A CONTENT ANALYSIS OF VARIABLES ON ADAPTIVE LEARNING ENVIRONMENT: 2000-2015

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ABSTRACT

In this current study context it is aimed to examine developing adaptive environments or developed adaptive environments' reflections on learning process. For this reason the related journals were investigated which are from Science Direct and Web of Science databases in the period of 2000-2016 (February).

According to the aim of the research adaptive learning, personalized learning and intelligent learning keywords were scanned. The journals which only developed adaptive environments or developed environments which were investigated during learning process are not involved in this study. Total journal number which is included in this content analysis is 61. The results of this content analysis will be helpful for guiding future research in this area.

Keywords: Intelligent teaching systems, adaptive learning systems, personalized learning, content analysis.

INTRODUCTION

It is an accepted fact nowadays that each learner is different from each other, and single method, design or material cannot provide teaching to everyone equally. Therefore, educators should know the need of each learner related to the subject and design the education accordingly in order to improve the effect of teaching, and present a learner-based education.

It is quite difficult and time-consuming process for educators to do those things (Zeng, Zhao and Liang, 2009). For this reason, education processes are mostly limited to failure in fitting to learners. Even though learners have different knowledge levels or different learning speed, their process of learning are not followed, mid-term evaluation are not performed. In fact, superficial conclusions are obtained only with the evaluations that are performed in the

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end of term, and even an evaluation about what the learners have learnt are not performed deeply. That causes unsuccessful learning processes (Kellman, 2013).

Interactive teaching materials, which lead the education to be shaped according to the performance of students, are started to be improved with the involvement of computers to education process. That approach is entitled various names like computer-based learning, adaptive educational hypermedia, intelligent education and adaptive learning (Griff and Matter, 2013). The term adaptive learning, which will be used in this research, is emerged as an alternative to the traditional "fit to all" approach, and has 2 main features as "variety" and "interaction" (Wang, Wang and Huang, 2008).

Variety is based on the understanding that a context might be suitable for some but not suitable for the others in contrast with the understanding of only one context. Accordingly, it is important to vary context in adaptive environments.

In addition to this, there needs to be a support system, which learners can interact with whenever they want, in adaptive learning environments since utilizers are achieving self-learning. That also emphasizes the interaction feature of adaptive learning environments (Wang, Wang and Huang, 2008).

The structure of the adaptive systems are based on creating a model according to learners' information, preferences and purposes so that it can fit their needs, and also using that model with the interaction of users (Brusilovsky, 2001).

Therefore, it can be said that adaptive learning environments are also aiming at presenting customized, flexible and personal education by considering various features of learners such as their knowledge level, preferences instead of providing the same training for every learner. Brusilovski (1999) stated that adaptive and intelligent systems could improve different aspects of learning environments. For example, while adaptive presentations increase the utility of course materials, whole process of course can be controlled by adaptive navigation support and also it can make learners choose their home works or assignments. Besides, homework doing can be increased significantly with the problem-solving support and by submitting intelligent feedbacks.

The previous research shows that adaptive learning environments are affecting learning positively. Kelly and Tangney (2006) stated in their research that students, who are in low learning level, and use only limited sources, are observed and it is found that when they use the adaptive learning strategies, they encounter with other sources they do not normally prefer and there is also an increase in their learning. In another research, Fasihuddin, Skinner and Athauda (2016) developed adaptive structure that related with personalization of open learning environments.

In the end of the research, they stated that the adaptive environment that they related to learning styles helped students in their learning and was quite admired by students. Similarly, Chen (2014) also stated in his study that adaptive e-learning environment affected positively both their learning level and motivation of learners. In another study, Yang et al. (2013) suggested an approach that provides a design of adaptive learning environment according to learners' learning styles and cognitive styles. In their research findings, they revealed that their adaptive environment that they developed basing on that approach lead a significance increase in the learning success of learners.

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In conclusion, it can be said that many research were made related with adaptive learning environments that spreading with the advantages presented by Web 2.0 technologies. It is seen that some of those researches evaluated the affectivity of existing environments whereas some researches were made to develop new adaptive environments or to produce an approach in order to develop adaptive environments. It can be said that examining that variety of researches deeply and studied variability, providing a clear table about participants or findings will reveal important information about the design and effectiveness of adaptive learning environments. Therefore, the purpose of this study is to develop an adaptive environment, or examining the researches that are about the reflection of developed adaptive environment on learning process and describe the existing situation.

METHOD

The related articles that were published in between 2000-2016 (February) in the Science Direct and Web of Science database are reviewed in order to develop adaptive environment or examine the reflection of developed adaptive environment on learning process with this descriptive study that has a review characteristic. In this way, description of existing situation intended for adaptive learning environments was aimed. The articles that were collected in the range of determined keywords are examined whether they are suitable or not to the purpose of the study, and descriptions were made after the determination of the articles that were going to be included to the study by conducting a content analysis.

Data Collection and Analysis

Within the purpose of the study, review was made with the keywords that adaptive learning, personalized learning and intelligent learning by examining the studies that were published in between 2000-2016 (February) data base about adaptive learning environments and also by examining the articles about intelligent learning and personalized learning that are used regarding adaptive learning in that period.

The number of obtained publications within the context of keywords is in Table 1.All acquired publications were examined, only studies that were published as articles were embraced, and only the examination of the development of adaptive environment or developed adaptive environment in learning process among those studies were included in the content analysis of this study.

In the study, the total number of article that were described with content analysis is 61.

Table 1.
Total number of articles acquired from related data base

Keywords	Number of Articles	
	Web of Science (n)	Science Direct (n)
Intelligent Learning	34	109
Personalized Learning	57	48
Adaptive Learning	33	189

61 articles that were examined in line with the purpose of the study were subjected by researchers under the main titles that were determined before. Those titles were, respectively, keywords, name of the journals, research methods, dependent and independent

variables, quality of the study groups and size, purpose of the study, data collection tools, data analysis type and general conclusions of researches.

FINDINGS

Keywords that were included in the study are in Table 2. According to that, commonly used keywords are, respectively, adoptability (n=21), intelligent learning systems (n=14) and personalized learning (n=12).

Table 2.
Keywords that were used in the studies

Keywords	Sayı (n)
Adoptability	21
Intelligent Learning Systems	14
Personalized Learning	12
Computer Supported	9
Evaluation	8
Mobile Learning	8
Learning and Teaching Strategies	8
e-learning	7
Interactive Learning Environment	6
Learning Styles	6
Data Mining	4
Model of Learner	4
Indistinct	3
Multimedia	3
Other	85

The journals that articles were located in are in Table 3. It can be seen that 34% (n=21) of the publications were in Computers & Education, 23% (n=14) is in Expert Systems with Applications, 10% (n=6) is in Computers in Human Behavior, and 33% (n=20) of the remained studies were published in other journals.

Table 3.
Journals that articles were located in

Name of the Journal	Number (n)
Computers & Education	21
Expert Systems with Applications	14
Computers in Human Behavior	6
British Journal of Educational Technology	3
Educational Technology Research and Development	3
Other	14

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When the procedural dimensions of performed studies were examined, it can be seen that a clear majority is quantitative. In fact, in 77% (n=47) of the studies, quantitative methods were based. Besides, 16% (n=10) of the studies used mixed method and 7% (n=4) of the studies used quantitative method. When the independent and dependent variables that were embraced in the study were examined (Table 4), it can be seen that 16% (n=15) of the dependent variable is learning performance, 9% (n=9) of the dependent variable is academic success. It is an expected situation to take those two dependent variables as dependent variable, which constitute 25% of the studies and examine the general learning conditions, in studies. When the independent variables that were examined in studies were looked, it can be seen that the large majority is learning styles with 30% (n=12). Cognitive style variable that follows it only constitute 10% (n=4) of the studies.

Table 4.
Variable types in the studies

Variable Types	Variable Names	Number (n)
Dependent	Learning Performance	15
	Academic Success	9
	Attitude	5
	Motivation	4
	Time of mission accomplishment	3
	Satisfaction	3
	Problem-Solving Skill	2
	Other	15
Independent	Learning Style	12
	Cognitive Style	4
	Prior Knowledge	3
	Attitude	2
	Interaction	2
	Satisfaction	2
	Gender	2
	Motivation	2
	Other	11

In Table 4., the dependent variables expressed as others are; speaking skill, vision, emotional condition, reaction, perception, creativity, early reading skill, learning style, student model, effort, satisfaction, feeling of success, work load, self-sufficiency and self-regulation. In the independent variables expressed as others are; cognitive load, self-perception about creativity, input variable, success, performance, working memory capacity, adaptive suggestions, course advises, critical thinking, technological acceptance and creative learning style.

It can be seen (Table 5.) that 92% (n=27) of the part, which constitutes majority of the quality of the groups in the study, is individuals that are in educational institutions. There were no mention about the quality of the study group in 3 study, and in only 1 study, employees that are in an institution can be seen. When the quality of the study group is examined in details, it was stated that 51% (n=27) of the studies were made with individuals that are in university.

Apart from this, when the studies that are stated as postgraduate, which constitute 6% (n=3) of the studies, are included, it can be seen that more than half of the studies (54%) were conducted in higher education institutions.

Table 5.
Quality of the study groups

Quality of study group	Number (n)
University	27
Primary School	7
High School	6
Post Graduate	3
Unspecified	3
Secondary School	3
Teacher	3
Employee	1

Table 6.
Size of the study groups

Size of the study group	Number (n)
51-100	21
26-50	10
101-200	10
201-500	10
1-25	5
501 and more	2
Unspecified	3

When the size of the study groups is examined, it can be seen (Table 6.) that major part of the studies were studied with the participant groups that are more than 50 (70%, n=43). Crowded groups that are 100 and more constitute 36% (n=22) of overall.

These are important factors in terms of providing normal distribution premise in analysis and generalizability of study outcomes, and therefore increase generalizability. Apart from that, there are 5 studies total (8%) that normality premise cannot be examined and constitute the necessity of application of the tests, which are not parametric, and out of generalizability. 3 of those examined studies (5%) were not mentioned about the size of the study group.

When the purpose of the conducted studies are examined, it can be seen (Table 7.) that in 66% (n=40) of the studies, environment development and evaluation practices were made. In 21% (n=13) of the studies, the effect of used environment on the related variables was examined. In 3 different studies, which constitute the remained 10% (n=6) part, with 3% parts (n=2), respectively, opinions of users about environment, relationship between variables and model or strategy presentations were examined.

Table 7.
Purpose of the study

Purposes of the Studies	Number (n)
Development and Evaluation of Environment	40
The effect of the usage of environment on variables	13
Users opinions about environment	2
Relationship between variables	2
Presentation of model or strategy	2

It can be seen in studies that the commonly used data collection tool type is survey. In total, in 38 studies survey were used as a data collection tool (Table 8.). Log data as collected (n=8) as the second major. Following those, achievement test (n=14) and interview (n=10) are stated to be used as a data collection tool.

Table 8.
The data collection tools that were used in the studies

Data Collection Tools	Number(n)
Survey	38
Log Data	16
Achievement Test	14
Interview	10
Preliminary Test	6
Posttest	6
Scale	5
Observation	2
Other	8

Other tools that were only used in one study as data collection tool are Web-OSPAN, learning processes, expert opinion, accuracy number, time of mission accomplishment, estimation, aptitude test and availability test.

It is seen that commonly the descriptive analysis (n=15) were made in studies. Following to that, t-test (n=12) and ANOVA (n=8) were conducted (Table9.). Applying those analysis were expected findings when considering commonly used data collection tools. Data analysis types that were only used one each studies are dynamic indistinct petri networks, estimation algorithms, Wilcoxon test and ki-square test.

Table 9.
Types of data analysis that were conducted in the studies

Types of data analysis	Number (n)
Descriptive	15
t test	12
Anova	8
Data Mining	4
Codification	4
Fuzzy Logic	3
Clustering	3
Content Analysis	3
Ancova	2
Mann Whitney U Test	2
Other	4

When the general conclusions are examined in the end of the studies, there emerge five different dimensions. These are success, personal difference, affectivity of learning and environment, autonomy and satisfaction and attitude. The results according to those five dimensions were examined in Table 10 as positive, negative and neutral. Accordingly, in 18 studies there were positive results towards success, in 2 studies there were no difference towards success, and the success's being influenced negatively were none of the studies. Personal differences were embraced in 10 studies.

Accordingly, there were positive improvements towards personal differences in 8 of the studies whereas one apiece studies there were negative and neutral results. The results about affectivity of learning and environment were found in 39 studies and 36 of those results were seen as positive. Besides, only 1 study was negative and neutral results were obtained in 2 studies.

In the context of autonomy, it was stated that in 5 studies there were positive results. When we looked the results from the satisfaction and attitude, it was seen that 17 of the 19 studies had positive result, and only one negative and one neutral result were appeared in remained studies.

Table 10.
Results of the Study

Result	Positive	Negative	Neutral
Success	18	0	2
Personal Difference	8	1	1
Affectivity of learning and environment	36	1	2
Autonomy	5	0	0
Satisfaction-Attitude	17	1	1

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DISCUSSION AND CONCLUSION

Dynamic and constant increase of information leads channels that present it diversified day by day. Nonetheless, different features that learners have bring the need of variety and preference in learning environment along. Adaptive environments, which have been in existence since 1970s, are considered as important in terms of providing convenient environment for that dynamism and distinctness.

Along with the running across to many definitions in literature, briefly, it can be said that adaptive learning environments are the environments provide a structure that is adapted according to the learner's, who is included to the learning process, features, interests, expectations and needs. Aforementioned adaptation has a dynamic structure, and it enriches the environment with the developments in technology and coding languages. Besides, it makes important contributions to those environments with Web 3.0 technologies setting to work.

Therefore, it is thought that this study is important in terms of recognizing from which perspective those gradually spreading areas are approached and which fields gaps exist in.

In this study, the condition of research articles that conducted about adaptive learning environments was examined. First review of the articles that was included to the study was made in Science Direct and Web of Science database. Article screening process was limited to, in the context of related keywords, social sciences field, 2000-2016 (February) and research articles.

397 research articles were reached in the end of database review. Study was performed with 61 research articles by eliminating those that did not fit the research content and those whose full text cannot be reached. It is seen that examined researches are mostly from Computer & Education (n=21) and Expert Systems with Education (n=14) journals.

It is possible to see according to what the structure is adapted by examining dependent and independent variables of adaptive learning environment that were handled in the inspected researches. It draws attention that learning style (n=12) was mostly handled in researches as an independent variable.

Following the learning style, it is also seen that cognitive styles (n=4) were also handled in some researches. It can be said, as the reason for that situation, that materials that developed to measure learning styles are easily applicable.

It is seen that Kolb's learning style inventory was applied for learning styles, and adaptive environment was arranged and presented according to the learning style that establisher, resolver, absorber, and changer. In this case, it can be said that adoptability has a dynamic structure in only 4 different environments. Since the tools related to measurement of learning styles are self-evaluation-based tools, they are also open to give disinformation.

Therefore, a wrong user profile that was defined to system in the beginning of the process can affect gain attainment process negatively by imposing a process that is not suitable for learner. For this reason, it is important to prefer cognitive styles, which are based on performance tests, for those kinds of environments because it provides a better environment. Moreover, the effect of developed adaptive learning environments on mostly the variables learning performance and academic success was also examined.

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It is seen that those environments has positive effect on performance and success. It is supported finding in literature that using adaptive environments in learning processes support learning process (Chen and Duh, 2008; Chen, Lee and Chen, 2005; Hong, Chen, Chang and Chen, 2007; Gaeta, Orciuoli and Ritrovato, 2009). By making variables diversified, a detailed discussion can be provided about the reflection of those environments on learners.

It was determined that developed adaptive environments in the researches were mostly towards university students (n=27). This situation can be explained as university students have the ability to use those kinds of materials and environments, and they are easily accessible.

It is important to diversify sample so that variety of developed materials and obtained results can be compared and discussed more comprehensively. When the sample size in the research is examined it can be seen that there is a concentration in between 51-100. The reason for this situation is considered as to provide normality assumption in order to execute statistical tests that are parametric. Survey (n=43) was mostly preferred to collect data while descriptive statistics (mean, frequency) (n=15) and t-test (n=12) were applied in the analysis of data. It is also seen that generally quantitative research method (n=47) was preferred. It is thought to be important to support research results with qualitative data for discussing data more deeply.

The purposes of the researches that were inspected were seen as to develop an adaptive environment and examine (n=40) its effect on some variables.

With this analysis study, in addition to recognize increase in the studies about adaptive learning environments, developed new environments are expected to provide more opportunities to user. Accordingly, adaptation mechanisms are important in terms of according to what they adapt.

Besides, it is thought that it would have positive effect on users and provide more dynamic structure if adaptation would not be limited to beginning of the process but continue in the period. Even though there were no detailed information about the environment/material content in researches, supporting content with multimedia materials will affect the process in terms of being efficient and sufficient, directly or indirectly.

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