



Universidade do Minho

Escola de Psicologia

Diogo Rafael Freitas Ferreira

**Online vs Pen-and-Paper Homework: An
Integrative Review**



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Dissertação de Mestrado
Mestrado Integrado em Psicologia

Trabalho realizado sob orientação de

Professor Doutor Pedro Rosário
Doutora Paula Magalhães

Declaração

Nome: Diogo Rafael Freitas Ferreira

Endereço eletrónico: ferreirafdiogo@gmail.com

Telemóvel: +351916813246

Número do cartão de cidadão: 14894942

Título da dissertação: Online vs Pen-and-Paper Homework: An Integrative Review

Orientação: Professor Doutor Pedro Rosário, Doutora Paula Magalhães

Ano de Conclusão: 2018

Designação do Mestrado: Mestrado Integrado em Psicologia

É AUTORIZADA A REPRODUÇÃO INTEGRAL DESTA DISSERTAÇÃO, APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.

Universidade do Minho, 16/10/2018

Assinatura: Diogo Ferreira

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Agradecimentos

A realização e finalização da minha dissertação de mestrado não teria sido possível sem a ajuda de várias pessoas.

Quero começar por agradecer ao Professor Doutor Pedro Rosário pela orientação e pela partilha de conhecimento. Sem dúvida que aprendi muito ao longo deste tempo, aprendizagens essas que levo para a vida.

Agradeço também à Doutora Paula Magalhães (e à Violeta) pelo apoio e orientação inicial. Por me ter dado o empurrão inicial para que a dissertação começasse a tomar forma e pelas estratégias de organização de escrita e “ataque” ao tema.

Agradeço ao GUIA e a todos que estão, ou já passaram pelo grupo, pela partilha de conhecimento e de todas as experiências pessoais.

Quero também agradecer aos meus pais e irmão pelo apoio incondicional, por me ouvirem e pela ajuda que me deram.

Por fim, quero agradecer á Raquel pelo amor, pelo apoio, por me ouvir e por ter estado disponível sempre que precisei. Estas palavras não chegam para descrever o que fizeste por mim.

Obrigado.

Resumo

Uma ferramenta escolar importante utilizada pelos professores e pelos alunos são os trabalhos de casa. Os trabalhos de casa são uma oportunidade para os alunos praticarem o que foi aprendido durante as aulas. Plataformas online estão disponíveis para os professores marcarem os trabalhos de casa e, conseqüentemente, para os alunos os realizarem. Este estudo tem como finalidade realizar uma revisão integrada de forma a mostrar o panorama geral da investigação em trabalhos de casa online e trabalhos de casa em papel com o objetivo de explorar qual tipo de trabalho de casa (i.e., online vs papel) apresenta mais benefícios para a performance dos alunos. Foram revistos trinta e três estudos e identificadas categorias tais como participantes, duração da intervenção e domínio do curso. Analisando a amostra de artigos revista, os trabalhos de casa online apresentam mais benefícios para os alunos do que os trabalhos de casa em papel.

Palavras-chave: trabalho de casa online, trabalho de casa em papel, trabalho de casa na web, revisão integrada

Abstract

One of the most important educational tool used by teachers and students is homework. Homework provides the opportunity for students to practice by themselves what was learned in class. Online platforms are available for teachers to assign homework and consequently for their students to complete the tasks assigned. The current study aimed to conduct an integrative review providing an overview of the research on online homework and pen-and-paper homework with the objective to explore which type of homework (i.e. online vs. pen-and-paper) has more benefits for student's performance. Thirty-three studies were reviewed and categories such as participants, duration of intervention and course domain were found. Analyzing the sample of the articles revised, online homework has more benefits for students than pen-and-paper homework.

Keywords: Online homework, pen-and-paper homework, web-based homework, integrative review

Online vs Pen-and-Paper Homework: An Integrative Review

One of the most common school activities involving students, parents and teachers is homework (Núñez et al., 2013). This educational tool is present in classrooms from distinct cultures and is assigned to and completed by students irrespective of their school grade (Rosário et al., 2008). Homework can be defined as tasks, assigned to students by their teachers, that are intended to be carried out during non-school hours (Cooper, 2001). Homework gives teachers the opportunity to extend the time of learning outside school hours and students the occasion to consolidate what they have learned in school (Kaur, 2010). This educational tool allows the independent practice of contents learned in class; in fact, one of the most important features of homework is that students are expected to take the responsibility to carry it out (Murillo & Martínez-Garrido, 2013).

Globally, homework has the potential to be a key component of students' education (Williams, 2010). Still, taken together, data on homework indicates both positive and negative impacts on students learning. Literature shows that completing homework assignments has positive effects for students, such as better retention of factual knowledge, better critical thinking, improved attitude toward school, greater self-discipline and better time management (Cooper, 2001). However, extant literature also alerts to the fact that homework may also show negative effects on students, such as loss of interest in school contents, physical and emotional fatigue, pressure to complete and outperform which may lead to copied responses from other students (Cooper, 2001). Despite this, homework is globally perceived as a valuable teaching tool that fosters academic achievement and success (Voorhees, 2011).

Parents, teachers, and students are likely to perceive the general purpose of homework differently. Parents and teachers may understand homework as a way to reinforce school learning and to develop self-regulatory skills (Xu, 2010). Conversely, students notice homework as a tool likely to improve their understanding of the contents delivered in class and as an opportunity to receive approval from their parents and teachers which is one of the main reasons for completing the assignments (Xu, 2010). However, and despite their understanding on homework general purpose, literature reports that students who complete their homework on a regular basis tend to achieve higher grades than their counterparts who do not complete their assignments (Galloway, Conner, & Pope, 2013).

Teachers play an important role on the homework process, their involvement occurs in two moments: when they plan the number and type of homework tasks and when they provide feedback on the homework handed by students (Núñez et al., 2014). The latter is important due to the impact homework may play on student's achievement (Ismail, Mokhtar, Nasir, Rashid, & Ariffin, 2014). For example, when teachers provide homework feedback on a daily basis, students' academic performance is expected to improve (Murillo & Martínez-Garrido, 2013). However, teachers are growing their involvement in administrative tasks which makes grading pen-and-paper homework a burden and often a non-feasible task. Moreover, this heavy workload is likely to prevent delivering on-task feedback (Demirci, 2010b). The use of technology in the class, particularly of homework systems that provide students with instant feedback seem to offer an alternative for teachers to overcome the barriers mentioned (Stickles, 2017).

In a world where the use of computers and portable services devices is entrenched in our everyday lives, technologies provide motivated students with the ability to learn and access information on-demand, without geographic limitations, whenever they are curious about a subject (Chan et al., 2006). Data from the Programme for International Student Assessment (PISA) shows that, by 2012, the majority of households from most of the Organization for Economic Co-operation and Development (OECD) member countries had computers. The report stated that, in average, 43% of the participating students lived in homes with three or more computers, and approximately 4% lived in homes with no computers (OECD, 2015).

The technology advances are also visible in the class; in fact, there is a fast growth in the use of web-based tools for teaching and learning. These tools help teachers deal with the increasing number of students per class and with the burden of their administrative workload (Elmehdi, Ibrahim, & Haba, 2013). For example, when compared with the pen-and-paper homework, the use of online homework has clear benefits for teachers (e.g., reduction in the time needed to copy, distribute and collect homework, less time to check the assignments, on-time feedback). Moreover, when using online homework teachers are no longer expected to score homework and record the scores in a grade book.

Online homework also helps teachers cope with dysfunctions in the homework process that are time consuming (e.g., missed, lost, and submitted-late assignments). Most importantly, the time teachers save on homework administrative tasks, can be used to prepare exercises and contents for the classes (Demirci, 2010a). The use of an online tool has the cost of setting up the

system, teaching the students how to use it and how to download information; however, the time spent grading the homework assignments of all the students is lowered (Fynnewever, 2008).

The use of web platforms with educational purposes allows students to receive immediate feedback which may encourage students to practice the exercises and compete to excel. Moreover, these platforms allow the randomization of exercises which is likely to reduce student's dishonesty behaviors related to copying homework from their peers (Bonham, Beichner, & Deardorff, 2001). These benefits help control some negative aspects related to pen-and-paper homework (e.g. difficulty to deliver on time feedback); however, online homework has also cons, such as trial-and-error submissions due to the possibility to submit multiple submissions, or the emphasis on the final answer rather than on the process of building answers (Bonham et al., 2001).

In sum, using a web platform allows to provide immediate feedback to exercises when uploaded, which give students the opportunity to correct their errors and submit new versions of the responses to the assignments in a timely manner. The possibility of receiving real-time feedback and assistance from the platform, may help students further understand the assignments. In fact, the online homework, simulates the learning activities students might experience when a teacher is present in class to assist and evaluate their work. The online homework system provides students with specific on time feedback, thus eliminating the need to wait for the next class to receive feedback, as would happen when teachers use the traditional pen-and-paper homework (Jr. & Smith, 2016). Students appreciate the possibility to learn instantly their homework grade and be provided with hints to help them find the correct answer. This is only possible using an online homework system (Davis & McDonald, 2016).

Aim of the study

The purpose of this study is to learn which type of homework, online or pen-and-paper, show more benefits for student's performance. Literature posits that positive attitudes towards homework are associated with higher achievement, this could be due to the fact that students with a positive attitude about homework tend to learn more from the assignments than their counterparts displaying negative attitudes (Chang, Wall, Tare, Golonka, & Vatz, 2014). Students motivation towards homework is affected by the way they perceive their ability to learn through homework (Smith & McCoy, 2011).

Across OECD countries, on average, 48% of students reported using a computer to do homework, 38% to use e-mail to communicate about schoolwork with their peers, and 33% declared to share school-related materials via computer (OCDE, 2015). The current generation of students use technologies on their daily life, and some complain that complete pen-and-paper homework is boring; so, ask them to use a computer for homework assignments might foster their school and homework engagement (Dillard-Eggers, Wooten, Childs, & Coker, 2008). One important aspect to note is that, when teacher grades homework and marks incorrect answers with no indications to help students understand their mistakes, then feedback is likely to be seen as criticism and does not help the student learning process. The opposite occurs when feedback is accompanied by an explanation on how they can improve and correct those mistakes; when this happens, learning is promoted (Williams, 2010). Homework may not be useful to students learning if they are not checked to rectify student's errors and to improve their work (Núñez et al., 2014). Online platforms can provide this type of feedback. Students that use online platforms have a favorable response, take the homework assignment more seriously, spend more time outside class and have a higher retention rate.

We opted for an integrative review as this method allows to summarize prior empirical and theoretical literature on a topic of interest. The current integrative review is focused on the comparison between online and pen-and-paper homework and their benefits for student's performance. This method of review allows the simultaneous inclusion of experimental and non-experimental types of research in order to capture the context, processes, and subjective elements of the topic. A rigorously integrative review allows for various perspectives on a phenomenon to be synthesized into a knowledge foundation (Whittemore & Knafl, 2005).

Method

Search strategy and selection criteria

A systematic literature search was performed with a preplanned review protocol specifying inclusion and exclusion criteria for the studies and subsequent data analysis. Only original research, peer-reviewed, and English-language studies were considered, excluding review articles and short conference abstracts. Inclusion criteria were as follows: (1) the study had to compare online and pen-and-paper homework and their effect on students performance, and (2) the study needed to include a quantitative measure allowing for that comparison (e.g., final grades); that is, papers were excluded when the only form of measure was students or

instructors' perceptions about each type of homework. The searches consisted of combinations of controlled terminology in each database. The keywords used were “online homework” and “web-based homework”. These keywords were chosen because “online homework” is the term authors use to define the type of homework and “web-based homework” was chosen because after the first database search the articles found also had this keyword in common. A total of three databases were searched, namely Web of Science, Education Resources Information Center (ERIC), and Google Scholar. The search was conducted from November 6th, 2017 to April 16th, 2018. Table 1 shows the search results of every search made and papers included from each database. For Web of Science, authors used the keywords as Topic and refined the search to show only articles. As for ERIC, authors used the keywords described above. Finally, for Google Scholar, authors used the tool advanced research and wrote the keywords on “with all the words” and “with the exact expression”, authors also ticked the option “on the title of the article”.

Table 1

Search results and final articles selected per database

Database	Web of Science	Google Scholar	ERIC
Results	67	318	122
Articles Selected	6	14	13

Selection process and data extraction

Prior to the extraction of data, two reviewers followed the protocol to select the articles working independently (e.g., followed the criteria set, used the same databases to search for results). In case of uncertainty or disagreement, the paper was screened in full-text, and consensus was reached through discussion. Data from included studies were extracted and organized using Microsoft[®] Excel[®] 2010. Data was extracted as follows: study design, participants, setting, online homework tool, time of intervention, area of education, outcome variables, and study findings.

Data analysis

For the purpose of this review and to facilitate reading and understanding of the results, authors grouped papers in four course domains. The groups were as follows: *Mathematics* including papers with a focus on algebra and statistics, *Business* comprising papers on

accounting, business statistics, and economics, *Sciences* including papers on physics, chemistry, and environmental sciences, and the last group comprising papers focused on *Engineering*. Furthermore, acknowledging that some articles used the academic year instead of semesters to describe the duration of the intervention, for the purpose of this investigation we considered two semesters equal to an academic year. Concerning the online homework tool used in each study, data was reported as “in house developed”, when the platform was developed by the author or by the institution which held research; or “text book developed”, when the platform was developed by a textbook publisher. Finally, regarding the results and conclusions of the articles, for the purpose of the current research, we opted to report data as (i) “Negative” when the papers concluded that online homework had poorer results than the pen-and-paper homework, (ii) “Neutral” when the articles settled that results were similar in both types of homework, and (iii) “Positive” when the articles concluded that online homework had better results than pen-and-paper homework.

Results

Study selection

The databases searched identified 507 records of possible interest. After screening all the records against the selection criteria 164 papers remained to be assessed in full-text review, yielding 33 studies for final data analysis. The most common reasons for exclusion were: (1) not comparing online homework with pen-and-paper homework, and (2) type of measure being students’ perceptions and not students’ performance. Table 1 shows the results per database and the articles selected in each.

Study’s characteristics

The dates of the publications of the 33 studies included in the research ranged from 2002 to date, but the majority was published after 2009 (see Figure 1). This result highlights that this research is new in the field, but also how much research has grown in the last eight years. The primary aim of the reviewed studies was to assess whether the performance of students (e.g., homework grades, final test or final grade on the course) improved by using an online homework platform. Next, the main characteristics of the selected studies will be described, including: participants, course, study design, characteristics of the intervention, and characteristics of the online platforms.

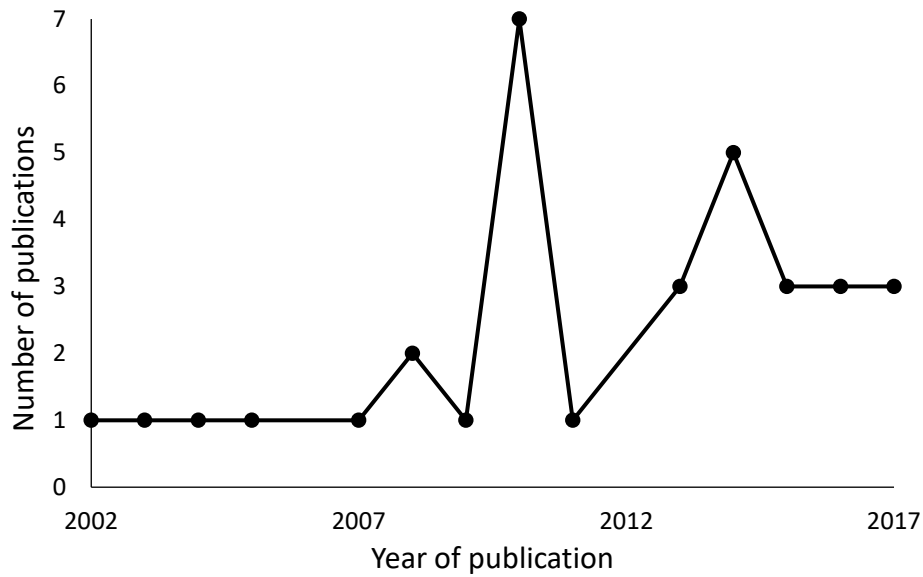


Figure 1. Number of publications per year since the first paper addressing the online homework topic was published

Participants

The majority of the articles included did not provide information about their participants, making it difficult to draw a demographic profile. Still, 29 studies provided information about the size of their sample (Arora, Rho, & Masson, 2013; Babaali & Gonzalez, 2015; Bonham, Deardorff, & Beichner, 2003; Brewer & Becker, 2010; Burch & Kuo, 2010; Demirci, 2007, 2010a, 2010b; Elmehdi et al., 2013; Fatemi, Marquis, & Wasan, 2014; Fratto, Sava, & Krivacek, 2016; Fynnewer, 2008; Gaffney, Ryan, & Wurst, 2010; Gok, 2011; Hauk, Powers, & Segalla, 2014; Johnston, 2004; Jonsdottir, Bjornsdottir, & Stefansson, 2017; Jr. & Smith, 2016; Lazarova, 2015; Lee, Courtney, & Balassi, 2010; Lenz, 2010; Malik et al., 2014; Mathai & Olsen, 2013; Mendicino, Razzaq, & Heffernan, 2009; Palocsay & Stevens, 2008; Stickles, 2017; Wessels & Oatsvall, 2017; Williams, 2010; Woolley, 2015). These studies used samples, ranging from 52 (Burch & Kuo, 2010) to 450 (Jonsdottir et al., 2017) with a mean of 177 participants ($SD = 118$).

Seventeen out of the 33 studies provided information about participant's gender, age, and grade level (Bonham et al., 2003; Brewer & Becker, 2010; Chow, 2014; Demirci, 2007; Dodson, 2014; Elmehdi et al., 2013; Fatemi et al., 2014; Fratto et al., 2016; Gaffney et al., 2010; Hauk et al., 2014; Jonsdottir et al., 2017; Jr. & Smith, 2016; Malik et al., 2014; Mendicino et al., 2009; Wessels & Oatsvall, 2017; Williams, 2010; Woolley, 2015). Specifically, 13 studies specified the gender of the participants (Bonham et al., 2003; Brewer & Becker, 2010; Demirci, 2007; Fatemi

et al., 2014; Fratto et al., 2016; Gaffney et al., 2010; Hauk et al., 2014; Jonsdottir et al., 2017; Malik et al., 2014; Mendicino et al., 2009; Wessels & Oatsvall, 2017; Williams, 2010; Woolley, 2015). One study had only female participants (Wessels & Oatsvall, 2017). The others presented a mean for females of 97 ($SD = 91$) ranging from 24 (Fratto et al., 2016) to 303 (Hauk et al., 2014). For the males the mean was 94 ($SD = 68$) ranging from 30 (Williams, 2010) to 223 (Bonham et al., 2003). Only two studies included information about the age of participants: in one study the mean age was 29.9 years (Williams, 2010), the other presented data in intervals; the majority of the participants had between 18-24 years old and only two participants were between 25-34 years old (Fratto et al., 2016). Moreover, except for two studies (Dodson, 2014; Mendicino et al., 2009) all the researches were conducted with college students. Nine studies provided information about the academic year of the participants (Chow, 2014; Dodson, 2014; Elmehdi et al., 2013; Hauk et al., 2014; Jr. & Smith, 2016; Malik et al., 2014; Mendicino et al., 2009; Wessels & Oatsvall, 2017; Williams, 2010). Two out of these nine studies conducted their research with fifth graders (Mendicino et al., 2009) and students from the third and fourth year of high-school (Dodson, 2014). Seven out of the nine studies investigated college students (Chow, 2014; Elmehdi et al., 2013; Hauk et al., 2014; Jr. & Smith, 2016; Malik et al., 2014; Wessels & Oatsvall, 2017; Williams, 2010). One of those studies mentioned that all participants were undergraduate students (Chow, 2014), two studies reported that students were from the first year (Elmehdi et al., 2013; Hauk et al., 2014), and two other mentioned that their students were enrolled in the third and fourth year (Jr. & Smith, 2016). The study by Malik et al. (2014) included 66 students from the fourth year, 38 from the third year, and four non-degree students. Wessels and Oatsvall (2017) investigated 35 students from second year, 12 from the third year, and six from the fourth year students. Finally, study by Williams (2010) included 45 master students and 26 doctoral students.

Course domain

The sample of studies investigated diverse course domains. Specifically, the research was conducted in areas as follows: Mathematics (12) (Arora et al., 2013; Babaali & Gonzalez, 2015; Brewer & Becker, 2010; Burch & Kuo, 2010; Chow, 2014; Hauk et al., 2014; Jonsdottir et al., 2017; Lenz, 2010; Mathai & Olsen, 2013; Mendicino et al., 2009; Stickles, 2017; Williams, 2010); Sciences (11) (Bonham et al., 2003; Demirci, 2007, 2010a, 2010b; Dodson, 2014; Dufresne, Mestre, Hart, & Rath, 2002; Elmehdi et al., 2013; Fynewever, 2008; Gok, 2011;

Lazarova, 2015; Malik et al., 2014); Business (8) (Fatemi et al., 2014; Fratto et al., 2016; Gaffney et al., 2010; Jr. & Smith, 2016; Lee et al., 2010; Palocsay & Stevens, 2008; Wessels & Oatsvall, 2017; Woolley, 2015); and Engineering (1) (Davis, & McDonald, 2016). Lastly, one paper did not define the domain in which the study was conducted (Johnston, 2004).

Study's design

Regarding the study design, most of the articles (Arora et al., 2013; Babaali & Gonzalez, 2015; Bonham et al., 2003; Brewer & Becker, 2010; Burch & Kuo, 2010; Chow, 2014; Davis & McDonald, 2016; Demirci, 2007, 2010a, 2010b; Dodson, 2014; Dufresne et al., 2002; Elmehdi et al., 2013; Fatemi et al., 2014; Fratto et al., 2016; Fynewever, 2008; Gaffney et al., 2010; Gok, 2011; Johnston, 2004; Jr. & Smith, 2016; Lazarova, 2015; Lee et al., 2010; Lenz, 2010; Malik et al., 2014; Mathai & Olsen, 2013; Mendicino et al., 2009; Palocsay & Stevens, 2008; Stickles, 2017; Wessels & Oatsvall, 2017; Woolley, 2015) used a convenience sample: i) the data was selected because it was readily available to the researchers or ii) the sample was constituted by the students enrolled in the subject which the researchers were teaching. Only two out of the 33 studies used a randomized sample (Jonsdottir et al., 2017; Williams, 2010). Jonsdottir and colleagues (2017) split the class randomly into two groups, with one of the groups completing an assignment in the pen-and-paper format and the other used the online format. After that assignment the groups took a test and changed the homework type assigned. This cycle was repeated four times throughout the study. The study by Williams (2010) assigned randomly four classes of a course to a type of homework, either pen-and-paper or online homework. Ten papers out of the 33 included a follow-up measure (Arora et al., 2013; Demirci, 2010a, 2010b; Fratto et al., 2016; Fynewever, 2008; Gok, 2011; Hauk et al., 2014; Lee et al., 2010; Mendicino et al., 2009; Williams, 2010) and two used pre and post measures (Brewer & Becker, 2010; Chow, 2014).

Intervention's characteristics

The duration of the intervention across studies had a mean of 2.6 semesters ($SD = 1.9$) and a median of two semesters (Arora et al., 2013; Bonham et al., 2003; Burch & Kuo, 2010; Fatemi et al., 2014, Fratto et al., 2016; Mathai & Olsen, 2013; Palocsay & Stevens, 2008; Stickles, 2017). The shortest intervention lasted for four days (this last information was not used in the calculation of the mean) (Woolley, 2015) and the longest intervention lasted for eight semesters (Jonsdottir et al., 2017).

Online platforms' characteristics

Most of the studies used platforms developed by a text book publisher. Three studies used a platform purposively developed for the study (Demirci, 2010a, 2010b; Dodson, 2014), and eight did not specify the nature of the platform used (Brewer & Becker, 2010; Chow, 2014; Davis & McDonald, 2016; Demirci, 2007; Fratto et al., 2016; Fynewever, 2008; Gaffney et al., 2010; Johnston, 2004). Seventeen of the platforms and types of online homework used included some kind of feedback (Arora et al., 2013; Babaali & Gonzalez, 2015; Burch & Kuo, 2010; Dufresne et al., 2002; Elmehdi et al., 2013; Fynewever, 2008; Gok, 2011; Hauk et al., 2014; Johnston, 2004; Jr. & Smith, 2016; Lazarova, 2015; Lee et al., 2010; Lenz, 2010; Mathai & Olsen, 2013; Mendicino et al., 2009; Palocsay & Stevens, 2008; Stickles, 2017). The remaining 16 studies did not specify whether their platforms provided feedback or not. Arora and colleagues (2013) used a platform that allowed the teacher to create their homework questions, whereas Babaali and Gonzalez's (2015) platform, for example, included a database of questions available for teachers to use. Conversely, Palocsay and Stevens' (2008) platform had the feature of allowing teachers to use a database or to create their own questions for students' homework. In two papers, the students were able to print the exercises from the platform, and solve them off the computer (Gok, 2011; Hauk et al., 2014). Seven papers limited the number of errors students could make in their homework (Babaali & Gonzalez, 2015; Burch & Kuo, 2010; Davis & McDonald, 2016; Fatemi et al., 2014; Lazarova, 2015; Lenz, 2010; Woolley, 2015). Two papers limited their students to only three attempts per exercise (Burch & Kuo, 2010; Lenz, 2010) and one paper gave students three attempts per homework plus three attempts to revise the homework (Fatemi et al., 2014). Lazarova (2015) posed a limit of five attempts per assignment, while the research by Woolley (2015) limited the attempts to five per exercise. Finally, the work by Davis and McDonald (2016) included a different type of limitation to students, e.g. the scores students could get on a single homework were reduced as a function of the number of attempts used to find the correct answer.

Homework's characteristics

Both pen-and-paper and online homework exercises showed similar features. Twenty one out of the 33 papers, used similar or the same exercises in both online and pen-and-paper homework (Arora et al., 2013; Babaali & Gonzalez, 2015; Bonham et al., 2003; Brewer &

Becker, 2010; Demirci, 2007, 2010a, 2010b; Dodson, 2014; Elmehdi et al., 2013; Fatemi et al., 2014; Fratto et al., 2016; Fynewever, 2008; Gok, 2011; Hauk et al., 2014; Jonsdottir et al., 2017; Lazarova, 2015; Lenz, 2010; Malik et al., 2014; Mathai & Olsen, 2013; Mendicino et al., 2009; Williams, 2010). Three papers asked students in the online homework condition to do their homework assignments individually, while students in the pen-and-paper condition were asked to complete it in group (Demirci, 2007, 2010a, 2010b).

Study results and conclusions

The authors defined “Study results” using parameters such as retention of knowledge, exam and final grades, homework assignments completed and overall performance when comparing online homework and pen-and-paper homework (see results per article on table 2). The conclusions made by the article’s authors were organized, as mentioned in the Data analysis section, in three categories: Positive, Neutral and Negative. Sixteen out of the 33 selected articles, were categorized as Positive (Arora et al., 2013; Babaali & Gonzalez, 2015; Burch & Kuo, 2010; Dodson, 2014; Dufresne et al., 2002; Elmehdi et al., 2013; Fatemi et al., 2014; Fratto et al., 2016; Gaffney et al., 2010; Gok, 2011; Johnston, 2004; Jonsdottir et al., 2017; Lazarova, 2015; Lenz, 2010; Malik et al., 2014; Mendicino et al., 2009), 12 as Neutral (Bonham et al., 2003; Brewer & Becker, 2010; Chow, 2014; Davis & McDonald, 2016; Fynewever, 2008; Hauk et al., 2014; Lee et al., 2010; Mathai & Olsen, 2013; Palocsay & Stevens, 2008; Stickles, 2017; Williams, 2010; Woolley, 2015), and five as Negative (Demirci, 2007, 2010a, 2010b; Jr. & Smith, 2016; Wessels & Oatsvall, 2017).

Table 2

Study results per article

Articles	<u>Study Results</u>					
	Retention of Knowledge	Exam and final grades	Homework assignments completed	Overall performance	No difference between groups	No information
Arora et al., 2013	X					
Babaali & Gonzalez, 2015		X	X			
Bonham et al., 2003					X	
Brewer & Becker, 2010					X	
Burch & Kuo, 2010	X	X				
Chow, 2014					X	
Davis & McDonald, 2016					X	
Demirci, 2007				X	X	
Demirci, 2010a				X		
Demirci, 2010b						X
Dodson, 2014		X				
Dufresne et al., 2002		X				
Elmehdi et al., 2013						X
Fatemi et al., 2014					X	
Fratto et al., 2016				X		

Fyneweever, 2008			X	
Gaffney et al., 2010			X	
Gok, 2011	X			
Hauk et al., 2014			X	
Johnston, 2004			X	
Jonsdottir et al., 2017		X		
Jr. & Smith, 2016				X
Lazarova, 2015				X
Lee et al., 2010			X	
Lenz, 2010		X		
Malik et al., 2014				X
Mathai & Olsen, 2013			X	
Mendicino et al., 2009				X
Palocsay & Stevens, 2008			X	
Stickles, 2017			X	
Wessels & Oatsvall, 2017	X			
Williams, 2010			X	
Woolley, 2015			X	

Discussion

The current study aimed to conduct an integrative review providing an overview of the research on online homework and pen-and-paper homework. The focus was to explore which type of homework (e.g. online *vs.* pen-and-paper) has more benefits for student's performance. The review included 33 studies that compared online with pen-and-paper homework against academic outputs. Most of the studies included college students and presented a varied range of number of participants, duration of intervention and course domain. The majority of the studies included in this review were published from 2010 to date; this finding indicates that the research in this area is still recent and has been growing in the last years. In addition, the current sample of studies used a variety of study designs and outcome measures, making challenging the task of comparing results and draw conclusions regarding the effects of online *versus* pen-and-paper homework. However, many of the studies included found online homework to be more beneficial to students' academic progress than pen-and-paper homework.

The majority of the papers used college students as participants, only two articles used a distinct sample: fifth graders and high-school students, which stresses that the researcher's attention has been focused on college. Moreover, Science, Technology, Engineering and Mathematics (STEM) and business were areas highly represented in the articles reviewed, with a particular focus on mathematics (12 studies). Due to their relevance for all the knowledge areas, Mathematics is a type of knowledge that is undoubtedly needed in a modern society and is always present in the technological development (González-Pienda et al., 2007). Moreover, mathematics is an important subject for student's development; in fact, early mathematics achievement is a strong predictor of student's performance in later mathematics achievement (Singh, 2015).

Most of the papers included used a sample of convenience, which could have happened due to participants availability (e.g., attending the researcher class). However, using a sample of convenience makes it difficult to control influences that might interfere in the results other than the format of collecting data (e.g. online or pen-and-paper homework). For example, the teachers' approaches to teaching, the difficulty of the course perceived by students, or the students interest on the course are among the variables likely to impact on results that should be controlled for that reason. The best way to control those influences is to use a randomized sample, but only two

studies in this review used that type of design. A clear line of scientific inquiry following robust methodologies would have allowed to reach reliable data and conclude on the efficacy of the distinct formats of presenting homework. Ten articles did a follow-up with their participants. Of the ten articles, seven found no differences between groups in the follow-up, showing that online homework was as effective as pen-and-paper homework (Demirci, 2010a, 2010b, Fynnewever, 2008, Gok, 2011, Hauk et al., 2014, Lee et al., 2010, Williams, 2010), and three showed better results for the students on online homework (Arora et al., 2013, Fratto et al., 2016, Mendicino et al., 2009). One of these latter studies conducted a follow-up to understand whether the gains with the use of online homework could be transferred to a different subject; results showed that students in the online homework condition presented higher academic results in the following course (Arora et al., 2013).

Researches included in the sample were conducted typically in a school year (two semesters). The first semester was used to test the use of pen-and-paper homework and the other to test the online homework. A semester (approximately 15 weeks) is a good duration of time when researchers want to compare data between groups and learn differences and similarities; however, in a limited time frame, many factors may influence the student performance making difficult to conclude about results (e.g., Woolley's (2015) intervention had a duration of four days). Future investigations could consider use methodological robust designs with control of the variables.

Most of the studies used platforms developed by a text book publisher; in fact, only three investigations developed a platform for the study. This finding is of particular importance because a few studies were developed in settings other than college. Researchers could consider focus their attention on elementary and middle school where students all over the world face important learning challenges, for example in mathematics and Science (OECD, 2015). Focusing research on elementary and high school would be particularly important due to the massive use of the internet and technological devices by young students (OECD, 2015). In fact, across OECD countries, 88% students reported to spend on average over two hours online every day browsing the Internet for fun. This is actually the most common online activity done by students. Moreover, students also reported that, on average, at school they typically spend at least 25 minutes online (OECD, 2015).

One of the advantages of online homework is the possibility to display feedback immediately after students complete their assignment, which is not likely to happen when homework is done using pen-and-paper. Typically, students in the latter condition have to wait until the next class to receive feedback (Bonham et al., 2001). Seventeen of the 33 articles reported that the platforms used displayed feedback. Three of the 17 articles did not provide information about the type of feedback present in their platforms (Elmehdi et al., 2013, Gok, 2011, Jr. & Smith, 2016). The other 14 displayed types of feedback such as stressing common errors, providing individualized coaching, providing extended consolidation exercises, checking correct or incorrect answers (Arora et al., 2013, Babaali & Gonzalez, 2015, Burch & Kuo, 2010, Dufresne et al., 2002, Fynnewever, 2008, Hauk et al., 2014, Johnston, 2004, Lazarova, 2015, Lee et al., 2010, Lenz, 2010, Mathai & Olsen, 2013, Mendicino et al., 2009, Palocsay & Stevens, 2008, Stickles, 2017). Regarding the homework exercises available in the online platforms, benefits were not consistent.

Reasons could be related to the distinct ways of delivering the exercises. A few papers using the platform of the textbook publisher presented the same exercises of the text book, which could be a good strategy to control the students work; however, teachers using this platform cannot add exercises fit to their students learning needs. Palocsay and Stevens's (2008) used a platform which allowed teachers to choose exercises among those available in the database, but also to create their own questions. The results reported by this paper was positive in favor of online homework.

One disadvantage of using online homework is the trial and error submissions; seven studies tried to overcome that limitation by adding a restriction to the number of tries available to solve homework (Babaali & Gonzalez, 2015; Burch & Kuo, 2010; Davis & McDonald, 2016; Fatemi et al., 2014; Lazarova, 2015; Lenz, 2010; Woolley, 2015). Adding this feature might be beneficial for students, because they can get immediate feedback on the number of tries and learn what they are doing wrong. Hopefully this strategy may encourage them to keep on working on the platform and complete exercises. However, only three out of seven studies reported that students using an online homework platform achieved higher results in retention of knowledge, exam and final grades, and homework assignments completed when compared with their counterparts using pen-and-paper homework (Babaali & Gonzalez, 2015, Burch & Kuo, 2010, Lazarova, 2015). Lazarova's paper (2015) did not present information about the results but

reported that students using online homework achieved higher results than their counterparts using pen-and-paper homework. The other four studies reported mixed results in overall performance and reported no differences between groups (Davis & McDonald, 2016, Fatemi et al., 2014, Lenz, 2010, Woolley, 2015). Davis and McDonald (2016) followed a distinct strategy to overcome the trial and error strategy. They did not limit the number of tries as a condition to complete exercises, however the score students could achieve on a single homework was reduced as a function of the number of attempts used to find the correct answer. This approach might discourage students that are trying hard to solve the exercise; in fact, they might avoid doing homework because they may get a bad score. Moreover, no studies addressed the comparison focused on the distinct features that platforms display to overcome the possibility of trial and error submissions. Future research could consider investigating this topic to help platform builders design platforms adjusted to students learning needs, and teachers on their practice in class.

Three articles had students in the online condition doing their homework assignments independently while the students in the pen-and-paper condition did their assignments in group (Demirci, 2007, 2010a, 2010b). The author concluded that pen-and-paper homework had better results in overall performance than online homework. In these cases, concluding for homework effectiveness would not be precise because the conditions were not balanced. Doing homework in group or independently is a variable in itself with potential impact in homework (Demirci, 2010a). Future research could consider controlling for the experimental conditions when comparing both types of homework (e.g. checking prior knowledge of the students about the online homework platform).

The majority of the papers (16) concluded that online homework compared to pen-and-paper homework was more beneficial for students; however, 11 studies concluded that results were similar in both conditions. Data is consistent with Mathai and Olsen (2013) that found that research on the effectiveness of online homework in improving students' performance has produced mixed results; Burch and Kuo (2010) wrote that most of the studies conclude that online homework is so much as effective as the pen-and-paper traditional method or is an improvement over the traditional techniques. Only five studies reported that results in the online homework were poorer than those in the pen-and-paper condition. However, as previously discussed the measures and instruments used in the 33 papers were diverse (e.g., no standard

measurement to compare pen-and-paper homework with online homework was used), thus prevented the analysis of the quality of the outcome, and ultimately respond with no doubt to the question of this research. Future research could consider using robust designs (e.g., randomized control trials) and validated measures to help further our knowledge on the benefits of these types of homework delivery.

Still, in sum and all considered, and analyzing the sample of the articles revised, we may conclude that online homework is more beneficial for students than pen-and-paper homework: online homework improved the overall student performance and helped teachers work in large classes where checking pen-and-paper is very time consuming (Jonsdottir et al., 2017).

In the current study, three databases were used in the search; however, and despite the novelty of this topic, a few papers comparing online homework with pen-and-paper homework might have been left out. Moreover, the present study did not control the quality of the papers reviewed because the papers published fail to inform on important aspects of the investigation (e.g., number and education level of participants; content domain of the homework assigned).

Due to the purpose of this research student's opinion was not analyzed, yet some articles in the sample asked students opinion about the use of online homework (Arora et al., 2013, Demirci, 2007, Elmehdi et al., 2013, Fynewever, 2008, Gaffney et al., 2010, Malik et al., 2014, Wessels & Oatsvall, 2017, Woolley, 2015). Overall, their opinion on online homework was more positive when compared to pen-and-paper homework. In general, students believe that online homework has more benefits for their performance than pen-and-paper homework. This finding is consistent with data related to students general understanding of homework benefits. For example, Woolley (2015) reported that students who believe that homework is helpful to get a better test score are likely to complete more homework assignments than those who do not understand homework benefits. Future reviews could consider further analyze student's opinions about the type of homework delivery.

The articles reviewed list advantages of adopting online homework. For example, using the platform faculty save time preparing and checking homework, and have more time to prepare classes and to attend students' needs in the office. Online homework is more fit for big classes, is environment friendly and provides data about student's performance. Students may benefit because platforms may deliver exercises adjusted to the students' knowledge (more or less demanding exercises) and the respective feedback, and a large set of exercises to help students

prepare for exams. The homework exercises assigned can be discussed in class and students can check the problem-solving strategies followed and the results found against their own output, thus improving their content knowledge. These class routines are likely to help improve students learning and the quality of their work, and their satisfaction with the University is expected to increase (Bonham et al., 2003).

One paper called our attention because low compared to high achieving students scored higher results using online homework (Brewer & Becker, 2010). This is a relevant finding with important educational implications that should be further investigated. Besides investigating the impact of using online homework with low achieving students, future research could also consider exploring the use of online homework throughout schooling (e.g., elementary, middle and high school) to expand our understanding on the effects of online homework benefits for student's progress.

All the papers included in the sample had a focus on STEM, perhaps because it is easier to develop exercises and feedback to be delivered by online homework systems; however, it would be interesting to explore other areas like languages or social sciences to compare results on the efficacy of these platforms. Finally, future research should consider using randomized samples to strengthen the design and reduce bias; for example, it would be interesting to investigate whether the benefits of using online homework could impact positively on student's school engagement.

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