Does Internet at Home Influence Academic Performance: A Systematic Literature Review

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Abstract

The way we learn has been affected by the rise of technologies, thus opening the door to a new set of powerful learning tools such as e-books, virtual reality, e-learning, among others. These tools can potentially substitute or complement the traditional set of learning tools like printed books and residential learning. Considering that Internet plays a key role in allowing access to this new set of learning tools, this paper comprehensively summarizes knowledge on the impact of internet at home on education outcomes by using a Systematic Literature Review (SLR). It finds an increase of publications over time, thus suggesting a growing importance of it. Regression analysis and comparison of means are the methods more used for analyzed papers. Results show a growing consensus on the fact that access to Internet at home is desirable. Most studies find positive relationships between access/use of Internet at home and academic outcomes. But a still important quantity of studies finds negative or no effect of Internet at home. The direction of the effect of Internet at home is still an open question since it depends on a wide range of factors like the socioeconomic context, misuse of internet, motivation of students, and others. Therefore, a new research agenda will take care of external validity, by opening the door to a new series of datasets and analysis methods, in order to lead us towards better estimations about the substitution degree and the impacts of Internet at home. Simultaneously, it would be helpful to work also with experimental approaches and panel data information in order to study how the impact of Internet is evolving over time. Finally, policies must foster access to the Internet at home, while simultaneously including programs to strengthen its adequate use.

Keywords

Internet, academic achievement, academic performance, SLR, literature review.

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Introduction

The way we learn has been affected by the rise of technologies, thus opening the door to a new set of powerful learning tools such as e-books, virtual reality, e-learning, among others. Considering that the Internet plays a key role in providing access to this new set of learning tools, this paper comprehensively summarizes knowledge on the impact of the Internet at home on educational outcomes. Using a narrative review, a kind of Systematic Literature Review (SLR), this paper synthesizes quantitative studies with no reference to their statistical significance (Siddaway, Wood and Hedges, 2019). There is no SLR of the effects of the Internet at home on academic performance, although there are various SLRs of the effects of the Internet on variables not related to education (Verhoeven et al., 2007; Hong, Pena-Purcell and Ory, 2012; Hou, Charlery and Roberson, 2014).

From an academic perspective, this paper will allow us to identify and analyse the impact of the Internet at home on academic results as well as recognise the methods used in the respective studies. It will also identify main agreements, disagreements, and unasked questions with the purpose of proposing a research

route for next years. From a practical perspective, this study will potentially support evidence-based policies on information and communications technology (ICT) deployment, digital education efforts, and education policies, generated by governmental, third, and private sectors.

The outline of this paper is as follows. Section one introduces the method and approach used in the SLR. Section two explains main results and critically reflects on them. Section three sets up a discussion around the results. Lastly, section four concludes.

Review of scientific literature

According to Duffin (2020), the e-learning market worldwide will exceed 240 billion USD dollars by 2022, whereas the number of online learners continues to grow year after year. These tools can potentially substitute or complement the traditional set of learning tools like printed books and residential learning. Despite non-conclusive results on the effects of substitution of the traditional set of learning tools by the new one (Zhang and Kudva, 2014; Saleh and Mashhur, 2015), it is clear that they are becoming increasingly important in the explanation of both academic opportunities and academic results.

Academic performance is explained by three main factors: school environment, family environment, and student's own characteristics. Access to cultural and educational tools at home such as computers and the Internet falls within the family context (Ruiz de Miguel, 2001; Biagi and Loi, 2013). Thus, framed within the family environment, this paper focuses on the Internet at home rather than on the Internet at school or other kinds of Internet access. It is important to note that the Internet at home is different from other kinds of Internet access in terms of accessibility, tools, usage, and impact on academic variables. By the Internet at home, this study means either the access to or the use of this technology.

Research methodology

According to Siddaway, Wood and Hedges (2019, p. 751), a SLR is "a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from studies that are included in the review". In this paper, a narrative review is conducted in order to collect information from quantitative studies that have used different methodologies, theoretical approximations, or relationships (Grant and Booth, 2009; Boell and Cecez-Kecmanovic, 2015). It must help to summarise academic literature about the effects of the Internet at home on academic performance in an accurate and reliable manner.

The search action was conducted on 13 March 2024 using Scopus, a well-recognized and large database in social sciences, as the primary resource. In order to supplement the Scopus search, Google Scholar was used with an identical search equation on the same day (Gusenbauer and Haddaway, 2020). The search equation included two constructs to look for information on the topic of "Internet at home" and three constructs to search for information about the area "student's academic performance". For each construct, I have used synonyms to the keywords to ensure a high degree of searching sensitivity. The constructs were added by using Boolean operator AND, while filtering results by title, abstract, keywords, and literature written in English (Table no. 1).

Table no. 1. Search equation

Construct	Parameters	Area
1	Internet	Internet at home
2	home OR household?	
3	student? OR scholar* OR learner?	Student's academic performance
4	academic? OR education	
5	result? OR outcome OR performance OR achievement	

Notes: The complete search equation is as follows: TITLE-ABS-KEY(Internet AND (home OR household?) AND (student? OR scholar OR learner?) AND (academic? OR education) AND (result? OR outcome OR performance OR achievement)) AND (LIMIT-TO (LANGUAGE,"English")).*

The criteria below were specified to select the important studies. The first two criteria are about the objective of the studies, while the third one refers to the methodology used by the studies.

• Include the Internet at home, rather than other kinds of Internet access, as the explanatory variable. A paper is discarded in case it does not clearly state whether it concerns access or use of Internet at home.

• Include the academic performance as the dependent variable.

• Contain a quantitative research method to study the relationship between explanatory and dependent variables. This is required to build a narrative review analysis focused on summarizing and explaining empirical results.

Both Scopus and Google Scholar were limited to English language, given its nature as an international language of science and that including other languages would potentially bias the analysis towards specific regions. There is no filter on time nor on subject. Resources that could not be fully obtained, even fulfilling the above criteria, were not included in the final stage of the SLR. This SLR does not have any protocol to handle neither the unpublished work nor the grey literature. So, this SLR is based on the findings from Scopus and Google Scholar databases.

Initially, 297 different texts were identified in Scopus and Google Scholar. Then, these articles were screened by abstract and title. Out of 297, 251 papers were excluded due to not meeting both inclusion criteria, objective and empirical evaluation. Thus, 46 remaining articles passed to the full-read text stage. From them, 6 articles were excluded because access to them was not available, while other 12 texts were discarded since they did not meet inclusion criteria. Finally, a total of 28 full articles were reviewed to carry out the SLR. Those articles were coded in terms of name of authors, journal, study field, date published, method, definition of both the Internet at home and academic performance, results, and conclusion.

In order to minimise selection bias and ensure the validity of coding, two independent coding stages were executed. The first one occurred from 17 to 20 March 2020, while the second one took place from 24 to 27 March 2020. Then, the discrepancy between stage one and stage two in terms of inclusion/exclusion of texts was solved by conducting a third stage revision of articles classified into different categories. There was not any specific measure to avoid publication bias. However, more than 15% of the studies included in the SLR find no statistically significant effects of the explanatory variable on the dependent variable, thus suggesting that articles that do not discover statistically significant effects can be potentially published in this topic.

Results and Discussion

• **Temporal analysis**

Although the Internet has its origin in the 60s and no time filter was used in the search equation, the oldest papers included in this SLR date back to 2004 (Masten and Chapman, 2004; Tamar Weiss et al., 2004). This phenomenon is explained by two factors. First, while the Internet has its origin in the 60s, it is not until the 80s and the 90s that the real take-off of the technology took place (Leiner et al., 2009; Perez, 2010). Secondly, initially, policies were oriented towards fostering the connectivity of the Internet at school with the purpose of improving academic outcomes. Thus, evaluations on the impact of the Internet at home are lagged in comparison with evaluations on the impact of the Internet at school. Figure 1 suggests an increase of publications over time, based on the papers included in the SLR.
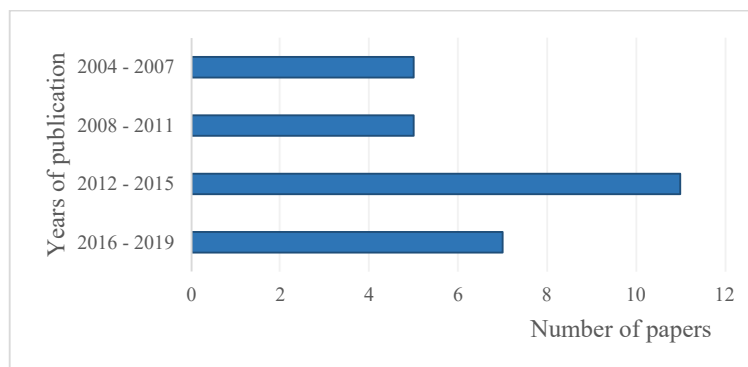

Figure no. 1. Number of papers by years of publication
Source: Own elaboration with data from Scopus

- **Methods of analysis**

Considering that this paper conducts a narrative review, all methods included in the SLR are quantitative approaches. The dependent variable is always related to academic performance, while the variable of the Internet at home is included either as a treatment or as a control variable.

Regression analysis and comparison of means are the most used methods in the analyzed papers. Initially, regression methods were based on Ordinary Least Squares (OLS) but, over time, these estimations were getting more complex including, among others, instrumental variables, logit regression, and hierarchical regression analysis. In the case of comparison of means, they are also including improved methods over time like Cohen's d and the highest density interval. These improved methods can potentially solve selection bias as well as find better estimators of the effects of the Internet at home on academic achievement. Pearson correlation coefficients tend to be used as an auxiliary of regression analysis or the comparison of means method. Since the decision tree is a prediction method, a machine learning technique, it tends to be used independently from estimation methods like regression analysis (Table no. 2).

Table no. 2. Methods of analysis

Method	Times used	Papers
Regression analysis methods*	12	(Biagi and Loi, 2013; Burušić, Šimunović and Šakić, 2021; Chen and Fu, 2009; Erdogdu and Erdogdu, 2015; Jackson et al., 2007; Jara et al., 2015; Makransky et al., 2019; Putjorn et al., 2018; Vigdor, Ladd and Martinez, 2014; Wang, Liu and Zhao, 2012; Xu and Jaggars, 2013; Zhao et al., 2010)
Comparison of means methods**	12	(Foo, Majid and Chang, 2017; Mabry and Snow, 2006; Makransky et al., 2019; Masten and Chapman, 2004; Tamar Weiss et al., 2004; Wainer et al., 2008; Wainer, Vieira and Melguizo, 2015; Wang, Liu and Zhao, 2012; Wu et al., 2014; Yebowaah, 2018; Yesilyurt et al., 2014; Zhao et al., 2010)
Pearson correlations	5	(Burušić, Šimunović and Šakić, 2021; Chen and Fu, 2009; Sowan and Idhail, 2014; Wang, Liu and Zhao, 2012; Zhao et al., 2010)
Chi-squared test	3	(Chen and Fu, 2009; Wu et al., 2014; Yebowaah, 2018)
Decision trees	3	(Chanchary, Haque and Khalid, 2008; Garcia-Gonzalez and Skrita, 2019; Liu and Whitford, 2011)
Factor analysis	1	(Kor, 2015)

Source: Own elaboration with data from Scopus

- **The effects of the Internet at home on academic performance**

Some papers have measured the impact of access to the Internet at home on academic performance, while others aim to study the use of the Internet at home to explain academic performance. In general, there is a growing consensus that access to the Internet at home is desirable. Most studies find positive relationships between access/use of the Internet at home and academic outcomes. However, a considerable number of studies finds negative or no effect of Internet at home. The direction of the effect of the Internet at home is still an open question since it depends on a wide range of factors like the socioeconomic context, misuse of the Internet, motivation of students, and others.

It is more common to find positive associations between the Internet at home and academic performance in Science, Technology, Engineering and Mathematics (STEM) than in other areas of knowledge like reading, languages, or social sciences. A possible explanation is that both computers and the Internet are based on mathematical logic or programming languages, which can potentially promote better STEM scores. Another common explanation of this phenomena is the fact that, when using the Internet at home, the student is subject to solving problems on his own and this exercise can have positive impacts on STEM grades (Jackson et al., 2007; Liu and Whitford, 2011; Wang, Liu and Zhao, 2012; Biagi and Loi, 2013; Erdogdu and Erdogdu, 2015; Kor, 2015; Garcia-Gonzalez and Skrita, 2019).

A significant proportion of the studies find divergent results depending on both the Internet usage and student's socioeconomic context. As pointed out by Wainer, Vieira and Melguizo (2015), the correlation

between having access to the Internet at home with higher test scores depends on the socioeconomic status of the student's family. For poor students, access to the Internet can be negative, while for rich students, access to the Internet seems to be positive. Vigdor, Ladd and Martinez (2014) find no effect of access to the Internet on reading scores, while it can cut down scores in Mathematics tests. Also, Yebowaah (2018) suggests that access to the Internet has a positive effect on learning outcomes, while its different uses do not affect academic performance.

Divergent results also suggest heterogeneous effects depending on Internet usage patterns. For instance, (Wainer et al., 2008; Chen and Fu, 2009; Jara et al., 2015) find negative effects of the Internet at home when it is overused or misused in activities like social networking, gaming, or music downloading, whereas positive effects are found when the Internet is used for looking for information or complementing course contents. Chanchary, Haque and Khalid (2008) discover heterogeneous effects depending on the ethnicity. In this case, native Bengali students, compared to non-native Bengali students, have different Internet usage patterns and no effect on academic achievement. Similarly, gender can affect Internet usage patterns, risks, and its academic effects. According to Chen and Fu (2009), online socializing makes girls vulnerable, while online gaming and Internet Cafés hurt boys' academic achievement.

There is more consensus on the complementary role of Internet learning tools on non-Internet learning tools, than on their role as a substitute. If misuse or overuse of the Internet is avoided, its effects on academic outcomes will be positive and it can be a good complement for offline learning activities (Jackson et al., 2007; Wainer et al., 2008; Chen and Fu, 2009). The role of substitution is still unclear since some evidence suggests substitution (Masten and Chapman, 2004; Tamar Weiss et al., 2004; Xu and Jaggars, 2013; Gazibara et al., 2015; Putjorn et al., 2018; Makransky et al., 2019), while other suggests no substitution (Vigdor, Ladd and Martinez, 2014; Zhang and Kudva, 2014; Saleh and Mashhur, 2015).

The direction of the effect of access/use of the Internet is still an open question since it depends on a wide range of factors like the socioeconomic context, misuse of the Internet, motivation of students, and others. Similarly, there is more consensus on the complementary role of Internet learning tools, than on their role as a substitute. Therefore, more research must be conducted, taking care of both internal and external validity as well as including more robust datasets and methods of analysis, with the purpose of understanding under what conditions the Internet at home can be a substitute and how it affects academic performance.

As to the methodological perspective of the studies used in this SLR, here is a short list of key aspects that should be thoroughly considered in future research:

- Internal validity has been the focus of the studies reviewed in this SLR. However, several papers using comparison of means methods and Pearson correlations do not include proper control variables nor convincing tools to avoid selection bias and naïve estimations. There is not enough information about the external validity of the studies, which hinders the formal basis of their generalisation and their application to support policy decisions. Therefore, it would be beneficial to investigate by using more powerful datasets and analysis tools, with the purpose of increasing both internal validity and external validity of new studies. For instance, involving more the microdata level coming from PISA evaluations or National Bureaus of Statistics will allow better estimations of the impact of the Internet at home on academic performance (Biagi and Loi, 2013).

- The papers included in this SLR tend to study cross-sectional data by using non-experimental approaches. Thus, it would be helpful to use both panel data approaches and experiment-based evaluations. Panel data analysis will help to identify how the impact of the Internet at home evolves over time. In fact, (Wainer, Vieira and Melguizo, 2015) find that there is an increase in positive effects of access to the Internet at home over time. However, there is not enough research on the nature of this evolution, which can also explain divergent results in the literature. An experimental evaluation like randomised control trials can potentially support better policy interventions by avoiding selection bias and assessing accurate estimations (Duflo, Glennerster and Kremer, 2006).

- Considering the divergence of results depending on a wide range of factors like the socioeconomic context, misuse of internet, motivation of students, and others, Machine Learning can be used to handle a wide range of independent variables. Going beyond decision trees, methods like random forest, bagging, boosting, or neural networks can classify and make predictions of academic outcomes based on access/use of the Internet at home (Gomes and Almeida, 2017).

To sum up, a new research agenda must take care of external validity by opening the door to a new series of datasets and analysis methods, in order to lead us towards better estimations about the substitution degree

and the impacts of the Internet at home. Simultaneously, it would also be helpful to work with experimental approaches and panel data information in order to study how the impact of the Internet evolves over time.

Finally, policies must foster access to the Internet at home, simultaneously including programs to strengthen its adequate use. Policies for targeted populations like the learning disabled, the poor, or students who misuse Internet tools at home should be implemented in order to ensure that those groups can take advantages of Internet-based tools (Wainer et al., 2008; Wu et al., 2014; Wainer, Vieira and Melguizo, 2015).

Conclusions

The way we learn has been affected by the rise of technologies, thus opening the door to a new set of powerful learning tools such as e-books, virtual reality, e-learning, among others. By using a SLR, this paper comprehensively summarizes knowledge on the impact of internet at home on education outcomes. Since the first publication identified in this SLR date back to 2004, the study finds an increase of publications over time, thus suggesting a growing importance of it. In terms of methods, regression analysis and comparison of means are the ones more used for analyzed papers. Over time, these methods are getting more complex including and robust to solve selection bias issues by including, among others, instrumental variables, logit regression, hierarchical regression analysis or Machine Learning.

Results show a growing consensus on the fact that access to Internet at home is desirable. Most studies find positive relationships between access/use of Internet at home and academic outcomes. Nonetheless, a still important quantity of studies finds negative or no effect of Internet at home. The direction of the effect of Internet at home is still an open question since it depends on a wide range of factors like the socioeconomic context, misuse of internet, motivation of students, and others. Similarly, there is more consensus on the complementary role of Internet learning tools, than on their role as a substitute of traditional learning tools.

Therefore, a new research agenda will take care of external validity, by opening the door to a new series of datasets and analysis methods, in order to lead us towards better estimations about the substitution degree and the impacts of Internet at home. Simultaneously, it would be helpful to work also with experimental approaches and panel data information in order to study how the impact of Internet is evolving over time. Finally, policies must foster access to the Internet at home, while simultaneously including programs to strengthen its adequate use.

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