



## General Trends of the Studies about the Sustainability of the Technology Usage in Education: A Thematic Content Analysis Study \*

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### Abstract

The aim of this study is to determine general tendencies through bringing a cumulative perspective to research on sustainability of technology usage in terms of education. In this respect, certain articles were reviewed in SSCI and CPCI-SSH citation indexes located at the ISI Web of Knowledge database. A total of 87 full-text articles were filtered according to the purpose of the study and they were analyzed through meta-synthesis (thematic content analysis) according to the types of theories or models they based on, names of the journals they were published in, along with their years of publication, number of citations, research groups, examined technology and learning environment, data analysis technique, structures with significant or insignificant effects and dependent variables to be explained. Research findings display that the most frequently used model is the Information Systems Continuance Model. While a significant increase is observed in the number of publications in recent years, the three variables with the most frequently researched effects on dependent variables are found to be satisfaction, perceived usefulness and perceived ease of use. In research studies where continuance intention was focused for prediction, variety of independent variables due to rich theoretical basis has been of interest. In the light of the data obtained, certain suggestions have been developed. Conclusions of this research are believed to have theoretical contributions to the literature by displaying the current situation.

### Keywords

Education  
Technology  
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### Introduction

More intensive utilization of technology in teaching and learning processes day by day has encouraged researchers to focus on various perspectives during their field studies. It is observed that certain studies were conducted through determined technologies and analyzed how these technologies could be integrated into teaching and learning processes, affecting factors, potential complications and mutual effects (Gülbahar, 2007; Kopcha, 2012; Liu, 2011). Some other studies are also observed to place the users in the center, concentrating on how certain technologies were based on and utilized by users

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(Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). Research on the adoption and usage of technological innovations analyze and predict the period starting from the introduction of the user to the new technology for the first time until the technology is adopted and utilized by the user. However, none of the theories or models in this literature predict the sustainability of utilizing various learning environments such as online learning environments, social networks and learning management systems. Variables that these theories are based on also vary. Although certain studies predict sustainability as an extension of adoption process (Jasperson, Carter, & Zmud, 2005; Karahanna, Straub, & Chervany, 1999; Venkatesh & Davis, 2000), this perspective has been widely criticized in recent theories (Bhattacharjee, 2001) and it is suggested that sustainability and long-term utilization could be predicted through different structures. Bhattacharjee (2001) and Lee (2010) believe that usage of an accepted technology would not necessarily be sustainable at all times and call this as “acceptance-discontinuance anomaly”, which is a phenomenon to be deeply analyzed.

Recent studies have emphasized that in order to fill this gap in the literature, sustainability of utilization behavior should be focused more than short-term utilization of certain learning environments (Bhattacharjee, 2001; Bhattacharjee, Perols, & Sanford, 2008; Ifinedo, 2006; Jasperson, Carter, & Zmud, 2005; Terzis, Moridis, & Economides, 2013; Thong, Hong, & Tam, 2006). Predicting sustainable usage of technological innovations has been the topic of different and extensive theories, where the observation of the process is not limited to the realization of usage behavior but enhanced with the prediction of long-term technology usage and sustainability.

#### *Literature Review*

Major theories and models emerged due to the sustainable usage of technological innovations are Information Systems Expectation Confirmation Model (Bhattacharjee, 2001), Self Determination Theory (Gagné & Deci, 2005) and Technology Continuance Theory (Liao, Palvia, & Chen, 2009).

#### *Information Systems Expectation Confirmation/Disconfirmation Model*

This model was introduced by Bhattacharjee (2001) to determine factors affecting individuals' intentions towards continuing to use of information technologies (sustainable usage). Information Systems Continuance Model is another name given to the model, which is based on theoretical research in the field of marketing conducted in older years. Inspired from certain studies on factors affecting individuals to repurchase a product (for instance Expectation Confirmation Theory by Oliver (1980), this model was presented in 2001 in the field of information systems. The essence of the model comes from its indication of the difference between usage and long-term usage. The target variable that the model tried to predict was an internal variable such as intention and this was criticized in studies conducted later (Limayem & Cheung, 2008, 2011). It was suggested that the continuity of usage shall be assessed directly and included in the models. Operational definitions of certain variables contributing to the model were made by Bhattacharjee (2001) as follows:

*Information System Usage Intention:* It is the intention of users for the usage of the targeted information system. It is the target variable to be predicted within the model.

*Perceived Usefulness:* Perceptions of users on their gains through the usage of the targeted information system.

*Satisfaction:* Feelings of users on their previous information system usage experience.

*Confirmation:* Perceptions of users on the coherence between their expectations from using the information system and the actual performance of the system.

The central variable of Bhattacharjee's (2001) Information Systems Expectation Acceptance Model is satisfaction. This variable has an important role within the model. According to the model, expectations are important determiners of satisfaction. Considering the fact that expectations change or may change in time, expectations of users according to their experiences are said to be significant and powerful indicators of satisfaction.

### *Self Determination Theory*

Another theory favored in determining internal variables regarding information systems is the Self Determination Theory, which was related to the motivation variable by Gagné and Deci (2005). Psychological requirements set forth by the Self Determination Theory [autonomy, competence, relatedness], self-determination and concepts like internal or external motivation are psychological structures that have been widely studied recently (Roca & Gagné, 2008). Self Determination Theory mainly focuses on two different types of motivation and their differences (Black & Deci, 2000). These are *internal motivation* and *external motivation*. Certain studies on the long-term usage of information technologies lack topics on motivation structure of the Expectation Confirmation, which is completed through this theory.

### *Technology Continuance Theory*

In terms of long-term usage of technological innovations, Liao, Palvia and Chen (2009) developed Technology Continuance Theory as joint theory in the form of a mixture of Technology Acceptance Model (TAM), Expectation Confirmation Model (ECM) and Cognitive Model (COG). The theory tested the other three theories in terms of their prediction power and put together the six variables contributing essentially to the general prediction percentage of these theory and models. Model is based on the following structures: confirmation, satisfaction, perceived usefulness, perceived ease of use and IS continuance intention. This theory is the most recent of all theories and models in the related literature. A prior variable such as attitude and a posterior variable such as satisfaction are brought together within the same model and a predicting relation in between is proved, which together differentiate the model form other models and theories. Although attitude is a type of perception which can be developed by individuals before the usage of a technology, it is required an adequate time to ensure the satisfaction.

Along with these theories and models, certain studies analyzed potential structures, which may affect the sustainability of the information systems. For instance, Limayem, Hirt and Cheung (2007), in their research on voluntary Internet users included "habit" as a variable in their research model. Researchers defined "habit" as "the extent to which people tend to perform behaviors (use IS) automatically because of learning" (Limayem, Hirt, & Cheung, 2007, p. 709). Considering that continuing to use Internet is affected not only by intention but also by habit and considered habit as a moderator variable. As a result of the analysis on the model, this hypothesis was confirmed and it was determined that satisfaction past behavioral frequency and usage comprehensiveness had important effects on the structuring of the habit variable and that it had an indirect contribution to sustainability through habit.

Another study focused on the predicted variables as potential affecting factors on sustainable usage of e-learning (Chiu, Hsu, Sun, Lin, & Sun, 2005). Researchers differentiated the Expectation Confirmation Model developed by Oliver (1980) (also known as Expectation Disconfirmation Model) and divided the perceived performance variable into three sub factors as usability, quality and value. Research conducted in Taiwan with 183 e-learning users concluded that the intention for sustainable usage could widely be predicted through the satisfaction variable. At the same time, perceived usability, perceived quality and perceived value variables were found to be important predictors of satisfaction.

Lee (2010) attempted to predict the sustainable usage intention with variables such as satisfaction, concentration, subjective norm and perceived usefulness. The study was conducted with 363 students participating in the web-based learning program designed for sustainable education. As a result of the testing on the research model as joint study on four different theories and models, satisfaction was found to be the most powerful predictor while perceived usefulness, attitude, subjective norm and concentration were determined to be rather weak.

Another study by Yeh and Tao (2012) analyzed factors affecting students' continuance intentions towards personal response systems. Expectation Confirmation Model, Information Systems Success Model, Motivation Theory and Agency Theory were structured as a mixture and 15 different hypotheses were tested. Perceived performance variable of Expectation Confirmation Model was analyzed in terms of education in the study and was transformed into learning performance. At the Information Management Department of Kaosiung State University in Taiwan, the study was conducted using the FingerClick personal response system and the data were collected in a hall of 120 participants with two management panels, each of which controls 60 students. Findings indicated that only the internal aim tendency out of the six variables deriving from Motivation Theory was effective on the intention for continuing to use. 23% of the variance observed in the confirmation variable, 48% of the variance observed in satisfaction variable and 50% of the variance observed in the continuous usage intention variable were predicted with the help of the independent variables of the study.

As the studies concluded, variables examined in different research activities conducted with different theories for different learning environments changed and this change would have different consequences in terms of continuous usage. Another clear-cut finding was that sustainability should be analyzed with variables other than adoption or acceptance and that each technology should be considered along with original variables with high levels of prediction powers. Therefore, based on this diversity seen in the studies, it can be said that there is a need to examine the studies with a holistic overview that exists in the literature. Consequently, the purpose of this study is to determine general tendencies through bringing a cumulative perspective to research on sustainability in terms of education as well as revealing their frequencies of analysis and making suggestions for the provision of sustainability in the usage of technology in education. In line with research findings to be obtained, it can be demonstrated by the terms of a systematic overview of the general trends and the similar or different ways of sustainability studies in educational context could be investigated. What percentage of acceptance-discontinuance anomaly is considered in the literature, on which groups and with what type of analyses were the educational sustainability studies carried out and which variables were mainly distinguished would be a source of inspiration for further studies. Because of this, this research seeks answers to the following sub-problems:

1. Which models and theories were made use of in articles on technological sustainability in education and how are they distributed?
2. Which journals were the articles on technological sustainability in education published in?
3. What is the distribution of articles on technological sustainability in education according to years?
4. What is the distribution of the total and average number of citations to articles on technological sustainability in education?
5. What is the distribution of sample/population that the data were collected in the articles on technological sustainability in education?
6. Which technologies and learning environments have been analyzed in articles on technological sustainability in education? What is their distribution like?
7. Which statistical analysis methods are used in articles on technological sustainability in education and what is their distribution like?

8. What are the dependent variables of the articles on technological sustainability in education?
  - a) How are these variables distributed?
  - b) What is the range of the prediction percentages for the observed variance in these variables?
9. What are the independent variables of the articles on technological sustainability in education?
10. What are the predictive relations, the effects of which were found to be insignificant in articles on technological sustainability in education and what is their distribution like?

### Method

Content analysis was selected as the method of this study. Content analysis, defined as an inductive and deductive method used with qualitative or quantitative data (Elo & Kyngäs, 2008), was indicated by Schreier (2012) as a flexible and systematic method which reduces data. Fraenkel, Wallen and Hyun (2012) spoke of content analysis as a method with a wide scope of utilization in educational research providing researchers with a perspective on problems to be tested through more direct methods. It is suggested that content analysis did not display a certain difference when considered in terms of qualitative or quantitative; however, it had certain subjective characteristics (Schreier, 2012). Additionally and more essentially, content analysis as a summarizing method draws attention to inter-subjectivity or objectivity while setting a scientific method allowing for testing of hypothesis as well as reliability, validity, replicability and generalizability (Neuendorf, 2002). Meta-synthesis (thematic content analysis) is used as a type of content analysis in this study. It is possible with the meta-synthesis (thematic content analysis) to synthesize and explicate the studies conducted in a specific content area via themes, templates and matrixes with a critical perspective (Çalık & Sözbilir, 2014). The reason of selecting the meta-synthesis (thematic content analysis) is to examine in depth with similar or different aspects of the current situation with identifying the similarities and differences in the specific subject area studies reached with previously determined criteria. Another reason is the lack of enough studies for descriptive content analysis because of the topicality of the subject. In addition, it can be said that the number of experimental research not yet carried out for a meta-analysis. Consequently, a meta-synthesis (thematic content analysis) was performed through synthesis and interpretations in this study.

This study had access to original studies via ISI Web of Knowledge database for analyzing sustainability in terms of certain theoretical basis and these studies were examined within a holistic approach through meta-synthesis (thematic content analysis). The common point of all these research studies is their educational context. Some of the studies analyzed sustainability to be used in the usage of e-learning environments, social networks, web 2.0 technologies or teaching platforms enriched with innovative technologies. While new approaches to these technologies were introduced through these studies, some other studies were considered within a more theoretical perspective and useful suggestions were generated to improve the existing models. In the light of this variety observed in the studies, with the help of the keywords determined according to the problem situation of this research, electronic and published journals registered in the national and international databases were investigated regardless of year limitation. The reason for unlimited period of years was the recentness of the studies on sustainability and accordingly nor outdated studies were detected. Keywords essential to the problem statement are as follows: *sustainability, intention to continue, continuance, continuance intention, behavioral intention, information systems continuance, real usage continuance, information systems continuance intention, sustainable usage, continuance usage*. These keywords are decided as a result of the examination of variables of theories and models discussed in the literature. Keywords were made from the target variables tried to be explained in the models. These target variables provide addressing the sustainability of the theories or models they discussed.

The study made use of the ISI Web of Knowledge database and articles reviewed in Social Sciences Citation Index (SSCI) together with Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH) citation indexes were chosen as primary resources. Out of the 315 articles, the

ones outside the scope of education or instruction such as the ones in the field of banking and finance, environment and nature, political sciences, international affairs and tourism management were left aside. In the filtering process, titles of all articles and journals in which they were published is investigated by the researchers. Articles which are not in educational context excluded from the review process. When the article can not be decided according to the title and the journal published, their summaries were read and the final decision was given. Eighty-seven filtered and reviewed studies based on the models and theories in line with the research were included in the study. Selected studies were assigned codes by the researchers according to the theory or model they are based on, name of the publication they were published in, year of publication, number of citations, research groups, examined technology and the learning environment, data analysis technique, structures, the effects of which were found to be significant or insignificant, as well as the dependent variables to be predicted. An article investigation form was developed by the researchers for gathering the codes as holistic. In this article investigation form which also can be expressed as a data collection tool, the publication name, year, the journal published in, theory or model discussed in, total and average number of citations and the study groups (population / sample) of the articles are given. In the article investigation form, investigated media / technologies, the statistical methods used, dependent variables and their prediction percentages, independent variables and statistically insignificant relationships are also available. Before starting the coding process, article investigation form is analyzed by the researchers, reached a consensus on and it was decided that the article investigation form is suitable for the aims of the research.

Assignment of codes made by the researchers to the 87 articles was checked by 10 field specialist coders studying in the Department of Computer Education and Instructional Technology at the graduate level. The codes, which were found to be uncertain, were discussed with the researchers and the final decisions were made. 9 articles were given to 9 field specialist and 6 articles were given to 1 field specialist initially and an informative training session was held such as the coding education suggested by Neuendorf (2002). Neuendorf (2002) assigned researchers and coders with different tasks within the recoding process and suggested that all possibilities shall be revised. At the end of this process, which could be counted as an expert opinion, validity and reliability of the study were contributed and the coding table was finalized. In such a control process, each expert investigated the articles and checked the codes given to him/her and did not see the others articles and codes. Because of this, an agreement percentage is not calculated. However controls and feedbacks of all experts have been controlled by the researchers and finalized.

### *Limitations*

Findings of this study are obtained through the thematic content analysis of articles in certain databases investigated in terms of predetermined indexes. More comprehensive databases could be reviewed to reach different research conclusions. Moreover, the number of citations reported in the study were obtained from the ISI Web of Knowledge database without any restrictions. Self-citations of researchers could be eliminated for further evaluation and analysis.

## Findings

Findings of the study according to the sub-problems are listed hereby below:

### *Findings related to the theoretical grounds*

Ten out of the research studies analyzed in this study set the 11,5% of the whole amount and was observed to be based on a single theory or model. Similarly, 77 (88,5%) of them were modeled as a combination of various theories or models. Table 1 displays the models and theories that the single theory or model research studies were based on in the literature.

**Table 1.** Referred Theory or Models Based on a Single Theory or Model

<b>Based theory or model in the studies</b>	<b>Frequency</b>
Information Systems Continuance Model	7
Social Cognitive Theory (SCT)	2
DeLone and McLean's Information Systems Success Model	1

Table 1 displays that the Information Systems Continuance Model developed by Bhattacharjee (2001) was widely used in research studies that are based on single theories. In some studies, the model was enhanced with the introduction of different theories and models reaching up to higher prediction percentages. In this respect, Table 2 displays the theories or models along with their frequencies, on which the research using a combination of theories and models were based.

**Table 2.** Referred Theory or Models Based on Mixed Theories or Models

<b>Based theory or models in the studies</b>	<b>Frequency</b>
Expectation Confirmation / Disconfirmation Theory	30
Information Systems Continuance Model	18
Technology Acceptance Model (TAM) (Davis, 1989)	16
DeLone and McLean's Information Systems Success Model (DeLone & McLean, 1992, 2003)	9
Self-Determination Theory (Gagné & Deci, 2005)	6
Hedonic and Utilitarian Values Literature	6
Habit Literature	5
Cognitive Model (COG)	4
Social Cognitive Theory (SCT)	4
Task Technology Fit (Goodhue & Thompson, 1995)	4
Theory of Planned Behaviour (TPB)	4
Flow Theory	3
UTAUT (Venkatesh, et al., 2003)	3
Theory of Reasoned Action (TRA)	3
Attribution Theory	2
Agency Theory	2
Van der Heijden's model (Van der Heijden, 2004)	1
SAFE Model	1
Fairness Theory	1
Computer Based Assessment Acceptance Model (CBAAM)	1
Information Adoption Model (Sussman & Siegal, 2003)	1
Contingency Theory	1
Motivation Theory	1
Social Network Site Adoption model (Sledgianowski & Kulviwat, 2009)	1
Self-Efficacy Theory	1

As seen on Table 2, there is a large theoretical variety in research studies using combined models. Additionally, the Expectation Confirmation/Disconfirmation Theory developed by Oliver (1980) and the Information Systems Continuance Model developed by Bhattacherjee (2001) were widely used in research studies to predict intentions of individuals to continue using information technologies (f=30 for Expectation Confirmation / Disconfirmation Theory and f=18 for Information Systems Continuance Model). These theories were followed by Technology Acceptance Model, which creates a contrast with the acceptance-discontinuance anomaly introduced by Bhattacherjee (2001) and Lee (2010). This study focused on 25 different theories and models among the 77 research studies analyzed in terms of combined theories within its scope, and this is a strong indicator that displays the enriched theoretical variety of research with combined theories and models.

#### *Findings related to the article statistics*

Table 3 shows the journals that published the articles within the scope of the study.

**Table 3.** Journals and Frequencies of the Technological Sustainability Studies

Journal Name	Number of the Percentage	
	studies	(%)
Computers & Education	11	12,6
Computers in Human Behavior	9	10,3
Decision Support Systems	8	9,2
Behaviour & Information Technology	8	9,2
Information & Management	7	8
International Journal of Human-Computer Studies	5	5,7
Industrial Management & Data Systems	3	3,4
International Journal of Information Management	3	3,4
Procedia Social and Behavioral Sciences	3	3,4
Information Development	3	3,4
MIS Quarterly	2	2,3
British Journal of Educational Technology (BJET)	2	2,3
Expert Systems with Applications	2	2,3
Group Decision and Negotiation	1	1,1
Information Systems	1	1,1
Information Systems Journal	1	1,1
Informing Science: The International Journal of an Emerging Transdiscipline	1	1,1
Journal of Computer Information Systems	1	1,1
Library Management	1	1,1
Journal of Information Science	1	1,1
Omega	1	1,1
Turkish Online Journal of Educational Technology (TOJET)	1	1,1
World Transactions on Engineering and Technology Education	1	1,1
ACM Transactions on Computer-Human Interaction (TOCHI)	1	1,1
Australasian Journal of Educational Technology (AJET)	1	1,1
Journal of Service Management	1	1,1
International Entrepreneurship and Management Journal	1	1,1
Journal of the American Society for Information Science and Technology	1	1,1
Educational Technology and Society	1	1,1
The International Review of Research in Open and Distributed Learning	1	1,1
Internet Research	1	1,1
Lecture Notes on Information Theory	1	1,1
Information Systems and e-Business Management	1	1,1
Cluster Computing	1	1,1

As seen in Table 3, 12,6% of the articles were published in Computers and Education, while 10,3% of them were published in Computers in Human Behavior. Articles published in these two journals set the 22,9% of the whole articles within the scope of the study. A total of 87 articles in 34 different journals revealed a wide perspective in terms of journal richness. Another finding obtained was that certain journals were chosen depending on the technologies of concern and the relevant research studies were published in the chosen journals. A study by Chang (2013) analyzed factors affecting students' intentions for continuance towards e-learning systems in academic libraries. This research was published in the Library Management journal. Similarly, articles published in Information & Management, Information Systems and Informing Science: The International Journal of an Emerging Transdiscipline journals indicate that the journals hosting the articles resourcing this study were quite rich and all the relevant articles were published in these journals by their contexts.

Distribution of the articles to years was analyzed and it was found that there was a significant increase in recent years. Figure 1 displays the yearly distribution of articles included in this study and published between 2001 and 2014. The black line in Figure 1 shows a logarithmic increase in the number of relevant articles, which is an indicator that relevant problems have been hypothesized, while the field has been updated and became more popular among the researchers.

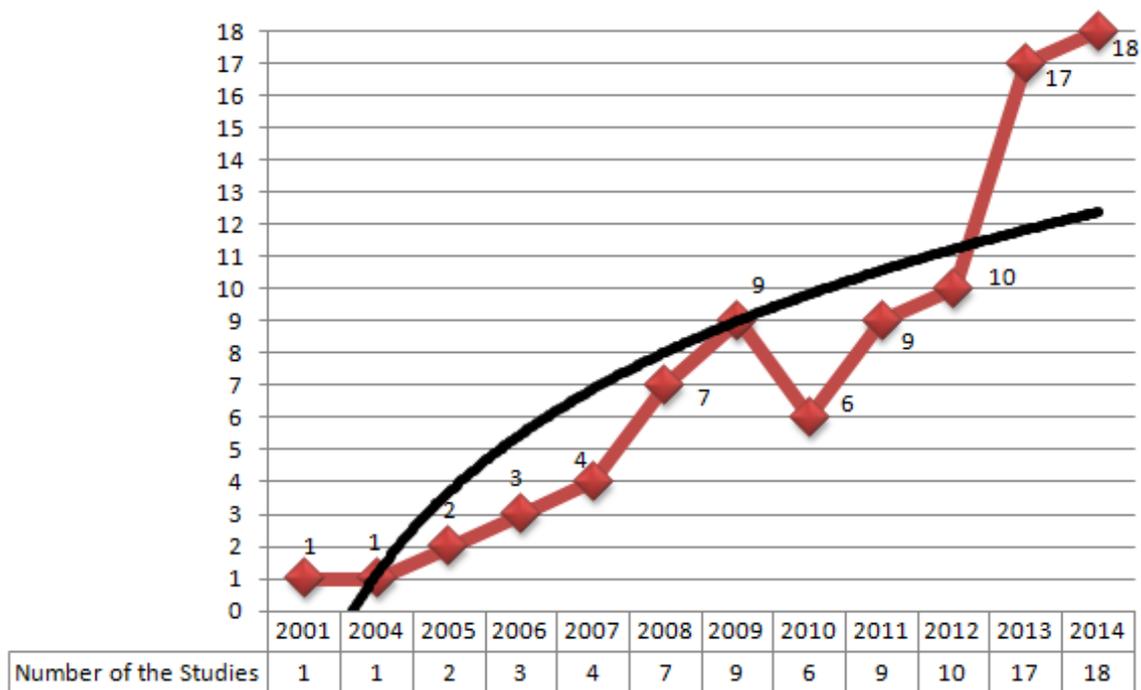
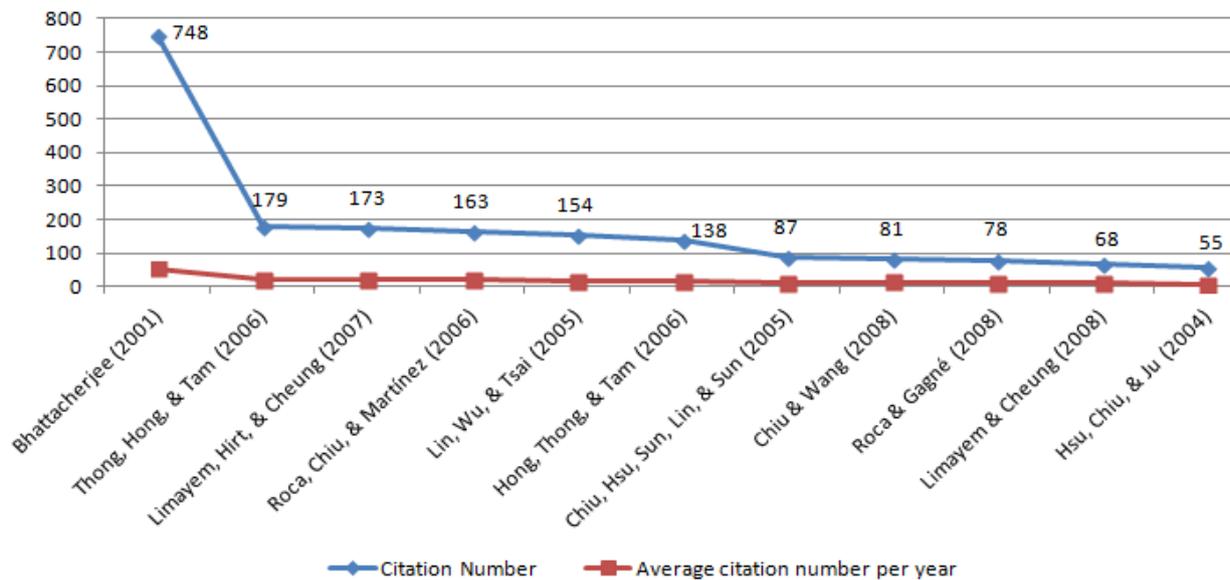


Figure 1. Distribution of the Studies to Years

Figure 2 displays the 11 articles that received 40 or more citations along with the total and average number of citations. The limit of citation number is 40 because of the average number of citations of all articles is 17.84 and the citations of the studies in Figure 1 are all over the average citation number. Citation search was done on the ISI Web of Knowledge database on 23 February 2015. Research findings showed that the most frequently cited article was the Information Systems Continuance Model developed by Bhattacharjee (2001). Since its publication, it has been the most popular research study in terms of both total and average number of citations (Total citation: 748, average citation per year: 53,38). Citation numbers of other 10 publications are displayed in Figure 2. The average number of citations to these publications per year is 17,84. These findings show that the Information Systems Continuance Model was widely used in the research studies. Additionally, in many combined research studies, the aforementioned model is also included and the variance percentage predicted was increased with the

contribution of other theories or models. Under all circumstances, the Information Systems Continuance Model has kept its popularity and is still the most cited model in the literature.



**Figure 2.** Citation Statistics of the Studies Received 40 or More Citations  
(As the Record of February 23, 2015)

#### *Findings related to the article statistics*

Table 4 shows the study groups that the data were collected from for the articles analyzed in this study. According to Table 4, it is observed that the studies were often conducted with university students and students benefiting from e-learning programs. The limitedness of studies on younger students, teachers or academicians is also striking. Twelve out of the 87 articles analyzed in this study (13,8%), data were collected from heterogeneous groups.

**Table 4.** Target / Study Groups of the Studies

Target / Study Group	Frequency
University students	30
Web-based learning students	14
Workers and staffs' of organizations or agencies	10
Smart Phone and Mobile Internet users	8
Others (Social network users, business and process analysts, blog users etc.)	7
Teachers	3
University faculty members	2
Primary and high school students	1

Findings on technologies or environments analyzed throughout the articles within this research are displayed on Table 5. In studies on sustainability, it was observed that Web-based learning environments and learning management systems were highly preferred (total  $f=47$ ; 55,3%). In the Web-based learning environments category seen in Table 5, not to be seen as a learning management system, but with a certain content of the e-mail group, with videoconferencing tools, chat rooms or with the support of the educational computer games are pointing in the research conducted. Although there was an increase in the number of studies on modern technologies utilized in educational research recently (Harden, Ryan, & Prybutok, 2012; Lin, 2012; Shiau & Chau, 2012; Yeh & Tao, 2012), it is considered as limited in number.

**Table 5.** Technology - Learning Environments Examined In Educational Sustainability Studies

<b>Technology - Learning Environment</b>	<b>Number of the studies</b>	<b>Percentage (%)</b>
Web-based learning environments	28	32,9
Learning management systems	19	22,4
Mobile Internet	9	10,6
Smart Phones	6	7,1
Online applications	5	5,9
Social networks	5	5,9
Information management systems	4	4,7
Virtual environment applications	4	4,7
Blogs	2	2,4
Virtual communities	2	2,4
Personal response systems (Clicker)	1	1,2

*Findings related to variables and statistical analyses of concern*

Eighty-six (98,9%) of the articles within the research were analyzed through structural equation modeling, while one (1,1%) of them was analyzed through multiple regression analysis. All research studies are regression based and this indicates that researchers have tried to determine the independent variables predicting the dependent variable along with finding out to what extent the observed variance in the dependent variable could be predicted by the independent variables. Looking at the structures studied and predicted in the articles, it is observed that 77 articles focused on continuance intention, 9 of them analyzed real usage continuance and one of them examined satisfaction.

Articles analyzed within the study were observed to have prediction percentages of the dependent variable at a wide range between 23% and 92%. In the study by Lin, Chen and Fang (2011), where the negative critical incidents perspective was investigated on the continuance intention for e-learning, a rather high prediction percentage as 92% was obtained and this value was found to be a lot higher than the prediction percentages obtained in previous research studies on e-learning (Chiu & Wang, 2008 (60%), Liao, Chen, & Yen, 2007 (70%) and Chiu, Sun, Sun, & Ju, 2007 (66%)). The Information Systems Continuance Model developed by Bhattacharjee (2001) was extended to habit and prior behavior variables in another study and a rather low prediction percentage as 23% was obtained (Limayem & Cheung, 2008).

Table 6 presents certain independent variables, which are analyzed for their significant effects on dependent variables, their frequencies, and the references of the articles they were contained in. The main reason for analysis on the effects of satisfaction and perceived usefulness on continuance intention is because these variables were the basic variables in the Information Systems Continuance Model. Additionally, the variety of independent variables in the studies could be related to the richness of theories or models made use of in the research studies with heterogeneous theories or models. Although many studies made use of the Information Systems Continuance Model as the theoretical basis, there are various studies enhanced with other theories or models in recent years for the prediction of observed variance on dependent variables at higher percentages.

**Table 6.** Independent / Moderator Variables Whose Effects are Significant on Dependent Variables

Independent Variable	Frequency	Article References
Satisfaction	40	Zhou, 2011; Limayem & Cheung, 2008, 2011; Lin, Chen, & Fang, 2011; Chen, Yen, & Hwang, 2012; Chiu vd., 2005; Chou & Chen, 2009; Hsu, Chiu, & Ju, 2004; Doong & Lai, 2008; Hung, Chang, & Hwang, 2011; Jin, Cheung, Lee, & Chen, 2009; Kang, Hong, & Lee, 2009; Chang, 2013; Larsen, Sørenbø, & Sørenbø, 2009; Premkumar & Bhattacherjee, 2008; Recker, 2010; Thong vd., 2006; Shiau & Chau, 2012; Liao vd., 2009; Hong vd., 2006; Chiu vd., 2007; Lee, 2010; Lin, 2012; Lin, Wu, & Tsai, 2005; Tao, Cheng, & Sun, 2009; Kang & Lee, 2010; Lin & Wang, 2012; Yeh & Tao, 2012; Bhattacherjee, 2001; Roca, Chiu, & Martínez, 2006; Jin, Lee, & Cheung, 2010; Harden vd., 2012; Zhou, Jin, & Fang, 2014; Lin, Fan, & Chau, 2014; Cheng, 2014; Chow & Shi, 2014; Chang, Hsu, Hsu & Cheng, 2014; Lai, & Yang, 2014; Liu, 2014; Hsu, Yu, & Wu, 2014
Perceived usefulness	30	Limayem & Cheung, 2011; Doong & Lai, 2008; Hung, Chang, & Hwang, 2011; Kang, Hong, & Lee, 2009; Kim, Choi, & Han, 2009; Roca & Gagné, 2008; Larsen vd., 2009; Limayem & Cheung, 2008; Premkumar & Bhattacherjee, 2008; Recker, 2010; Thong vd., 2006; Liao vd., 2009; Hong vd., 2006; Lee, 2010; Lin vd., 2005; Lin, Chen, & Yeh, 2010; Kang & Lee, 2010; Lin & Wang, 2012; Bhattacherjee, 2001; Li, Duan, Fu, & Alford, 2011; Smith & Sivo, 2012; Sørenbø, Halvari, Gulli, & Kristiansen, 2009; Venkatesh, Thong, Chan, Hu, & Brown, 2011; Barnes, 2011; Cheng, 2014; Huang, Hsiao, Tang, & Lien, 2014; Zhou, 2014; Wu & Zhang, 2014; Liu, 2014; Hsu, Yu, & Wu, 2014
Perceived ease of use	10	Xu, Lin, & Chan, 2012; Roca & Gagné, 2008; Premkumar & Bhattacherjee, 2008; Recker, 2010; Sørenbø & Eikebrokk, 2008; Thong vd., 2006; Hong vd., 2006; Lin, Chen, & Yeh, 2010; Li vd., 2011; Smith & Sivo, 2012
Attitude	10	Lin vd., 2011; Kim, Chan, & Chan, 2007; Liao vd., 2009; Lee, 2010; Lin, 2011; Venkatesh vd., 2011; Ajjan, Hartshorne, Cao, & Rodriguez, 2014; Zhu & Chang, 2014; Wu & Zhang, 2014; Hsu, Yu, & Wu, 2014
Subjective norm	9	Chen, Yen, & Hwang, 2012; Hsiao, 2012; Lee, 2010; Cheng, 2014; Zhou & Li, 2014; Huang, Hsiao, Tang, & Lien, 2014; Chang, Liu, & Chen, 2014; Liu, 2014; Hsu, Yu, & Wu, 2014
Perceived enjoyment	5	Zhou, 2011; Kang, Hong, & Lee, 2009; Kim vd., 2009; Thong vd., 2006; Kang & Lee, 2010
Facilitating conditions	4	Bhattacherjee et al., 2008; Zhou, 2011; He & Wei, 2009; Venkatesh et al., 2011
Perceived behavioral control	4	Lee, 2010; Recker & La Rosa, 2012; Liu, 2014; Hsu, Yu, & Wu, 2014
Habit (Moderator)	4	Limayem & Cheung, 2008, 2011; He & Wei, 2009; Limayem et al., 2007
Performance expectancy	3	Zhou, 2011; Chiu & Wang, 2008; Hsiao, 2012
Perceived fee	3	Kim vd., 2009; Chang, 2013; Chang, Hsu, Hsu & Cheng, 2014
Self efficacy	3	Chiu & Wang, 2008; Hsu, Chiu, & Ju, 2004; Li, 2011

**Table 6.** Continue

<b>Independent Variable</b>	<b>Frequency</b>	<b>Article References</b>
Enjoyment	3	Gwebu, Wang, & Guo, 2014; Hong, Hwang, Liu, Ho, & Chen, 2014; Kim, Kim, & Oh, 2014
Effort expectancy	2	Venkatesh et al., 2011; Chiu & Wang, 2008
Perceived playfulness	2	Lin et al., 2005; Roca & Gagné, 2008
Past Usage	2	Kang, Hong, & Lee, 2009; Xu, Lin, & Chan, 2012
Continuance intention	2	Bhattacharjee et al., 2008; Limayem et al., 2007
Service quality	2	Ramayah, Ahmad, & Lo, 2010; Li et al., 2011
Utility / utilitarian value	2	Kim & Oh, 2011; Chiu & Wang, 2008
Intrinsic motivation	2	Recker & La Rosa, 2012; Sørenbø et al., 2009
Critical mass	2	Chen et al., 2012; Chang, Liu, & Chen, 2014
Perceived habit	1	Kang & Lee, 2010
Perceived fit	1	Lin, 2012
Social influence	1	Zhou, 2011
Information usefulness	1	Jin et al., 2009
Causal attributions	1	Hung, Chang, & Hwang, 2011
Outcome expectations	1	Hsu, Chiu, & Ju, 2004
E word-of-mouth	1	Chen, Yen, & Hwang, 2012
Computer anxiety	1	Chou & Chen, 2009
Habit (Direct effect)	1	Barnes, 2011
Contribution belief	1	He & Wei, 2009
Seeking belief	1	He & Wei, 2009
Utilization	1	Larsen et al., 2009
Affect	1	Hsiao, 2012
Self-image congruity	1	Kang, Hong, & Lee, 2009
System quality	1	Ramayah et al., 2010
Information quality	1	Ramayah et al., 2010
Attainment value	1	Chiu & Wang, 2008
Intrinsic value (Playfulness)	1	Chiu & Wang, 2008
Image	1	Chen, Yen, & Hwang, 2012
Anxiety	1	Chiu & Wang, 2008
Regret	1	Kang, Hong, & Lee, 2009
Concentration	1	Lee, 2010
Social presence	1	Smith & Sivo, 2012
Sociability	1	Smith & Sivo, 2012
Resistance to change	1	Harden et al., 2012
Contextual factors	1	Chen, 2007
Technological factors	1	Chen, 2007
Course design	1	Chow & Shi, 2014
Learning process	1	Chow & Shi, 2014
Task-technology fit	1	Cheng, 2014
Sense of belonging	1	Lin, Fan, & Chau, 2014
Usefulness	1	Gwebu, Wang, & Guo, 2014

Table 7 displays predictive relations that were found insignificant in terms of their effects on continuance intention or real usage continuance along with the articles they are contained in.

**Table 7.** Insignificant Relations

<b>Predictive Relation</b>	<b>Article References</b>
Perceived Usefulness → Continuance Intention	Lin, Chen, & Fang, 2011; Larsen et al., 2009; Shiao & Chau, 2012; Liao et al., 2009
Continuance Intention → IS Continued Usage Behaviour*	Limayem & Cheung, 2008, 2011
Perceived Ease of Use → IS Continuance Intention	Shiao & Chau, 2012; Kim, Choi, & Han, 2009
Arousal → IS Continuance Intention	Kim, Chan, & Chan, 2007
Perceived Enjoyment → Continuance Intention	Lee, 2010
Satisfaction → Intention to Continue	Sørebø, Halvari, Gulli, & Kristiansen, 2009
Quality Attributes Cumulative Satisfaction → Continuance Intention**	Lin, 2011
General Computer Self-Efficacy → Continuance Intention	Chou & Chen, 2009
Personal Innovativeness in IT → Continuance Intention	
Effort Expectancy → Continuance Usage	Zhou, 2011
Attention Focus → Continuance Usage	
Confirmed Usefulness → Continuance Behavioral Intention	Terzis et al., 2013
Confirmed Content → Continuance Behavioral Intention	
Intrinsic Value → Continuance Intention	Chiu, Sun, Sun, & Ju, 2007
Cost → Continuance Intention	
Attainment Value → Continuance Intention	
Risk of arbitrary learning → Continuance Intention	
Delay in responses → Continuance Intention	
Social isolation → Continuance Intention	
Social influence → Continuance Intention	
Facilitating Conditions → Continuance Intention	
Extrinsic Goal Orientation → Intention to Continuing Use	
Task Value → Intention to Continuing Use	
Control of Learning Beliefs → Intention to Continuing Use	Yeh & Tao, 2012
Self-Efficacy for Learning and Performance → Intention to Continuing Use	
Test Anxiety → Intention to Continuing Use	
Incentive → Intention to Continuing Use	
Critical Mass → Continuance Use	Ajjan, Hartshorne, Cao, & Rodriguez, 2014
Habit → Continuous Use	Gwebu, Wang, & Guo, 2014
Trust → Continuous Use	
Satisfaction → Continuous Use	

\* Habit negatively moderates the link between continuance intention and IS continued usage behaviour.

\*\* For only more experienced e-learning users

## Discussion, Conclusion and Suggestions

This research is designed to determine tendencies in studies in the field of technological sustainability in education and is prepared to display the existing situation in the form of a general total evaluation. Keywords expressed at the beginning of the research period, database to be considered (ISI Web of Knowledge) and the citation indexes (SSCI and CPCI-SSH) resulted with 87 articles, the thematic content analysis of which led to findings of the study. Therefore, findings of the study and the evaluations depend more on the findings of the articles analyzed rather than the subjective perspectives of the researchers.

Many of the articles analyzed were found to be modeled as a combination of various theories and models. This result may be due to the willingness of researchers to predict the continuance intention potentially emerging in the target audience towards technologies that researchers focused on. Another potential reason could be the intention to gather variables of different theories and models with strong prediction powers and to reveal the relations between them. Various studies (Jin, Lee, & Cheung, 2010; Liao et al., 2009; Thong et al., 2006; Xu, Lin, & Chan, 2012) indicate theoretical basis, while this finding is supported by description of weak or strong aspects of targeted models or theories and inclusion of other variables found effective in the model together with their reasons.

Among all 87 articles analyzed, the most frequently used and referred model is observed to be the Information Systems Continuance Model developed by Bhattacherjee (2001). On the other hand, various theories have been made use of in heterogeneous research studies. This theoretical diversity reflects on the variables and the research studies contain various independent variables. Accordingly, the most frequently used variables in the studies are satisfaction, perceived usefulness, attitude and perceived ease of use. Another finding deriving from this variable diversity is that the observed variance of the dependent variables could be predicted at a wide range. While quite high levels of prediction percentages could be observed in certain studies (Chang, 2013; Doong & Lai, 2008; Lee, 2010; Lin, 2011; Lin et al., 2011), some remained with low percentages (He & Wei, 2009; Limayem et al., 2007; Limayem & Cheung, 2008, 2011; Lin, Wu, & Tsai, 2005). In the light of this finding, it is suggested that continuance intention or real usage continuance should be considered separately according to each type of technology and the predictive power indicated by the literature should also be considered in determination of appropriateness of the models. It would be beneficial for the researchers to analyze deeply the studies with strong theoretical basis but low predictive powers and to evaluate the links that the findings derive from.

Acceptance-discontinuance anomaly introduced by Bhattacherjee (2001) and Lee (2010) supports that certain sustainability may not necessarily be provided in the usage of an accepted technology; however, certain studies in the literature were observed to take Technology Acceptance Theory as basis (Hong, Thong, & Tam, 2006; Liao et al., 2009; Recker, 2010; Roca & Gagné, 2008; Shiau & Chau, 2012; Xu et al., 2012). Some variables of Technology Acceptance Model (attitude, perceived usefulness and perceived ease of use) were able to produce significant findings in sustainability studies; nevertheless, it should never be taken as a theoretical basis by itself in research studies of this field. Although adoption and acceptance is the prior step for the sustainability of any technology, it would be more appropriate to consider that the two theories attempt to predict different behavioral intentions. While the intention variable in Technology Acceptance Model refers solely to the usage of technology, the intention in Information Systems Continuance Model refers to the continuance of the intention. Some studies suggest that both theories could predict the intention for continuance (Shiau & Chau, 2012); however, according to what is observed, this approach is not found to be appropriate.

Many (41,3%) of the 87 articles in this research study were found to be published in journals with strong impacts in SSCI such as Computers & Education, Computers in Human Behavior, Behaviour and Information Technology and Decision support Systems (Impact factors are 2.630, 2.273, 0.839 and 2,036 respectively in 2014). The reason for this finding lies in the willingness of researchers to produce more qualified publications in years and the coherence between the purposes of these journals

and the sustainability in usage of technological innovations in education. The large impact sizes of the aforementioned journals indicate that the published articles have higher tendencies to receive citations and that they could reach to broader reader audiences due to their popularity. The significant quantitative increase observed in recent years reveals the increasing usage of technological innovations in education and indicates that new field-related research problems are produced, which contributed to the popularity of the field.

Looking at the articles establishing the data resource of this study, it was observed that the article, which presented the Information Systems Continuance Model developed by Bhattacharjee (2001), received the highest number of citations both in general and on average yearly basis. This is because the article is the principle research study in the field of sustainability and has set a resource to various other research studies in terms of theoretical basis. Another reason may be that the article is the oldest article among all articles studies in this research. Although the average number of citations per year overtakes the historical effect on the number of citations, the aforementioned study is observed to have such a high number of citations that could not be compared to other articles.

Articles of concern were found to be conducted mainly with university or e-learning students. It is suggested that researchers preferred to work on groups that they could reach easily. On the other hand, working with other data collection groups and testing the effects of theories on different groups could contribute to the literature. Teachers as inseparable parts of learning and teaching process should be consulted for their opinions on sustainable usage of relevant technologies and existing studies could be enhanced through supporting the findings with qualitative studies. As the research studies are proceeded with technology, e-learning tools, learning management systems and mobile Internet, it is suggested that determining the variables affecting the sustainability of alternative technologies, which have recently been used in research studies, would contribute to learning processes to be realized with the help of aforementioned technologies.

In studies by Limayem and Cheung dated 2008 and 2011, it was suggested that real usage continuance should be assessed directly and included in the models as the continuance intention is an internal variable; it is observed that the research studies still focus on continuance intention. The structure that researchers analyzed is an internal variable as intention and this is in coherence with the finding that the Information Systems Continuance Model was highly made use of. Hence, the target variable of this model developed by Bhattacharjee (2001) is intention. This may be due to the assessment tools and easy access to the scale items in terms of the aforementioned variable. Items in the Information Systems Continuance Model developed by Bhattacharjee (2001) could be revised and used in terms of the technology of concern. Additionally, continuance intention could be assessed in sections. The reason why real usage continuance is not focused on in the studies could be the difficulty in longitudinal approach. Analysis on whether independent variables that could be assessed in sections could turn into an actual sustainable usage is suggested to have contributions to the literature.

Another finding of this study is that certain predictive relations could produce significant results in some studies, while others could produce insignificant relations. For instance, the effect of perceived usefulness on continuance intention was found to be statistically insignificant in some studies (Lin, et al., 2011; Larsen et al., 2009; Shiau & Chau, 2012; Liao, et al., 2009), while some others concluded that it had a significant predictive characteristic (Doong & Lai, 2008; Li, Duan, Fu, & Alford, 2011; Limayem & Cheung, 2011; Premkumar & Bhattacharjee, 2008). Similar findings were observed in different variables (see Table 7) and it is suggested that the reasons for this situation could be further analyzed. Certain predictive variables that can produce statistically significant results could produce insignificant results from time to time due to the relevant technology, study groups of data collection processes or other variables that were analyzed in studies in terms of their effects. The reason for inconsistent findings shall be deeply examined considering that the theories, models and data collection groups of the studies are similar to each other. Although researchers state reasons for such findings, researching of this inconsistency through qualitative studies and considering variables in multiple dimensions would have essential contributions to the literature.

Articles analyzed within the study had a wide range of prediction percentages for the variance observed in dependent variables. In the light of this finding, it is recommended that instead of holding the anxiety to reach higher prediction percentages, variables that do not produce significant results should be analyzed for their reasons, and the findings should be interpreted sufficiently in terms of the data collection groups. Rather than predicting more of the observed variance in the dependent variable, focusing on the previously suggested theoretical model and revealing the complex relation patterns between variables would be more appropriate.

Following suggestions are made in the light of the findings and conclusions of this study:

- Predictive relations that are found insignificant in studies should be deeply analyzed for their reasons. This could help in understanding the nature of variables that produce different results in different studies.
- The new sustainability researches which will be held in the educational context, can be evaluated in the journals shown in the findings of this research. Because when considering the aims and scopes of these journals, specific to the technology or behavioral context journals have a potential for publication.
- Longitudinal research studies are required to talk about sustainability in real terms regarding the usage of education technologies. Assessments to be made in two different time periods would reach to more accurate conclusions.
- While predicting the intention for the sustainable usage of a certain technology, unique characteristics of the technology should also be considered. Hence, certain predictive variables may produce different results depending on the type of technology.
- It is suggested that the sampling of the study should be described in detail in terms of their characteristics. While discussing the significant or insignificant structures in the light of the findings in the literature, the characteristics of the sampling group should also be considered.
- Educational sustainability studies should be also carried out with teachers or university lecturers. Because this study's findings reveal that the studies are carried out with the students.
- Future research on sustainability to be conducted with teachers or academicians should be compared to those conducted with students and observed variables found significantly effective regarding certain technologies should be determined for consideration in further teaching and learning processes.
- Variables based on the perceptions such as satisfaction, attitudes, subjective norms, perceived usefulness and perceived ease of use generally show significant and predictive features. Thus, in future studies with these variables, the dependent variable can be explained by the large percentage of the variance and is likely to reach significant findings. However, the effects in the models are not considered to be a means of giving more weight to other variables not investigated thoroughly.
- In the event that the observed variance in dependent variables are found to be low, qualitative studies should be conducted to analyze this results deeply.

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## Appendix 1. Articles Investigated within the Thematic Content Analysis

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