researchers tried to discuss issues revealed in the literature review and presented suggestions at the end of the study.

As for the studies reviewed, it was seen that generally the studies were produced from authors' thesis studies and rest of the studies was limited to conceptual views. The reason behind this fact might be that development of an adaptive educational hypermedia environment is time consuming and requires special effort. Thesis studies mostly were designed in a way that adaptive educational hypermedia environment was developed and its effect on students in terms of various variables was tested. There is also a gap in literature in Turkey concerning the issue of improvement of the systems architecturally. There is a need for such kind of studies so as to develop better adaptive educational hypermedia environments (Serçe, 2008). When the developed adaptive educational hypermedia environments in available studies were classified according to ranking by Inan et al. (2010), it is seen that the systems are mostly developed in basic and advanced level classrooms. It is especially regarded significant to develop systems enjoying technologies like perturbation adaptive educational hypermedia environments having features such as having totally dynamic user modeling and monitoring users' motions (eye tracking tool etc.)(Akbulut & Çardak, 2012; Graf & Kinshuk, 2014; Inan, Ari, Flores, Arslan-Ari, & Zaier, 2013). Hence, it is suggested that studies should be conducted on ultimate adaptive learning environment and its effectiveness.

It was seen that the studies considered knowledge and learner style in setting a user model. Similar results were obtained literature review studies conducted by Chrysafiadi and Virvou (2013), and Akbulut and Çardak (2012). Apart from these characteristics, Chrysafiadi and Virvou (2013) states that different individual characteristics such as cognitive style, motivation, working memory capacity, cognitive characteristics and affective features were used in user modeling process. In this context, it is possible to conduct studies in Turkey setting user models according to different learner characteristics and examine its effect on learning process.

When the studies on naive adaptive learning environments were examined, rule-based static modeling was generally preferred in these studies. In the studies with advanced adaptive learning systems, stereotype modeling and rule-based modeling were generally chosen as modeling type. There was no study apart from Somyürek (2008)'s study using Bayesian network in user modeling. However, the international literature focuses on Bayesian network and fuzzy logic techniques enabling sensitive decision making (Chrysafiadi & Virvou, 2013; Vandewaetere et al., 2011). There also needs a study on relations between learners' individual differences and navigation on the system. As data collection tool, achievement tests and log files were more used in the studies. Especially log files should be considered seriously in designing adaptive learning environments (Güyer & Güyer, 2009). So as to use navigation data effectively, navigation metrics were seen to be used in literature review (Güyer & Güyer, 2009). By using these metrics researchers may make use of study results shedding light on the relations for the process of dynamic user modeling. In the studies reviewed, dynamic user model is set according to students' answers to systems. Researchers may contribute to the literature by developing dynamic user modeling and testing its' efficiency by considering learners' knowledge level as well as learner preferences. In most of the studies, both content and navigation adaptation was preferred. This result fall in the line with those obtained in the literature review study by Vandewaetere et al. (2011). Both of them in fact enjoy different techniques. It is also difficult to infer from the available studies' results that which techniques are more efficient in which cases since they are used altogether in available studies. A further study which tests efficiency of adaptation techniques with different learner characteristics is needed.

As the studies on adaptive learning environments were analyzed, experimental research methodology was employed in most of the studies and many of these studies compared traditional learning environments with web-based learning environments. Unlike studies conducted abroad, there exists no study focusing on individual differences and testing efficacy of strategies employed in the system (Graf & Kinshuk, 2007; Popescu, 2010). In the future, researchers interested in this field may design such kind of experimental environments.

It was also observed that sample size was small and time period devoted to applications was limited in the studies reviewed. However, so as to make generalizations, bigger sample size and more time is required. Although there are some studies on primary, secondary and students with special educational needs, it was determined that higher education students were more chosen as sample. This result was similar with those in studies conducted by Akbulut and Çardak (2012), and Şahin and Kışla (2013). This is maybe because of the fact that researchers can easily access such sample groups. But, similar studies on different sample groups may contribute to the literature. As data collection tools, achievement tests and scales determining different psychological characteristics were commonly used. As stated by Akbulut and Çardak (2012), available learning style scales and indexes in literature are used in determining especially learning styles. In accordance with this, quantitative data analysis is preferred. It is also observed that qualitative data is employed so as to support quantitative data in some studies. The number of qualitative studies on adaptive educational hyper media systems in both national and international is limited. Quantitative methods were preferred in testing efficacy of such environments; nevertheless, it is important to get stakeholders' views about developed systems and user modeling. Therefore, it is considered significant to conduct studies by mixing methods.

As the studies were examined, it was seen that influences of adaptive educational hypermedia on academic achievement, perception of disorientation, cognitive load and satisfaction were studied. Further studies are needed so as to test if, with different samples, similar influences of these variables exist or not. It is also possible to test adaptive educational hypermedia environments on various psychological variables (self-confidence, anxiety, motivation etc.)

Adaptive educational hypermedia environment is a new and rarely studied issue by a few researchers in our country whereas it has been a focus in international literature for a long time. No research was reached apart from studies published in a number of journals. It is an interesting fact that there exists no study on adaptive educational hypermedia environments in journals of education faculties. It is necessary for the literature that researchers conduct studies on this issue as well as editors accept these studies to their journals.

As the articles published in journals indexing in SSCI with Turkey address were examined, even if they were produced from thesis studies, it was observed that these studies were supported by TUBITAK and conducted with experts in related fields. These studies are regarded significant in the sense that these are supported by different institutions and various researchers in different disciplines so as to conduct quality studies in both national and international literature and decrease limitations.

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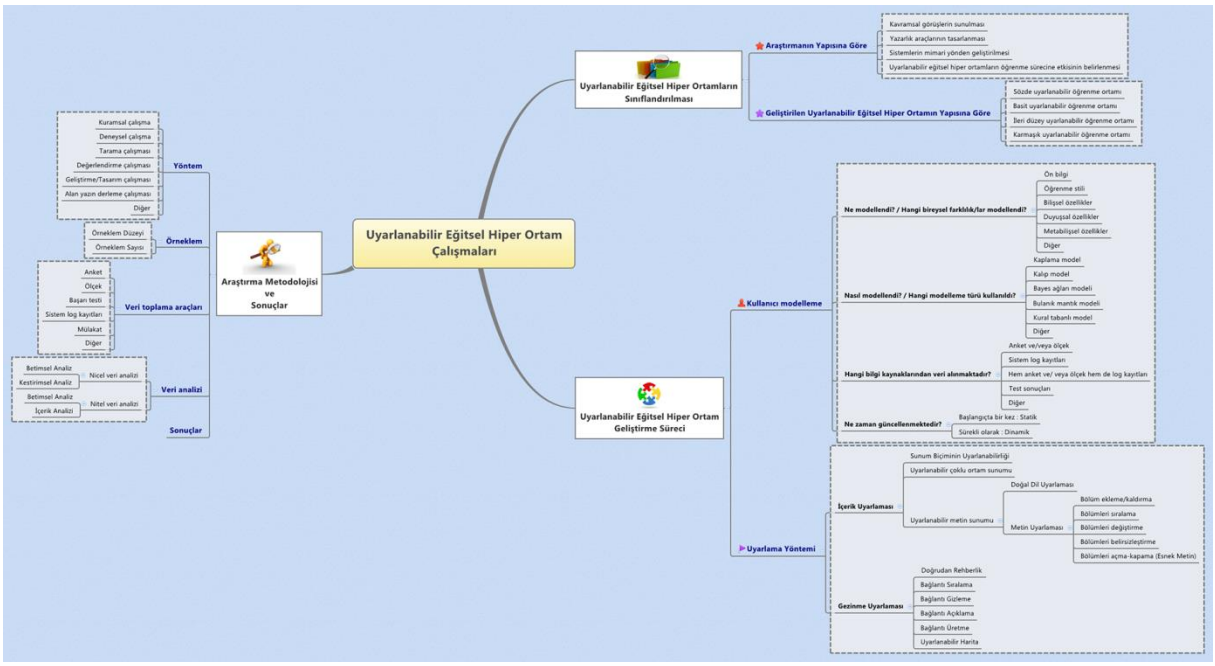
Appendix 1. Conceptual framework



Appendix 2. Reviewed journals

Refereed journals in the field of education in Turkey

1. Çağdaş Eğitim Dergisi (Journal of Contemporary Education)
2. Eğitim ve Bilim Dergisi (Education and Science) (SSCI)
3. Eğitim Bilimleri ve Uygulama Dergisi (Educational Science and Practice)
4. Eğitim Araştırmaları Dergisi (Eurasian Journal of Educational Research)
5. Kuram ve Uygulamada Eğitim Bilimleri Dergisi (Educational Sciences: Theory & Practice)(SSCI)
6. Milli Eğitim Dergisi
7. Pegem Eğitim ve Öğretim (Pegem Journal of Education and Instruction)
8. Kuram ve Uygulamada Eğitim Yönetimi (Educational Administration-Theory and Practice)

Journals published by universities' education faculties

1. Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi
2. Afyon Kocatepe Üniversitesi, Kuramsal Eğitim Bilim Dergisi (Journal of Theoretical Educational Science)
3. Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi
4. Ahmet Yesevi Üniversitesi, bilig: Türk Dünyası Sosyal Bilimler Dergisi (bilig Journal of Social Sciences of the Turkish World) (SSCI)
5. Amasya Üniversitesi Eğitim Fakültesi Dergisi
6. Ankara Üniversitesi Eğitim Bilimleri Fakültesi Dergisi (Ankara University Journal of Faculty of Educational Sciences)
7. Atatürk Üniversitesi Kâzım Karabekir Eğitim Fakültesi Dergisi (Journal of Kâzım Karabekir Education Faculty)
8. Balıkesir Üniversitesi Sosyal Bilimler Dergisi
9. Boğaziçi Üniversitesi Eğitim Dergisi (Boğaziçi University Journal of Education)
10. Bülent Ecevit Üniversitesi-Yükseköğretim ve Bilim Dergisi Bülent Ecevit University- The Journal of Higher Education and Science)
11. Celal Bayar Üniversitesi Eğitim Fakültesi Dergisi
12. Çukurova Üniversitesi Eğitim Fakültesi Dergisi (Cukurova University Faculty of Education Journal)
13. Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi (Buca Faculty of Education Journal)
14. Gazi Eğitim Fakültesi Dergisi (Gazi University Journal of Gazi Educational Faculty)
15. Gazi Üniversitesi Türk Eğitim Bilimleri Dergisi
16. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (Hacettepe University Journal of Education) (SSCI)
17. İnönü Üniversitesi Eğitim Fakültesi Dergisi
18. İstanbul Üniversitesi Hasan Ali Yücel Eğitim Fakültesi Dergisi
19. Kastamonu Üniversitesi Eğitim Fakültesi Kastamonu Eğitim Dergisi (Kastamonu University, Kastamonu Education Journal)
20. Mehmet Akif Üniversitesi Eğitim Fakültesi Dergisi (Mehmet Akif Ersoy University Journal of Education Faculty)
21. Mersin Üniversitesi Eğitim Fakültesi Dergisi (Mersin University Journal of the Faculty of Education)
22. Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi
23. Pamukkale Üniversitesi Eğitim Fakültesi Dergisi (Pamukkale University Journal of Education)
24. Sakarya Üniversitesi Eğitim Fakültesi Dergisi (Sakarya University Journal of Education)
25. Uludağ Üniversitesi Eğitim Fakültesi Dergisi (Uludag University the Journal of Education)
26. Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi

Refereed online journals in the field of education in Turkey

1. Bilişim Teknolojileri Dergisi (International Journal of Informatics Technologies)
2. Contemporary Educational Technology
3. Eğitim Bilimleri Araştırmaları Dergisi (Journal of Educational Sciences Research)
4. Eğitim ve Öğretim Araştırmaları Dergisi (Journal of Research in Education andTeaching)
5. Eğitimde Kuram ve Uygulama (Journal of Theory and Practice in Education)
6. Eğitim Teknolojisi Kuram ve Uygulama (Educational Technology Theory and Practice)
7. Eğitim Teknolojileri Araştırmaları Dergisi
8. İlköğretim Online (Elementary Education Online)
9. Journal of Instructional Technologies & Teacher Education
10. Uluslararası İnsan Bilimleri Dergisi (International Journal of Human Sciences)
11. Uluslararası Online Eğitim Bilimleri Dergisi (International Online Journal of Educational Sciences)
12. The Online Journal of Global Education
13. The Online Journal of New Horizons in Education
14. The Online Journal of Science and Technology
15. The Turkish Online Journal of Distance Education
16. The Turkish Online Journal of Educational Technology
17. The Turkish Online Journal of Qualitative Inquiry
18. Turkish Journal of Education
19. Türk Fen Eğitimi Dergisi (Journal of Turkish Science Education)