The Studies on Educational Digital Games Regarding Children: A New Word Analysis Approach

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ABSTRACT
The aim of this research is to investigate, through data analysis, the studies conducted on the use of educational digital games by children. As part of this study, a search of the Science Direct, Web of Science, and ERIC databases was performed to identify the studies on this topic published within the last decade (2007 and 2017). From this database search, a total of 403 studies related to educational science and including the keywords "child" and "game" were retrieved. Proceedings and book reviews were omitted from the scope of the study. The articles were downloaded in PDF document format and then extracted as text to the MySQL database through the Python programming language. The articles that were not related to digital games, that used physical games, or that were inconsistent with the purposes of this study in terms of target group were excluded. After the elimination process, a total of 103 articles constituted the sample of the study. In the data analysis, the most repeated words, word pairs, and abbreviations were tallied using Python programming language. In addition, the keywords *qualitative*, *quantitative*, *experimental study*, and *control group*, which were preselected by the researcher, were searched and recorded. The results revealed that different descriptions were applied for the concept of educational digital games (e.g., digital games, computer games, game-based learning, video games, and serious games). A prodigious number of studies were listed in the search of the current databases, a situation which can result in significant time loss for researchers.

Keywords: educational digital games, child, data mining, big data analysis

INTRODUCTION
The use of games in education has a long history. The latest type of games, that is, digital games, have gained a significant place in today's society as a result of the growing influence the internet has had in the lives of people. Looking at the facts that individuals, who are accustomed to playing games, play games for approximately 10 thousand hours before they reach the age of 21 and that this period of time partly coincides with the time spent in education from primary to elementary school, provides significant insight about the place of digital games in individuals' lives (McGonigal, 2011).

Since being first designed, computer games have been considered as educational tools (Egenfeldt-Nielsen, 2011). In these games, players encounter cases requiring short- and long-term decision-making skills, and they need to plan problem-solving strategies for complex missions or nested sub-missions (Johnson, 2006). Computer games can serve as an effective learning tool by facilitating opportunities for interaction and learning through practice (Kirriemuir & McFarlane, 2004). McFarlane, Sparrowhawk and Heald (2002) maintained that playing games is related to the skills of decision making, design, strategy, collaboration, and problem-solving. Playing games is also thought to develop cognitive skills (Robertson & Howells, 2008), in addition to the aforementioned skills (Ebner & Holzinger, 2007).

Digital games for learning are widely used (Martín-SanJosé, Juan, Gil-Gómez & Rando, 2014). O'Neil, Wainess and Baker (2005) described the learning potential through computer games as "striking". The relevant literature has revealed that children use computers every day to play games (Mumtaz, 2001), that learning through games is motivating (Virvou, Katsionis & Manos, 2005) and supports collaborative learning (Hoda, Henderson, Lee, Beh & Greenwood, 2014), that computer game playing improves mental rotation abilities in children between the ages of 8 and 9 (Lisi & Wolford, 2002), that playing games improves their thinking skills (Furió, González-Gancedo, Juan, Seguí & Costa, 2013), and that games can stimulate children's attention and memory as well as support their language development (Garaigordobil, 2005). The literature generally shows that games have a positive influence on learning. Lee, Wong and Fung (2010) pointed out a gap in the literature on how, precisely, computer games facilitate learning.

The amount of data stored in databases has reached an incredible size today. Investigating this data and transforming it into meaningful findings and information attracts the attention of researchers, with the data mining concept operating at the forefront of this matter. Data mining or knowledge discovery in databases is the automatic extraction of implicit and interesting patterns from large data collections (Klösgen & Zytkow, 2002). In other words, data mining is producing useful data by analyzing big data. Data mining is a multi-disciplinary field involving various computer paradigms. Some of the most useful data mining tasks and methods are statistics, visualization, clustering, classification and association rule mining (Romero, Ventura & García, 2008). Both specially designed and general tools are available for data mining. There also exist data mining tools for educational purposes (Romero et al., 2008). Text mining, one of the concepts closely related to data mining, deals with the investigation of structured or semi-structured full-text documents (Feldman & Sanger, 2006).

Another concept related to data analysis is "big data". More recently, big data and big data analytics have been used to describe the datasets and analytical techniques in applications that are very large (from terabytes to exabytes) and complex (from sensor to social media data), requiring advanced and unique data storage, management, analysis, and visualization technologies (Chen, Chiang & Storey, 2012). Big data is currently a major issue of interest for the business, government and healthcare sectors due to the growing abundance of data collected and stored in these environments (Daniel, 2015). Baker & Inventado (2013) indicated that predictive models used in the educational data mining context are intended to reduce, through inference, the data down to a single factor (the predicted variable, similar to dependent variables in traditional statistical analysis) from some combination of other aspects of the data (predictor variables, similar to independent variables in traditional statistical analysis). Recent studies have been conducted in the field of education using the data analysis concepts mentioned above (e.g., Mitchell, Keast, Panizzon & Mitchell, 2017; Prinsloo, Archer, Barnes, Chetty & van Zyl, 2015; Selwyn, 2015; Thompson, 2017). The University of Washington in Seattle and Northwestern University in Chicago, for example, have each announced the development of new educational programs focused on introducing how big data works (Horn, 2016).

Bibliometric analysis is another concept within the field of data. Leeuwen (2004) described bibliometric analysis as "the field of science that deals with the development and application of quantitative measures and indicators for sciences and technology, based on bibliographic information" (p. 374). With bibliometric methods, qualitative data can be obtained from the existing data of publications. However, this approach has been heavily criticized because it mostly deals with qualitative presentations (Hung, 2012). Therefore, there have been efforts to come up with different approaches in the field. Attempts have been made to achieve useful analysis by classifying the data obtained or by visualizing the data through relational network maps.

Data analysis techniques to sort through big data, such as bibliometry and data mining, attract attention on account of the fact that databases can store large amounts of data, with computer-assisted analysis able to be applied on this data. The data collection procedures of these techniques differ from the classical statistical techniques. The interpretation of the data is similar to document analysis. The data collection tools generally used in classical methods, such as scales, questionnaires, and interviews, are not used in the new data analysis techniques. The ultimate aim is to generate useful meanings from texts and datasets. This study aims to perform a similar data analysis by applying a new technique that involves counting words and word pairs. To carry out this aim, the studies on educational digital games for children (EDGC) were examined. The following research questions were developed for the study.

1. How are the studies distributed according to publication year?
2. How are the studies distributed according to journals in which they are published?
3. What are the findings according to the data analysis based on the most frequently used words?
4. What are the findings according to the data analysis based on the most frequently used word pairs?
5. What are the findings according to the data analysis based on the most frequently used abbreviations?
6. What are the findings regarding the data analysis used in this study?

Within the scope of these research questions, a trend analysis of the studies on EDGC was conducted and the effectiveness of the performed method was investigated.

METHODOLOGY

Data collection and sample selection

Science Direct, Web of Science, and ERIC databases were searched to collect data. These databases were preferred for the magnitude of their data. The articles published in these databases within the last decade (2007-2017) were included in the study. A total of 403 studies related to educational science and including the keywords "child" and "game" were retrieved by the end of the database search in July 2017. The studies that

included both the keywords “game” and “child” in their heading, abstract, or full-text were listed. Proceedings and book reviews were left out of the scope of the search to ensure the quality of the downloaded studies. Target audience constituted one of the exclusion criteria; that is, the studies with target audiences of kindergarten, early school, nursery, or toddler were excluded. Only those articles cited in the relevant publication search indexes were included. The language criterion for the chosen articles was set to English. The use of a single language in data mining helps to provide a more effective analysis. After the elimination process, a total of 103 articles constituted the sample of the study. Eliminations were made based on the intent to frame the study according to a particular theme and for the purpose of excluding the studies that were irrelevant in terms of the aim and sample of this study.

Data analysis

The articles were downloaded in the PDF document format. Only those publications related to educational digital games were included in the study. Some studies regarded games as leisure or physical games, and although such studies were listed in the dataset, they were nonetheless excluded by the researcher.

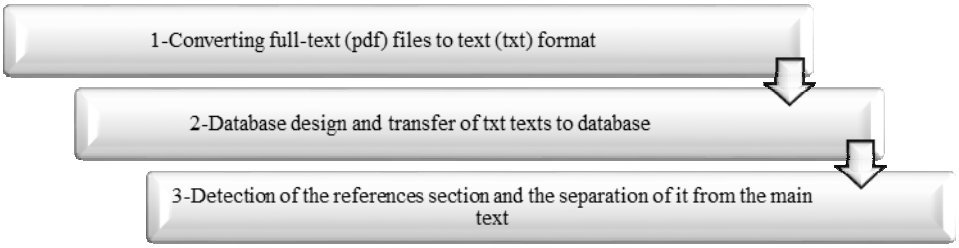


Figure 1– The transformation process of the articles to data

The transformation process of the articles to data is depicted in Figure 1. The full-text PDF documents were converted to text using scripts prepared through the Python programming language and stored in the MySQL database. The stored data were grouped under the following headings. These headings are listed under ‘Column names’ in the paper table below.

Table 1 – The column names of the paper table

Column names	Data type	Explanation
`id`	auto_increment, unique	Identification of number set for each publication
`fulltext`,	text	Full text of the publication
`eligible`	Boolean (True/False)	The data regarding the elimination result
`filename`	varchar	The physical name of PDF file
`year`	varchar	Publication year
`game count`	int	The number of the word Game
`child`	int	The number of the word Child
`primary`	int	The number of the word Primary
`student`	int	The number of the word Student
`article`	varchar	The name of the journal
`title`	varchar	The publication heading
`authors`	varchar	Author names
`references`,	text	References

The simplification of the full-text articles that were transferred to the database was carried out in the following stages:

1. *Separation of the reference section:* The references section of the full-text was transferred as a single piece to another area of the table using the prepared scripts. Therefore, the words in the references section were excluded in the word count.
2. *Word count and the recording of them in tables*: All of the words in each article were counted using the prepared Python scripts. The words counted were recorded on a separate table under the headings of *word_name, count* and *paper_id.* A total of 155,416 records were retrieved by the end of the counting operation. During the counting operations, the most frequently used words in English that did not yield meaningful results for the analysis (e.g., "the", "and", "are", "for", "was", "not", "from", "have", "only", "they", "such", "all", "our", "then", "thus", "once", "that", "with", "them", "also", "one", "two", "same", "more", "can", "used", "because", "there", "what", "more") were excluded.
3. *Counting the predefined data:* The frequency of the words in the text that had been purposefully determined by the researcher was calculated. These words were selected on the basis of them being

amenable to a deep investigation of words/word pairs thought to be useful in the analysis. These words/word pairs were: "questionnaire", "augmented reality", "learning outcome", "serious game", "thematic analysis", "experimental group", "quasi-experimental", "scale", "design recommendation", "theory driven", "data driven", "case study", "interview ", "explorative design", "log ", "participatory design", "pre-test", "post-test", "pretest", "posttest", "control group", "k-12", "qualitative", "quantitative", "primary school", "elementary school", and "junior school".

4. *Counting word pairs and recording them on a separate table:* All the operations performed in the 2nd step were repeated in counting word pairs. A total of 78,066 records were retrieved by the end of the counting activities.
5. *Counting abbreviations*: The abbreviations used in the publications were counted because abbreviations were given in parenthesis for some concepts, and these abbreviations were used in the text. For example, “serious games” is abbreviated as “SG” and the longer version is not used anymore. Making a count of the abbreviations was considered necessary to guarantee the accuracy of the numbers. A total of 1,315 abbreviations were identified and recorded in the database table.

The data stored in the database were listed through SQL, and the words were counted using the prepared scripts.

FINDINGS

Publication time trends

The number of studies published between the years 2007-2017 is depicted in graph form in Figure 2. Looking at the trend in terms of publication year, it can be seen that there was a significant dip in 2009 and then an increasing tendency as of 2010, followed by a pronounced decreasing trend after an increase in 2015.

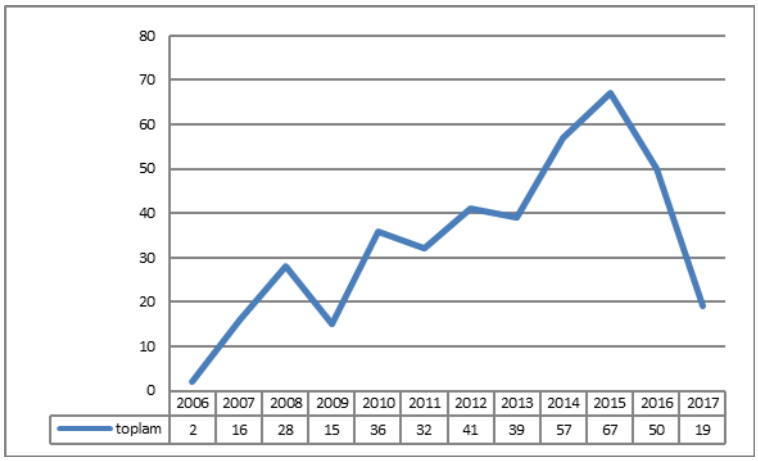


Figure 2 - Publication trends from 2007 to 2017

Prolific journals

Examining the publication numbers presented in Table 2 below, the *British Journal of Educational Technology* and *Computer & Education* published the most in the field. The journals that were at the forefront, quantitatively, in the dataset fall under the type that publishes educational studies.

Table 2 – The article distribution according to journals

Journal	n	%
British Journal of Educational Technology	33	32.04
Computers & Education	25	24.27
International Journal of Child-Computer Interaction	9	8.74
Computers in Human Behavior	5	4.85
Developmental Review	2	1.94
Entertainment Computing	2	1.94
Other (journals with less than two articles)	27	26.21
Total	**103**	

Findings regarding the game used in the studies

The following table (Table 3) was created considering the word pairs that were most frequently used with the word "game. Video games, computer games, educational games and serious games were among the most frequently used word pairs. The word pairs were grouped as general concept, game-related concept, game type, behavior, and classification.

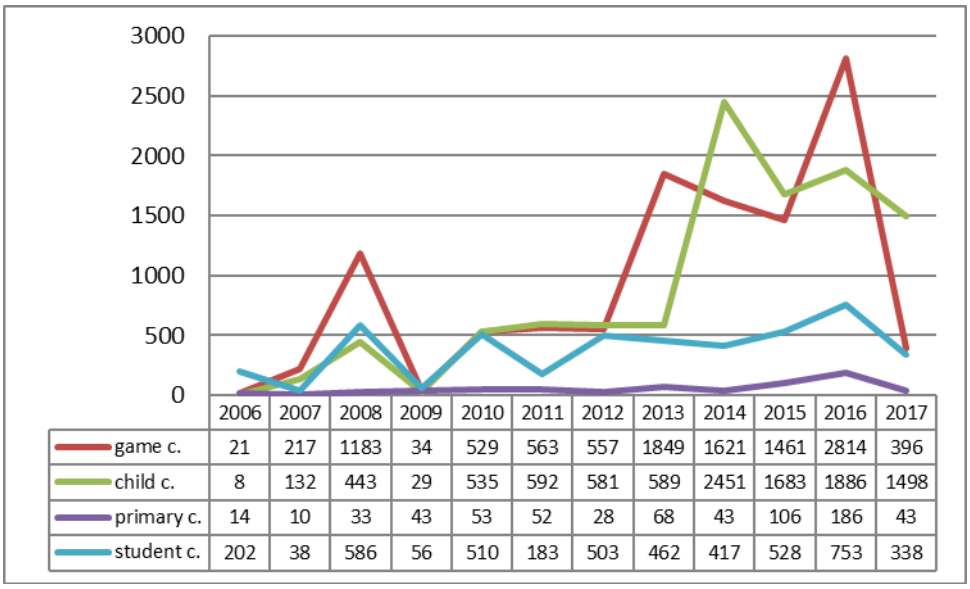
Table 3 – Word pairs regarding the game concept

Word pair	General concept	Game-related concept	Game type	Behavior	Classification	n
video games	✓		✓		✓	71
computer games	✓				✓	53
educational games	✓				✓	46
serious games	✓		✓			44
game design		✓				37
game play				✓		37
game-based learning	✓					34
digital games	✓					25
simulation games	✓		✓		✓	12
game environment		✓				9
game consoles		✓				8
game world		✓				8
game development		✓				7
board game	✓		✓		✓	6
game mechanics		✓				6
online game	✓				✓	6
teaching games	✓				✓	6
game elements		✓				5
games design		✓				5
electronic games	✓					4
game designers		✓				4
game levels		✓				4
reality games			✓			4
scenario-based games	✓		✓			4
commercial games	✓		✓			3
commercial off the shelf (cots) games	✓		✓			3
edutainment games	✓				✓	3
game characters		✓				3
game features		✓				3
game performance				✓		3
game scenario		✓				3
mobile games	✓		✓			3
olympic games			✓			3
game components		✓				2
game engine		✓				2
game experience				✓		2
game literacy		✓				2
game logic		✓				2
game object		✓				2
game preferences				✓		2
iphone game			✓		✓	2

negotiation game	✓	2
notable games	✓	2
persuasive games	✓	2
traditional games	✓	2
training game	✓	2

Findings according to the word count

The words *game*, *child*, *primary*, and *student* were counted in the dataset within the scope of the study in order to secure more in-depth analysis results. The distributions of word count according to publication year are presented in Figure 3 below. The results revealed that the words *game* and *child* were frequently used. The word *student* was counted because the studies that were conducted with students were intended to be included in this study. The word counting operation highlighted the high-use frequency of the word *student*. The word *primary* was therefore also included in the study, considering the word pairs *primary student* or *primary school*. These word pairs were found to be used at varying degrees of frequency according to publication year.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
game c.	21	217	1183	34	529	563	557	1849	1621	1461	2814	396
child c.	8	132	443	29	535	592	581	589	2451	1683	1886	1498
primary c.	14	10	33	43	53	52	28	68	43	106	186	43
student c.	202	38	586	56	510	183	503	462	417	528	753	338

Figure 3- Selected word counts

There was a steady increase in the use of the words *game* and *child* together in studies from 2008, 2014, and 2016. Moreover, there was an increasing tendency by studies to use the words *game*, *child*, and *student* together in 2008 and 2016.

The most frequently used words are presented in Table 4, where it can be seen that game, child, learning, study, and students were among the words most often used. The table also shows a noteworthy use of terminology specific to academic language (e.g., research, design, results, data, participants, significant).

Table 4 –The most frequently used words in the studies

Word	n	Word	n
game	8370	results	1191
child	8072	different	1166
learning	5890	social	1042
study	3584	information	973
students	2884	data	955
group	2323	development	840
educational	2285	digital	826
computer	2229	level	811
research	2011	content	795
play	1937	experience	794
education	1918	participants	759
teachers	1909	control	747
school	1704	scores	746
technology	1587	age	744

design	1403	found	731
time	1337	test	726
knowledge	1336	questions	725
skills	1299	video	724
activities	1209	significant	719

Computer game, educational technology, video game, educational research, educational game, and young children were among the most frequently used words. As seen in Table 5, there was a significant use of terminology specific to academic language (e.g., significant differences, control group, experimental group, data collection). Augmented reality and serious games express a specific kind of game or technology. In addition, these concepts are popular among the studies conducted in the field and give clues about the target audience, educational level, educational environment, and scientific research method of the relevant studies.

Table 5 – The most frequently used word pairs in the studies

Word pair	Count	Word pair	Count
computer game	492	primary school	117
educational technology	443	augmented reality	115
video game	368	game play	111
educational research	282	digital games	106
educational game	268	child-computer interaction	105
young children	265	special education	101
research association	264	active gaming	97
game design	253	game-based learning	97
control group	251	serious games	97
virtual world	231	working memory	96
learning environment	228	multiplicative reasoning	90
learning outcomes	194	interactive music	89
social skills	167	digital media	81
experimental group	145	educational software	81
significant differences	145	science learning	81
learning activities	139	educational communications	80
mobile learning	126	technology agency	80
television viewing	126	data collection	77
educational computer	119	elementary school	77

Another word group investigated within the scope of the study was abbreviations. Some researchers in their studies prefer to use abbreviations instead of long noun phrases. However, the results showed that there was not a remarkably high use of abbreviations in the studies.

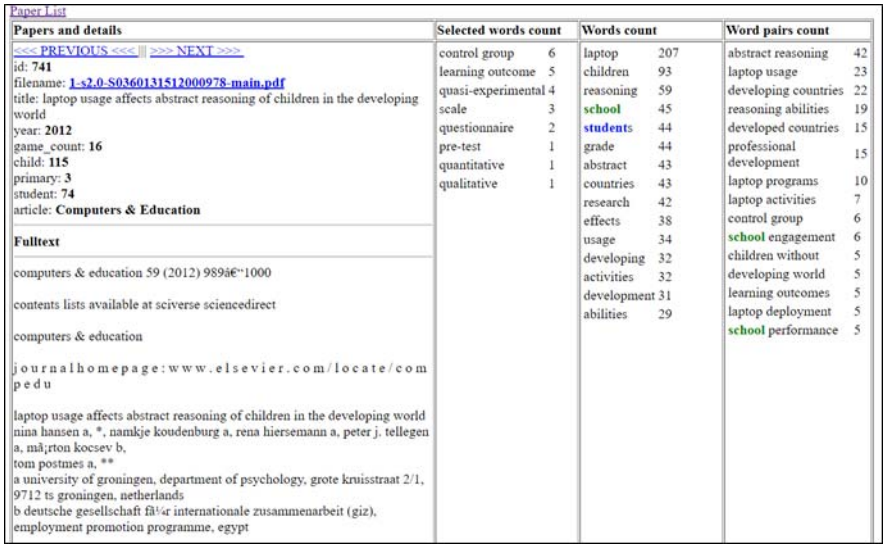
Table 6 – The most frequently used abbreviations in the studies

Abbr.	Word	Count	Abbr.	Word	count
(ict)	information and communication technology	16	(awma)	automated working memory assessment	4
(pd)	participatory design	14	(ddr)	dance dance revolution	4
(ar)	augmented reality	10	(er)	emotional regulation	4
(ple)	playful learning environment	10	(hsct)	hematopoietic stem cell transplantation	4
(cpl)	creative and playful learning	8	(it)	information technology	4
(dans)	data archiving and networked services	8	(iq)	intelligence quotient	4
(ece)	early childhood education	8	(its)	intelligent tutoring system	4
(cai)	computer assisted intervention	7	(ig)	inventing games	4
(elis)	everyday life information seeking	6	(dma)	degree of musical activity	4
(hme)	home musical environment	6	(zpd)	zone of proximal development	4
(ite)	initial teacher education	6	(pta)	proxy technology assessment	4
(par)	participatory action research	6	(nui)	natural user interfaces	4
(qa)	quest atlantis	6	(spp)	schome park programme	4
(cci)	child computer interaction	5	(sdk)	software development kit	4
(pnab)	phonetic alphabet	4	(tgfu)	teaching games for understanding	4
(tdm)	technology and digital media	4	(ts)	transactional support	4
(au)	anxiety and uncertainty	4	(uiui)	unsafe internet usage index	4

(av)	augmented virtuality	4	(vle)	virtual learning environment	4

Findings regarding the analysis method

This study aimed to obtain useful findings by applying a word analysis approach in investigating studies. The most frequently used words, word pairs, and abbreviations found within the studies examined were counted within the scope of this study. In addition, the presence and frequency of certain predetermined words or word pairs in the studies were investigated. To serve as an example, the details and analysis data of a publication by Hansen et al. (2012) are presented in Figure 4:



Paper List

Papers and details	Selected words count		Words count		Word pairs count	
<<< PREVIOUS <<< || >>> NEXT >>> id: **741** filename: 1-s2.0-S0360131512000978-main.pdf title: laptop usage affects abstract reasoning of children in the developing world year: **2012** game_count: **16** child: **115** primary: **3** student: **74** article: **Computers & Education** **Fulltext** computers & education 59 (2012) 989â€“1000 contents lists available at sciverse sciencedirect computers & education journalhomepage:www.elsevier.com/locate/compedu laptop usage affects abstract reasoning of children in the developing world nina hansen a, *, namkje koudenburg a, rena hiersemann a, peter j. tellegen a, mã¡rton kocsev b, tom postmes a, ** a university of groningen, department of psychology, grote kruisstraat 2/1, 9712 ts groningen, netherlands b deutsche gesellschaft fã¼r internationale zusammenarbeit (giz), employment promotion programme, egypt	control group	6	laptop	207	abstract reasoning	42
	learning outcome	5	children	93	laptop usage	23
	quasi-experimental	4	reasoning	59	developing countries	22
	scale	3	school	45	reasoning abilities	19
	questionnaire	2	students	44	developed countries	15
	pre-test	1	grade	44	professional development	15
	quantitative	1	abstract	43	laptop programs	10
	qualitative	1	countries	43	laptop activities	7
			research	42	control group	6
			effects	38	school engagement	6
			usage	34	children without	5
			developing	32	developing world	5
			activities	32	learning outcomes	5
			development	31	laptop deployment	5
			abilities	29	school performance	5

Figure 4 –Screenshot of publication details and analysis data

Papers and details: Figure 4 is a screenshot of the webpage designed by the researcher. In the furthest left column, the data related to title, year, game_count, child (word count), primary (word count), student (word count), article and full-text are presented.

Selected words count: Under this column, the word count, in the article, of the words predefined by the researcher is presented. For the model applied in the study conducted by Hansen et al., the words/word pairs *control group* (n=6), *learning outcome* (n=5), *quasi-experimental* (n=4), *scale* (n=3), *questionnaire* (n=2), *pre-test* (n=1), *quantitative* (n=1), and *qualitative* (n=1) were used. Considering the frequency of these uses, it can be inferred that among the studies investigated, some used a control group, some reported results or information derived from learning outcomes, some were designed as a quasi-experimental study, and some used a scale and/or questionnaire.

Words count: The top 5 most frequently used words in the sample study were: laptop (n=129), children (n=93), laptops (n=78), reasoning (n=59), school (n=45), and students (n=44). These words provide clues about the content. In this study conducted by Hensen et al. (2012), the sample model was structured around the laptop concept, as indicated by its title, which highlighted laptop use.

Word pairs count: The top 5 most frequently used word pairs in the sample study were: abstract reasoning (n=42), laptop usage (n=23), developing countries (n=22), reasoning abilities (n=19), developed countries (n=15), and professional development (n=15). Results similar to those shown in the previous paragraph were obtained in this part as well, as indicated by the most frequently used word pairs *abstract reasoning* (n=42) and *laptop usage* (n=23). Another concept that was often mentioned was *developing countries* (n=22).

CONCLUSIONS

Considering the trend analysis of the publications according to years, there was a decrease in the number of the publications towards 2009. A similar tendency was also determined towards 2016 and 2017. Although the studies on EDGC did not appear to diminish in popularity in the short term, there was an emergent decrease underway in the studies. However, it should be noted that the year 2017 has not yet been completed at the time the literature review for this study was carried out. Therefore, it will become evident in the coming years whether the trend will increase or decrease. In examining the journals in which the studies were published, the British Journal of Educational Technology and Computers & Education were found to be the most prominent,

followed by the Journal of Child-Computer Interaction and Computers in Human Behavior.
There was a diversity of words or word pairs mentioned together with the game concept. The same meaning is attached to some of the concepts (teaching game, educational game, edutainment game etc.). Although today, smartphones and tablets have taken the place of computers, the concept of video games and computer games remain popular. These definitions/classifications are made according to the platform in which they operate. One of the concepts frequently used under this heading is iPhone games. The concepts of educational games or edutainment games indicate games related to learning. It is recommended that future studies on this topic focus on developing a common concept or unity of terminology, or seek to determine whether these terms are used accurately.

In Table 4, which presents the most frequently used word pairs, the concepts of serious games, simulation games, and reality games are shown to be prominent concepts.
The most frequently used words and word pairs offer an important clue about the content of the studies. Considering the publication-based reviews, the titles of the publications clearly coincide with the frequencies. From this, it can be inferred that such studies were accurately titled, as the titles of studies are an important indicator of their content. However, with that said, it may not always be possible to include all relevant concepts in the title.

A new method was applied in the current study. The literature from the last decade on learning through EDGC was reviewed and analyses were conducted based on big data analysis. Advanced technology has led to there being an excessive amount of data in the hands of humankind. Studies have been conducted to make inferences from this large amount of data. This situation also holds true in the field of education. This study was conducted to serve as an example of the use of big data analysis in education.

The studies that have been conducted in this field have tended to apply meta-analysis, document analysis, trend analysis, and bibliometric analysis. While the method used in this study does have similarities to these said methods, there are nonetheless major differences. To date, analyses have been based on the interpretation of quantitative data. In such studies, analyses of the change in the trend have been performed according to year, the number of authors in publications, citations, and common citations. Although the search of the databases listed a superabundance of studies, useful clues about the content of the publications can be obtained by examining the frequently used words and word pairs. Approximately 1,500 publications were downloaded within the scope of the study. After the elimination process, the number was initially decreased to 403 before being further reduced to 103 at the final stage. This number could even be further decreased if this dataset on EDGC were to be subjected to a more specific filtration. The increase in the number of publications and thus the increase in the dataset makes it more difficult for researchers to handle the data. It is here that more detailed and intelligent search systems are needed to support researchers. Methods capable of providing better support to researchers can be discovered through the development of higher-order software. For example, inferences about samples, method, and technology can be analyzed through software by using word analysis/data analysis, and the results can be shared with researchers.

Abbreviations are extensively used in studies. However, the analysis regarding abbreviation use did not yield meaningful findings. Abbreviation use can make it possible for readers to become informed about the concept related to the abbreviated term(s) and to get familiar with the abbreviation itself. It was found, in this study's analysis, that after using abbreviations, the long version continued to be used in some studies.

Considering the word pairs that included the word *parental* in the dataset, the word pairs of parental supervision, parental control, parental support, parental education, parental involvement, parental rating, and parental scaffolding were listed. This result served to indicate that when purposefully selected special words are searched in the dataset, the related word pairs are listed. These searches revealed records that yield meaningful results. According to these findings, the word-based analysis can provide useful results. It is not yet evident what kind of findings can be obtained by performing investigations through data analysis. Different findings can be reached as data become more enlarged or new data analyses are attempted. More studies need to be conducted on this topic or similar such topics.

The analyses revealed that some words and word pairs are important parameters despite not being frequently used in the studies. For example, the fact that a study used qualitative data analysis was an important indicator for this study. An analysis may reveal that the word *qualitative* is not frequently used. However, this does not mean that using qualitative data analysis is not an important parameter in data analysis results. A greater amount of theoretical and practical knowledge is needed in order to better understand how to perform data analysis techniques in this field.

REFERENCES

Ai-Lim Lee, E., Wong, K. W., & Fung, C. C. (2010). How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach. *Computers & Education*, *55*(4), 1424–1442. https://doi.org/10.1016/j.compedu.2010.06.006

Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In *Learning analytics* (pp. 61-75). Springer New York.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS quarterly*, *36*(4).

Daniel, B. (2015). Big Data and analytics in higher education: Opportunities and challenges. *British Journal of Educational Technology*, *46*(5), 904–920. https://doi.org/10.1111/bjet.12230

Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers & education*, *49*(3), 873–890.

Egenfeldt-Nielsen, S. (2011). *Beyond edutainment: Exploring the educational potential of computer games*. Lulu. com.

Feldman, R., & Sanger, J. (2006). Information extraction. *The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data*, 94-130.

Furió, D., González-Gancedo, S., Juan, M.-C., Seguí, I., & Costa, M. (2013). The effects of the size and weight of a mobile device on an educational game. *Computers & Education*, *64* (Supplement C), 24–41. https://doi.org/10.1016/j.compedu.2012.12.015

Garaigordobil, M. (2005). Importancia del juego infantil en el desarrollo humano. *Aula de infantil*, 25, 37–43.

Hansen, N., Koudenburg, N., Hiersemann, R., Tellegen, P. J., Kocsev, M., & Postmes, T. (2012). Laptop usage affects abstract reasoning of children in the developing world. *Computers & Education*, *59*(3), 989–1000. https://doi.org/10.1016/j.compedu.2012.04.013

Hoda, R., Henderson, A., Lee, S., Beh, B., & Greenwood, J. (2014). Aligning technological and pedagogical considerations: Harnessing touch-technology to enhance opportunities for collaborative gameplay and reciprocal teaching in NZ early education. *International Journal of Child-Computer Interaction*, *2*(1), 48–59. https://doi.org/10.1016/j.ijcci.2014.06.001

Horn, J. D. V. (2016). Opinion: Big data biomedicine offers big higher education opportunities. *Proceedings of the National Academy of Sciences*, *113*(23), 6322–6324. https://doi.org/10.1073/pnas.1607582113

Hung, J. (2012). Trends of e-learning research from 2000 to 2008: Use of text mining and bibliometrics. *British Journal of Educational Technology*, *43*(1), 5–16. https://doi.org/10.1111/j.1467-8535.2010.01144.x

Johnson, S. (2006). *Everything bad is good for you: How today's popular culture is actually making us smarter*. Penguin.

Kirriemuir, J., & McFarlane, A. (2004). Literature review in games and learning.

Klösgen, W., & Zytkow, J. M. (2002). Knowledge discovery in databases: the purpose, necessity, and challenges. Içinde *Handbook of data mining and knowledge discovery* (ss. 1–9). Oxford University Press, Inc.

Leeuwen, T. Van. (2004). Descriptive Versus Evaluative Bibliometrics. Içinde *Handbook of Quantitative Science and Technology Research* (ss. 373–388). Springer, Dordrecht. https://doi.org/10.1007/1-4020-2755-9_17

Lisi, R. D., & Wolford, J. L. (2002). Improving Children's Mental Rotation Accuracy With Computer Game Playing. *The Journal of Genetic Psychology*, *163*(3), 272–282. https://doi.org/10.1080/00221320209598683

Martín-SanJosé, J.-F., Juan, M.-C., Gil-Gómez, J.-A., & Rando, N. (2014). Flexible learning itinerary vs. linear learning itinerary. *Science of Computer Programming*, *88*(Supplement C), 3–21. https://doi.org/10.1016/j.scico.2013.12.009

McFarlane, A., Sparrowhawk, A., & Heald, Y. (2002). *Report on the educational use of games*. TEEM (Teachers evaluating educational multimedia), Cambridge.

McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. Penguin.

Mitchell, I., Keast, S., Panizzon, D., & Mitchell, J. (2017). Using "big ideas" to enhance teaching and student learning. *Teachers and Teaching*, *23*(5), 596–610. https://doi.org/10.1080/13540602.2016.1218328

Mumtaz, S. (2001). Children's enjoyment and perception of computer use in the home and the school. *Computers & Education*, *36*(4), 347–362. https://doi.org/10.1016/S0360-1315(01)00023-9

O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: evidence from the computer games literature. *The Curriculum Journal*, *16*(4), 455–474. https://doi.org/10.1080/09585170500384529

Prinsloo, P., Archer, E., Barnes, G., Chetty, Y., & van Zyl, D. (2015). Big(ger) Data as Better Data in Open Distance Learning. *International Review of Research in Open and Distributed Learning*, *16*(1), 284–306.

Robertson, J., & Howells, C. (2008). Computer game design: Opportunities for successful learning. *Computers*

& Education, *50*(2), 559–578.
Romero, C., Ventura, S., & García, E. (2008). Data mining in course management systems: Moodle case study and tutorial. *Computers & Education*, *51*(1), 368–384. https://doi.org/10.1016/j.compedu.2007.05.016
Selwyn, N. (2015). Data entry: towards the critical study of digital data and education. *Learning Media and Technology*, *40*(1), 64–82. https://doi.org/10.1080/17439884.2014.921628
Thompson, G. (2017). Computer adaptive testing, big data and algorithmic approaches to education. *British Journal of Sociology of Education*, *38*(6), 827–840. https://doi.org/10.1080/01425692.2016.1158640
Virvou, M., Katsionis, G., & Manos, K. (2005). Combining Software Games with Education: Evaluation of its Educational Effectiveness. *Educational Technology & Society*, *8*(2), 54–65.