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Emerging mixed methods in social research: The digital challenge

Metodologías mixtas emergentes en investigación social: El reto de la digitalización

English Edition

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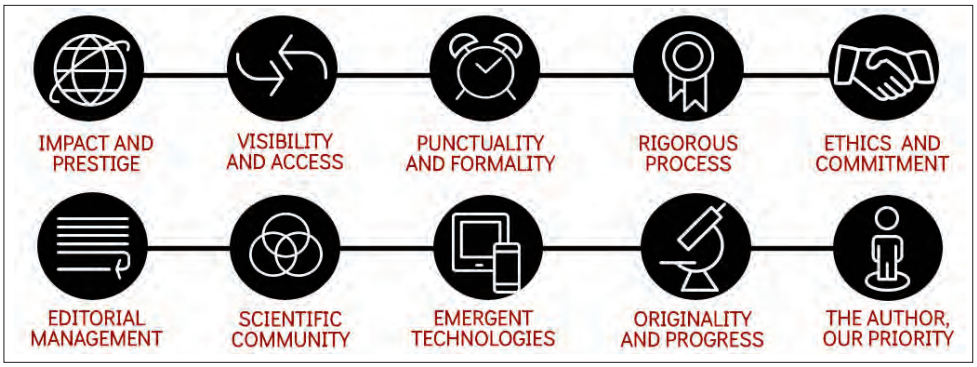

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Systematic review of mixed methods in the framework of educational innovation

Revisión sistemática de métodos mixtos en el marco de la innovación educativa

Dr. María-Soledad Ramírez-Montoya, Senior Research Professor, School of Humanities and Education Tecnológico de Monterrey (Mexico) (solramirez@tec.mx) (https://orcid.org/0000-0002-1274-706X)
Dr. Jairo Lugo-Ocando, Director of Executive & Graduate Education, Northwestern University, Doha (Qatar) (jairo.lugo-ocando@northwestern.edu) (https://orcid.org/0000-0002-9533-2088)

ABSTRACT

In the field of education research, mixed methods have traditionally referred to the combination of quantitative and qualitative data that brings us closer to 'reality'. However, recent literature on social and educational studies has increasingly incorporated works that integrate digital technologies and mixed methods. This novelty provides an opportunity to re-examine original contributions in the field, particularly in relation to educational innovation. Therefore, the objective of this article is to analyze the characteristics and the trends of new contributions from researchers in education. To achieve this, we carried out a systematic literature review (SLR) of 311 articles published from January 2010 to January 2020 in the Web of Science (WoS) and Scopus databases. We worked with nine questions that explored three key themes: characteristics, technologies and designs within the realm of educational innovation. The validation for this analysis was achieved using a criterion adopted by scholars at York University, which incorporates: inclusion and exclusion, relevance and description of data, as well as peer review in the analysis. Our findings indicate that networks of co-terms, identification of educational innovations and the types of designs –currently applied in educational innovation– as well as the adoption of a mixed-method approach seem to be much better suited to underpin the required combination of strategies and processes that are interwoven in order to address the complexity of the education phenomenon in our times.

RESUMEN

En el ámbito de la investigación, los métodos mixtos usan combinadamente datos cuantitativos y cualitativos para un acercamiento con la «realidad». En la literatura reciente de los estudios sociales y educativos, se ubica un crecimiento de publicaciones que integran tecnologías digitales y métodos mixtos y, con ello, se presenta la oportunidad de generar un aporte original de posibilidades para investigar la innovación educativa. El objetivo de este artículo fue analizar las características de estos estudios y las tendencias de nuevas contribuciones para la educación. Para lograrlo se realizó una revisión sistemática de literatura (SLR) de 311 artículos publicados, de enero 2010 a enero 2020, en las bases de datos Web of Science (WoS) y Scopus. Se trabajó con nueve preguntas que exploraron tres temas: características, tecnologías y diseños con líneas de innovación educativa. La validación se dio con los criterios de la Universidad de York: inclusión y exclusión, pertinencia y descripción de datos, así como evaluación de pares en el análisis. Los hallazgos dan cuenta de redes de co-términos, identificación de innovaciones educativas y tipos de diseños que están siendo trabajados en líneas de investigación de innovación educativa. Se concluye que el enfoque de métodos mixtos aporta con una combinación interceptada de estrategias y procesos para abordar la complejidad del fenómeno de la educación, con comprensión holística, interdisciplinar y cambio en la forma de hacer investigación en nuestros tiempos.

KEYWORDS | PALABRAS CLAVE

Mixed methods, educational innovation, digital trends, innovation, education, science dissemination, validation, technology.

Métodos mixtos, innovación educativa, tendencias digitales, innovación, educación, divulgación científica, validación, tecnología.

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1. Introduction

The paths used by researchers to approach 'reality' are the methods. They set the relationships, strategies and techniques that will be used, and which will be established through a particular methods design. In this sense, an approach to 'reality' in social environments can be provided through mixed methods. These last are usually defined as the combination of multiple methodological strategies to study and answer questions on a particular topic. Among these definitions of mixed methods, we find that of Plano-Clark and Ivankova (2016: 57) who have conceptualized it as "the intentional integration of quantitative and qualitative research approaches to better address a research problem". Meanwhile, others have defined it as the ability to conduct balanced study analyses that increase the validity of a rationale (Edmonds & Kennedy, 2017) and its scope (Onwuegbuzie & Teddlie, 2003). Similarly, various authors have argued about philosophical assumptions that guide data collection and analysis, mixing quantitative data and general qualitative approaches incorporated into the various phases of the research process (Creswell, 2007; Yu, 2009; Tashakkori & Teddlie, 2010).

More recently, Valenzuela-Gonzalez (2019) has indicated that the merger of both data forms in the same research design or method is something new as the idea of mixing data, specific research designs, the note-taking process, terminology, procedures, and difficulties in using different designs are recent features that emerged at the dawn of the 21st century. This, as previous definitions, indicates that mixed-methods studies are much more than the sum of quantitative with qualitative data as they encompass a strategic combination, triangulation and integration of both types of data that is based on the particular research design.

Creswell (2003) classifies research designs into six types: sequential explanatory design, sequential exploratory design, sequential transformative design, concurrent triangulation design, concurrent nested design, and concurrent transformative design. Another classification by Johnson and Onwuegbuzie (2004) suggests there are nine designs represented in a four-quadrant matrix where the researcher must decide between the paradigm (dominant or not) and the time to carry out the study (concurrent or sequential). For their part, Teddlie and Tashakkori (2006), analyzed the usefulness of various design typologies, as well as the dimensions used by the authors and proposed a Method-Strands Matrix, which presents research designs, especially four families: sequential, concurrent, conversion, and fully integrated. Based on these classifications, other authors have contributed in terms of the possible questions and analyses (Onwuegbuzie & Leech, 2006). As part of this classification, Harwell (2014) links these designs to research questions that they provide in the process of carrying out studies, including examples for each design. Moreover, DeCuir-Gunby and Schutz (2017) propose five basic designs: explanatory sequential design, exploratory sequential design, convergent parallel design, embedded design and multiphase design. Having said that, it is important to consider that mixed methods also have their challenges for researchers, mainly in relation to the incompatibility of qualitative and quantitative approaches (Creamer, 2018). Each of these designs has its own benefits and its own difficulties and challenges, so the choice depends on the research questions and the purpose of the research study.

In the field of social and educational research, the digital imprint and technological developments have provided opportunities to design studies with mixed methods that have made important contributions to innovation in the sector. In a systematic literature mapping, González-Pérez et al. (2019) located the emerging themes of educational technology: digital education, technological models, adaptive technologies, open technologies, smart technologies and disruptive technologies. These themes have provided opportunities for innovations in different fields. Rogers (2003: 11) has defined innovation as "an idea, practice or project that is perceived as new by an individual or other adoption unit", where collaboration is substantial (Corbo et al., 2016); it has also been defined as the process of coming up with new products that can be adopted or redesigned for use and transformation (Rikkerink et al., 2016), and even in an open way (Ramírez-Montoya, 2018). Innovation, accordingly, can promote a new process (organization, method, strategy, development, procedure, training, technique), a new product (technology, article, instrument, material, device, application, manufacture, result, object, prototype), a new service (attention, provision, assistance, action, function, dependence, benefit) or new knowledge (transformation, impact, evolution, cognition, dissent, knowledge, talent, patent, model, system).

From this we can derive that new processes, products, services and knowledge are the engines of change in the field of education, where innovation often contributes to address problems and situations arising from teaching practices and delivery. In this respect, Sein-Echaluce et al. (2019) argued that educational innovation means making changes in learning/training in order to improve learning outcomes. In order to achieve this, educational innovation must be embraced holistically and inclusively. Consequently, companies, students, educational providers, communities and political organizations need to integrate the objects of innovation at all levels (Baumann et al., 2016).

Equally, it is important to understand how these research foci are classified. In this sense, some scholars at the Educational Innovation Research Group in Mexico (Ramírez-Montoya & Valenzuela-González, 2019) have proposed a comprehensive classification. It is one that includes: psycho-pedagogical (related to general learning and teaching); use and development of technology in education (application and impact of technology in education, both face-to-face and at a distance); educational management (administration processes: planning, organization, management, and evaluation of human, material, and financial resources of educational institutions); and, socio-cultural (emphasis on the sociocultural context in which the educational process takes place). In addition, these scholars also highlight a 'disciplinary' category, which relates to the curriculum and the teaching-learning process in disciplines such as mathematics, medicine, natural sciences, engineering, accounting, business, and English, among others (Rodríguez et al., 2015). Moreover, these scholars go on to say it is important to ask what types of contributions can be made with studies that use mixed methods within the particular research spectrum.

Among scholarly works that have undertaken systematic literature reviews, meta-analyses and/or studies based on mixed methods, we find contributions to a variety of disciplines. Among them are those related to computers and the use of software in small and medium enterprises (Sharma & Sangal, 2018). We should also mention those in the field of health and gender (Mabweazara et al., 2019) as well as those that deal with autism spectrum disorder (Frantzen & Fetters, 2016) and the safety of elderly drivers (Classen & Lopez 2006). Scholars such as Pluye and Hong (2014), on the other hand, have contributed with reviews providing guidelines for planning, conducting, and evaluating mixed-method research. Specifically, in the field of education, the work of Imanuel-Noy and Wagner (2016; 2014) who have looked at teacher training in the clinical area, is worth mentioning. In turn, Levin and Wagner (2009) produced a theoretical and practical vision of education, which argued about its importance for the advancement of knowledge and public policy. Overall, these contributions provide a valuable basis from which to argue that mixed methods have in fact contributed to advance our knowledge in these areas.

However, important questions still need to be addressed and in some cases remain unanswered. Particularly, around challenges and opportunities that arise in the combination of the digital era and education. Indeed, in the existing literature there are still important gaps in knowledge in relation to the contributions of mixed methods, specifically in terms of their potential for educational innovation. One particular example of this is the gap in areas such as the representation of culturally and linguistically diverse students (Klingner & Boardman, 2011). In this sense, this article aims to analyze recent studies (2010-20) that have integrated digital and technological components in social and educational research, where mixed-method designs were applied. Therefore, the aim would be to understand the characteristics of the studies, the research topics that are often undertaken, the types of research designs found, and the nature of the innovation contributions made in the field. It is necessary to fill this gap in order to dissect the original knowledge that can in turn allow us to develop a theoretical framework to provide further guidance for trainers, researchers and decision-makers with a vision of improvement and change in education in general.

2. Method

Our central approach involved a systematic literature review (SLR) due to its ability to help identify, assess and interpret available research related to a topic area (Kitchenham & Charters, 2007). The process is broadly based on guidelines established by Verner et al. (2012) and the University of York (2009). In order to analyze the articles in a fair, rigorous and transparent manner, we established an analysis protocol with the following phases: 1) Research questions; 2) Search process; 3) Inclusion and exclusion criteria; 4) Data selection and extraction process; 5) Data synthesis.

- Phase 1: Research questions: Based on the aim of analyzing the characteristics of the social and educational studies that have been published in the last ten years, nine research questions were posed to locate the characteristics of the articles, the findings and digital technologies, the types of designs and lines of educational innovation, where they have contributed.

The origin of the nine research questions that drove the study was in the identification of gaps previously observed in studies conducted by the authors of this paper, as well as the challenges (and benefits) they have found in the implementation of the methodology, both in the implementation of other studies, as well as in training activities with their students and research groups. The possible answers came from the theoretical support on which the study was based. The motivation for the topics and research questions were based on the opportunity to contribute new ways of studying educational innovation.

Table 1. Topics and research questions

Topics	Research questions (RQ)	Possible answers
Characteristics of social and educational studies that have integrated mixed methods in recent years	RQ1- What are the key words in the studies, how are they related and what groups of incidents are detected?	Keywords of the studies Coterminus network More frequent incidents List of the most frequent incidents
	RQ2- In which years have the articles been published and in which journal quartile levels are they located?	Year of publication
		Q level of the journal
	RQ3- Which journals have published the most on the subject and how many citations have their articles received?	Most cited articles
		Journals with more publications
	RQ4- What is the geographical distribution of the authors?	Geographical location of the first author
Digital technologies and innovation findings that have emanated from studies that have integrated mixed methods	RQ5- What are the emerging digital technologies that have been studied using mixed methods?	Digital education Technological models Adaptive technologies Open technologies Smart technologies Disruptive technologies
	RQ6- What kind of innovation does the article bring?	New process New product New service New knowledge
Design of mixed methods and research lines of educational innovation	RQ7- What sample have you worked on in the study?	Between 1 and 50 Between 51 and 100 Between 101 and 150 Between 151 and 200 More than 200
	RQ8- What kind of design did they use?	Sequential explanatory design Sequential exploratory design Sequential transformative design Concurrent triangulation design Concurrent nested design Concurrent transformative design
	RQ9- In what lines of research and topics have mixed methods been used?	Psychopedagogical Socio-cultural Use and development of technology Educational Management Disciplinary

- Phase 2: Search process. The protocol for the search of articles integrated electronic processes in the Scopus and Web of Science (WoS) databases, delimiting the keywords (mixed methods, education, social, digital), language (Spanish and English), time window (2010-2020), type of document (article), type of access (open) and language (English and Spanish). The search strings are presented in the integrated Excel.
- Phase 3: Inclusion and exclusion criteria. Articles were included if: they were articles that integrated in their title, abstract or keywords the topics of mixed methods, social or educational

and digital or tech*, published between January 2010 and January 2020, written in English or Spanish and were open access.

Articles were excluded if: they were papers, book chapters, literature reviews related to the topics of the search (mixed methods, social or educational and digital or tech*), published in languages other than Spanish and English, that were not open access and that were published before January 2010 or after January 2020.

- Phase 4: Selection process and data collection. The search resulted in the identification of 190 articles in Scopus and 184 in WoS. Articles were reviewed in both databases with the aim of identifying and eliminating duplicates. The articles were reviewed to verify that they contained the integration of mixed methods in the studies and that they were related to the social and educational areas. Finally, 311 articles were selected and can be consulted in the integrated Excel.

The following data had been previously extracted from the studies identified: Authors, Title, DOI, Abstract, Country and Keywords. The researchers used a data extraction strategy specifically related to the nine questions under study in the SLR. Validation was done through peer review to check the identification of the answers; in cases of discrepancies, agreements were reached for the selection of answers and to approach 100% data verification.

- Phase 5: Data synthesis. In order to synthesize the answers, a previous classification of the possible graphic representations was made, an analysis was carried out to locate the intersection that could be interesting to relate terms, keywords, networks of co-terms, clusters and concatenation of categories and subcategories.

3. Results

In this section, which is organized by the themes and sub-themes identified in the research, we report the results related to the research questions. The graphing tools were Vosviewer and Tableau.

3.1. Characteristics of social and educational studies that have integrated mixed methods in recent years

- RQ1: What are the key words in the studies, how are they related and what groups of incidents are detected?

The keywords of the 311 articles were located (Figure 1a) and clusters of higher prevalence were identified in the words "Education" (Figure 1b), "Qualitative" (Figure 1c) and "Quantitative" (Figure 1d). Clusters establish networks of co-terms that are at the same level (keywords) and their most frequent relationships with other terms. The representation is shown in the following figures (Figure 1).

Figure 1. Network of keyword and cluster co-terms

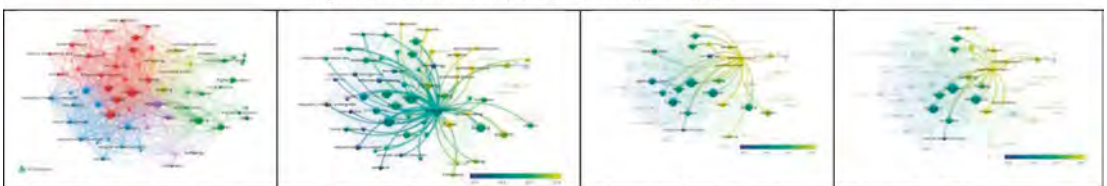
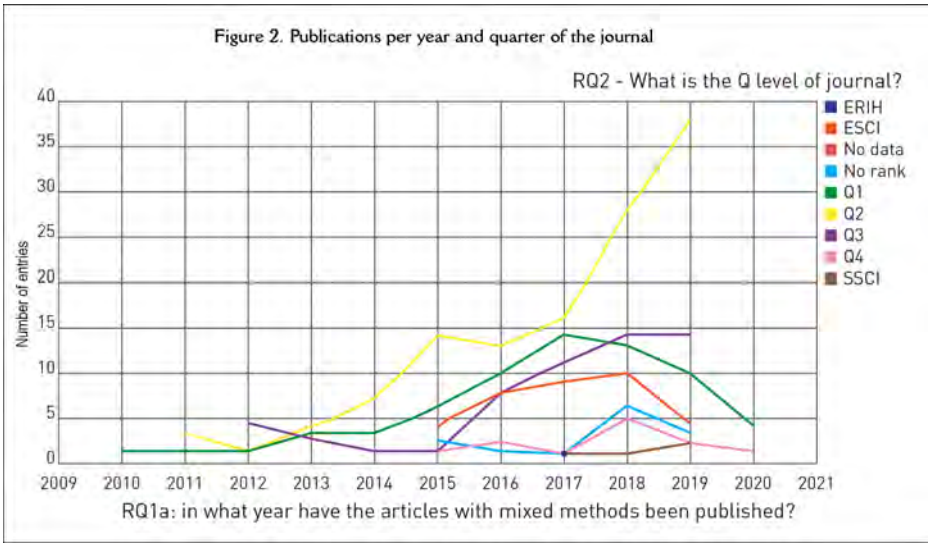


Figure 1a-Network of co-terms that are at the same level | Figure 1b-Cluster with term relations "Education" | Figure 1c-Cluster with term relations "Qualitative" | Figure 1d-Cluster with term relations "Quantitative

The keyword co-terms (Figure 1a) highlight four major groupings (colors) where the most related terms are highlighted: human, education, curriculum and teaching, followed by assessment, educational technology, students, higher education, and medical education. Based on the objective of this article, researchers conducted a deeper exploration of clusters of interest and their relationship with human, psychological, woman, man, learning and teaching located in Education (Figure 1b). The clusters of the words Qualitative (Figure 1c) and Quantitative (Figure 1d) relate with the terms under study: education, human, adult, learning and curriculum.

These results shed light on the key terms that have been recurrent in the articles and may be useful for theoretical frameworks of studies related to educational innovation, mixed methods applied to education, educational assessment and for support of training programs, with interest in educational innovation.



- RQ2: In which years have the articles been published and in which journal quartile levels are they located?

Quartile data from the journals were sought to classify them according to level (Q1, Q2, Q3, Q4). There were journals with ESCI and ERIH indexes and others that were classified as No data (from the WoS database) and No rank (from the Scopus database) because they are journals newly entered in these databases and do not yet reflect the level (Figure 2). The growth of publications in Q2 journals in the last few years, and the decrease of Q1 journals in this period are noteworthy.

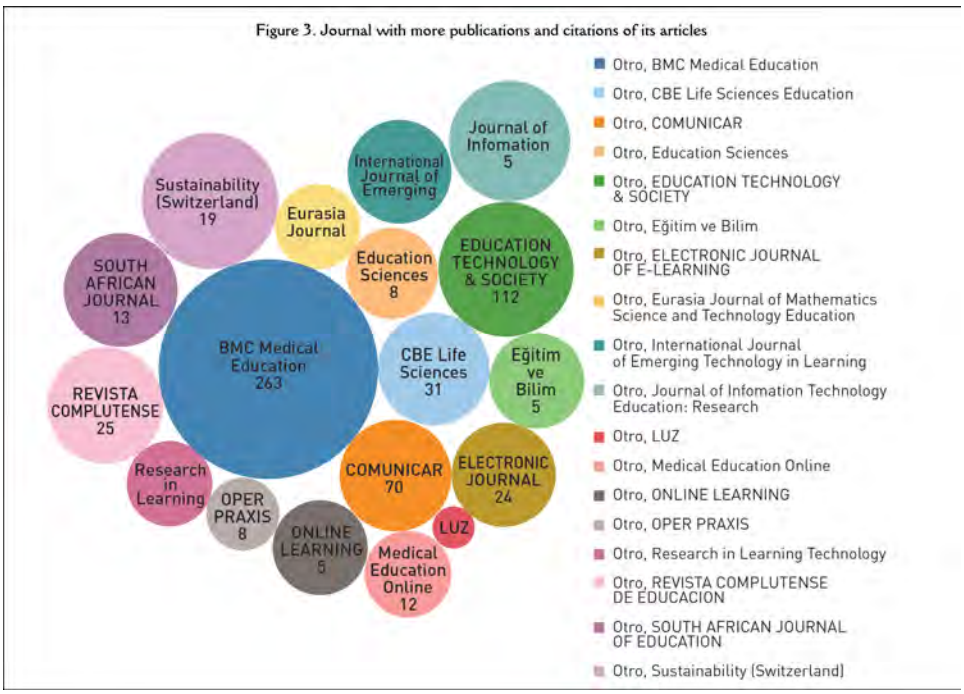


Figure 2 is relevant to academic communities of educational institutions (with an interest in rankings), research groups (with an interest in consolidation), training programs (undergraduate and graduate), researchers (for their careers and publication visibility) and journal editors (thematic vs. impact factor), by enabling the recognition of the growth of publications that have used mixed methods in their research, as well as the range of impact factor, according to the type of journal.

- RQ3: Which journals have published the most on the subject and how many citations have their articles received?

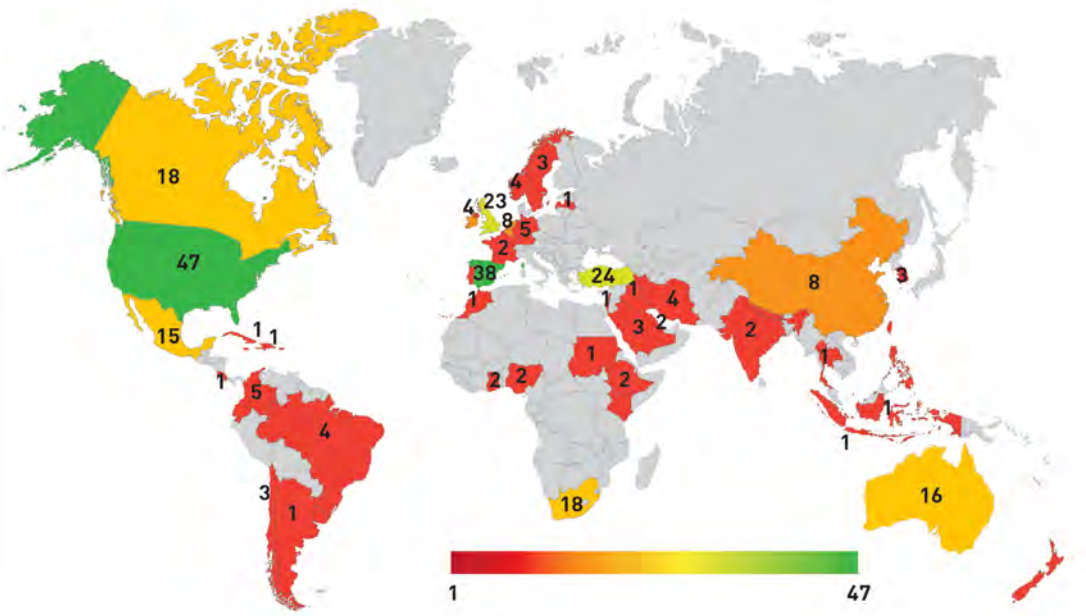
The citations received for the articles were identified and related to the journals that have the most publications on the subject (Figure 3). The journal that stands out is BMC Medical Education with articles that have accrued 263 citations.

The contribution that this Figure gives is the location of two themes of great interest for communities attracted to educational innovation, both in the social sectors, as well as in government, academia and business, where training and innovation are important, by locating the journals that have published the most research articles with mixed methods and the number of citations they have had. The visibility of articles is an important consideration for the social appropriation of knowledge.

- RQ4: What is the geographical distribution of the authors? In order to locate where the authors who have worked most with mixed methods in recent years are, the country of the first author was identified, and the number is represented in Figure 4.

Networking in educational innovation is a strategic engine for growth at all levels: institutional, national, regional and international. Locating authors who have worked on a topic of interest, in this case, locating authors who have used mixed methods in their studies, can support the strategic relationships of students, teachers, researchers and trainers. Some possibilities include carrying out collaborative academic activities, research, publication or academic internships. Also, Figure 4 helps us to identify the regions with authors working on the topic of mixed methods.

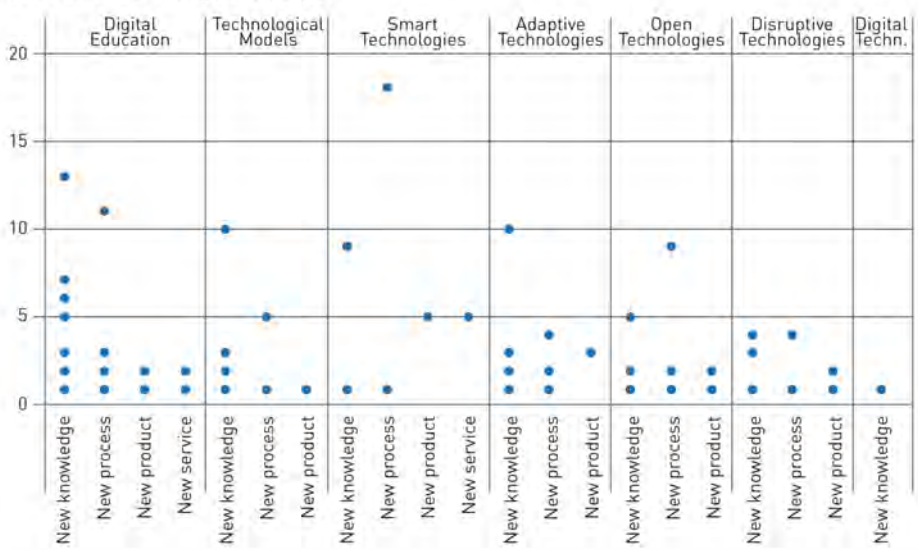
Figure 4. Geographical location of the authors



- RQ5: What are the emerging digital technologies that have been studied with mixed methods? / RQ6- What kind of innovation does the article bring? It was relevant to correlate the types of

emerging technologies identified in the articles, following the classification of González-Pérez et al. (2019) and the possibilities of contributions to educational innovation. It was done so that two same-level dimensions were analyzed for each article: the digital technologies that were identified in the articles and the type of innovation located in the publications. Figure 5 shows this crossing, highlighting a homogeneous frequency among the different types of innovation.

Figure 5. Digital technologies and innovations provided by the studies



The result located in this figure brings threefold light: a) In the dimensions of the upper axis it is possible to identify which the emerging digital technologies that are being worked on are, such as digital education, and which are less , such as disruptive technologies; b) In the dimensions of the lower axis are located the new contributions given by the studies in terms of knowledge, processes, products or services and; c) At the intersection of both axes and the frequency identified in the articles, one can see the picture of how emerging technologies have supported innovation in research practices, leaving challenges, such as driving new products (not identified in four technology categories) and fostering disruptive innovations (which had less frequency in the analysis of the articles). These results provide development opportunities for creative and innovative program teams, where innovators, decision makers and the educational community can locate advances from research and visualize challenges to bring new knowledge.

- RQ7: What kind of design did they use? / RQ8- What sample have you worked on in the study? The studies were analyzed to locate the mixed-method research design and the sample being conducted in the studies (see Figure 6 at https://doi.org/10.6084/m9.figshare.12269414.v1). We highlighted the exploratory sequential designs with a large sample (over 200 participants).

The crossing of the design and sample dimensions is a data that we consider interesting to identify how the different types of research design have behaved (following the classification of Creswell, 2003), with respect to the number of participants that have been present in the studies. This may shed light for students, researchers and research groups interested in contributing using mixed methods.

- RQ8: What kind of design did they use? / RQ9: In what lines of research and topics have the studies been carried out with mixed methods? The research lines of educational innovation of the articles were analyzed, with emphasis on the research question of the study, given that 'digital' was a key word in the publications. The research designs used in those lines were identified, as well as the most studied topics in the lines (Figure 7 at https://doi.org/10.6084/m9

.figshare.12269477.v1).

Once the articles were identified by their type of design, it was considered interesting to cross-refer them with the educational innovation lines of research (Ramírez-Montoya & Valenzuela-González, 2019; Rodríguez et al., 2015). In this way, it is possible to see the areas that are being worked on in the articles and the type of design. In addition, the topics that are being worked on are located within these lines. For example, in the psycho-pedagogical line, articles that deal with evaluation stand out, or in the disciplinary line, medical education studies are of great frequency. This result can be of interest to the areas of planning, instructional design, evaluation and educational research, among others, where decision makers, stakeholders, academic groups and training agents can have a reference to develop new forms of creation and research.

4. Discussion and conclusions

The publications related to research that integrates digital technologies, gives an opportunity to carry out analysis from a perspective that contributes to educational innovation. The objective of this article focused on providing original contributions to research the characteristics of these studies and the trends of new contributions to education. Our SLR highlighted important research foci on educational innovation. Particularly, around findings that were implied by the analysis and that led to the deduction of networks of co-terms, identification of educational innovations and types of designs that are being worked by scholars. It is worth highlighting some, including:

- The articles in the areas of social sciences and education, with components of digital integration, which are studied with mixed methods. They stand out for their emerging growth in recent years and for focusing on key aspects of educational sciences (the human factor and the educational process) and on processes that combine quantitative and qualitative strategies. Figure 1 shows the network of key words in the studies, the relations established between the most outstanding terms (human, education, curriculum and teaching) and their relationship with others of the same level; likewise, the clusters of qualitative and quantitative processes to study educational phenomena are highlighted. Figures 2, 3 and 4 report the growth in the number of articles, citations of these studies and geographical location where they are conducted. These findings are in line with what some methodologists indicate regarding conducting mixed methods, where collection and analysis must be balanced in the phases of the study process (Creswell, 2007; Tashakkori & Teddlie, 2010). The networks of co-terms and the characteristics of these studies analyzed in recent years can help to identify conceptual frameworks to support academic communities and stakeholders in project approaches, training and evaluation.
- Another theme is that of digital mediation in social science and education studies, which brings with it the integration of emerging digital technologies and contributions to new processes, products, services and knowledge. This finding is reflected in Figure 5 where the crossover of technologies and contributions is identified, highlighting that there is a greater incidence of technologies classified as digital education and the need to scale up new products and disruptive technologies. These integrations in training processes are linked to the basic ideas of Rogers (2003), who defines innovation as an idea, practice or project that is perceived as new, either individually or in adoption processes. Identifying digital technologies and new contributions helps in addition to establish a link with educational innovation, areas that can be of value to stakeholders, decision makers, scholars and creative teams interested in generating new options for education.
- We could also observe that the mixed methods are implemented with differentiated samples and designs that contribute to the research lines of educational innovation. The sample sizes in the different designs are reflected in Figure 6 and also in Figure 7. It shows a cross-section of the designs and the lines of research. The data is classified within the taxonomy provided by Ramirez-Montoya and Valenzuela-Gonzalez (2019), and Rodríguez et al. (2015) where the psycho-pedagogical, use and development of technology in education, educational management, socio-cultural and disciplinary lines are located. Educational innovation has -together with the

different types of designs- an opportunity to generate new knowledge for processes such as design, evaluation, training and research, where academia, business, government and society in general have the opportunity to undertake and innovate.

One thing that became clear from the analysis of the data is that the growth of educational research must include the recognition that working with mixed methods implies designs that converge. This, in order to enrich the approach that scholars undertake when assessing facts on the ground. Therefore, it is not only the sum of collecting quantitative and qualitative data but the intersection in the different levels of the research process (research question, selection of techniques and strategies, data collection, analysis, interpretation, legitimation and report presentation) that marks, in fact, the difference between being innovative or not.

One of the most important aspects that we can highlight is that by embracing a mixed-methods approach in education research it has been possible for scholars to not only close important gaps in our understanding of the field, but also to enhance interdisciplinarity. Indeed, the mixed-methods approach not only provided a more holistic grounding to knowledge, but also changed the mindset about how researchers approach the issues in question. This review of existing literature also provides additional guidance towards an inquiry that, due to its nature, is always organic and on the move. That is, the changing nature of education itself requires a combination of research strategies that brings about a better and more comprehensive understanding of the subject in question.

Furthermore, our SLR highlights how the technological imprint and digitalization of processes has brought about changes in educational processes and in the ways and possibilities of doing research. Indeed, as Klingner and Boardman (2011) point out, the mixed methods research can lead to insights about possible challenges to implementation as well as the circumstances under which a practice is most likely to be successful; therefore, adding depth and breadth not available through quantitative designs alone. Particularly, because this approach is better suited to address the enormous complexity of the education phenomena, which tends to be overall heterogeneous and particular-specific to each case and discipline.

Based on the work found that has used mixed methods, one could ask how mixed methodologies help to carry out better research in the field analyzed here, at least compared to studies that use a single method. In other words, it is important to ask: what is the added value of the mixed methodology to advance and improve research in this field? The contribution lies in the possibility of approaching the knowledge of complex entities, such as studies in social sciences, education, communication, with views of depth and scope. In this sense, the different designs around mixed methods help also to link quantitative and qualitative data, providing meaning and sense to complex realities.

The differential value is found in the way of combining data, research designs, collection processes, terminologies, procedures, which in their mixture lead to differentiated results. The amalgamation (not just the sum) of quantitative and qualitative data in the same design or research method, is something new, with great potential for more complete studies. Hence, there is little doubt that the mixed-methods approach brings with it a combination of strategies and processes to address the complexity of the education phenomenon. One that offers a holistic and interdisciplinary understanding and that has the potential to change the way research is done in our field. This study is an invitation to continue exploring and researching this topic and specifically expand our knowledge around how to bring continuous educational innovation into our work. This, we believe it is an opportunity for change and improvement that should not be missed.

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The impact of science communication on Twitter: The case of Neil deGrasse Tyson

El impacto del discurso científico en Twitter: El caso de Neil deGrasse Tyson

Elena Denia, Predoctoral Fellow in Science Communication, Institute of Innovation and Knowledge Management (INGENIO), CSIC/Polytechnic University of Valencia (Spain) (elenadeniacc@gmail.com) (https://orcid.org/0000-0002-9187-9051)

ABSTRACT

Public perceptions of science have been studied extensively since the mid-twentieth century. The aim of this project is to explore the interaction between science and the public in the digital world as a complement to traditional studies on the societal impact of science, particularly on the social network Twitter. It thus proposes a low-cost, easily reproducible methodology involving the design of an algorithm operating on representative sets of tweets to analyse their content by using computational techniques of data mining and natural language processing. To test this methodology, I analyse the communications of the popular science communicator Neil DeGrasse Tyson. The impact of the information is calculated in terms of 1) likes and retweets; 2) suggested formulas for measuring the popularity and controversial nature of the content; and 3) the semantic network. Relevant elements of the communications are then identified and classified according to the categories of "science", "culture", "political-social", "beliefs", "media" and "emotional". The results reveal that content with an emotional charge in the communicator's message triggers a substantially more profound response from the public, as do references to socio-political issues. Moreover, numerous concepts peripheral to the scientific discussion arouse more interest than the concepts central to the communication. Both these results suggest that science is more interesting when it is linked to other issues.

RESUMEN

La percepción social de la ciencia se ha estudiado ampliamente desde mediados del siglo XX. El presente proyecto pretende abordar la interacción ciencia-público en el marco de la vida digital para complementar los estudios clásicos sobre impacto social de la ciencia, en particular en la red social Twitter. Se presenta así una propuesta metodológica con el diseño de un algoritmo que opera sobre conjuntos representativos de tweets para analizar su contenido utilizando técnicas computacionales de minería de datos y procesamiento del lenguaje natural, fácilmente reproducible por otros investigadores y de bajo coste. Para probar la herramienta, se analiza el discurso del popular divulgador Neil DeGrasse Tyson. El impacto de la información se calcula en términos de: 1) likes y retuit; 2) medidas sugeridas para la popularidad y el grado de contenido polémico; y 3) la red semántica. Tras identificar y clasificar los elementos relevantes del discurso por las categorías «ciencia», «cultura», «político-social», «creencias», «medios» y «emocional», los resultados revelan que una transmisión con carga emocional en el mensaje del divulgador despierta una respuesta sustancialmente más profunda en el público, así como la alusión a cuestiones socio-políticas. Además, numerosos conceptos periféricos a la discusión científica suscitan mayor interés que los propios centrales en el discurso. Ambos resultados sugieren que la ciencia interesa en mayor medida cuando va ligada a otros aspectos.

KEYWORDS | PALABRAS CLAVE

Twitter, communication, science, dissemination, impact, public, participation, computational analysis.
Twitter, comunicación, ciencia, divulgación, impacto, público, participación, análisis computacional.

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1. Introduction

Public perceptions of science have been studied extensively since the mid-twentieth century by means of public opinion polls like the Eurobarometers in Europe, the National Science Foundation (NSF) surveys in the United States, or the reports of the Spanish Foundation for Science and Technology (FECYT) in Spain, among others. Ever since they were introduced, these surveys have sought to measure public interest in, knowledge of, and attitudes towards science (Davis, 1958), although they have not been immune to criticism (Bauer et al., 2007; Pardo, 2001). Science communication in particular has often been presented as an essential strategy for fostering public engagement with science (European Commission, 2008).

Given that the current trend in science communication is to involve the public in scientific dialogue (Nisbet & Scheufele, 2009), the performance of science communicators on social networks, which have massive numbers of user accounts and high levels of participation, has become a question of particular interest. Academics have highlighted the need for a better understanding of how these new virtual environments affect science communication (Brossard & Scheufele, 2013). At the same time, social networks themselves offer the opportunity for close-range investigation of public debates about scientific issues, with special attention to new voices and different contexts (Kapoor et al., 2018; Shan et al., 2014), on media platforms where content is often accessed without mediators. It is for this reason that studies of social networks can constitute a useful complement to traditional surveys of public perceptions of science (Li et al., 2019). With respect to public participation, researchers have highlighted the need to assess public involvement in open discussions about science in these environments, considering aspects like ease of access to content, the type of information disseminated and even the type of audience, among other factors (López-Pérez & Olvera-Lobo, 2019). It has been suggested, however, that audiences that follow science accounts do not generally interact with them, as in most cases they use them merely to keep updated (Álvarez-Bornstein & Montesi, 2019). It is worth noting that the content generated every day on Twitter is intimately linked to current scientific developments (Veltri, 2013; Wilkinson & Thelwall, 2012; Zhao et al., 2011), a quality that makes it especially attractive for research on science communication (Büchi, 2016), and that constitutes one of the most powerful reasons for its selection for this study, along with the open access it offers to bulk data. On the other hand, it has been suggested that the best strategy for communication on Twitter is actively focusing on increasing followers rather than relying on keyword searches to make scientific content visible (Mohammadi et al., 2018). With this in mind, to test the methodology proposed in this article I have chosen to use the Twitter account of the popular science communicator Neil de Grasse Tyson, who has gathered a very large number of followers (more than 13 million in 2019).

The objective here is to present the possibilities offered by a methodology designed to analyse sets of tweets and assess the impact of communications on Twitter about scientific issues, with the aim of revealing unexplored dimensions of the public interest in science and attempting to answer a question that has been inspired by the results of traditional surveys: What triggers an interest in science? Scientific advances and discoveries or aspects associated with everyday human life, like cultural, political, or even emotional factors? Attempting to answer this question will help reveal trends that indicate the most effective ways of communicating science. My starting hypothesis is that the social network Twitter, understood as a space for public participation, could prove useful for learning about these issues. To address the questions outlined above, this study includes the following stages: 1) Development of an algorithm in Swift programming language that can analyse large sets of data and measure the degree of interest and impact of information released on Twitter based on conversations about science; 2) Application of the algorithm to a set of publicly available data extracted from the account of the astrophysicist Neil de Grasse Tyson; 3) Graphic representation and interpretation of results; and 4) Assessment of the scope of the study.

It should be noted first of all that there is very little consensus about what methods are reliable for research on Twitter and what information it can reveal to us (Veltri & Atasanova, 2015), since rigorous methodologies that would permit reliable systematic analysis have yet to be developed (Kahle et al., 2016). However, there are various exploratory studies of science communication on Twitter in specific areas; for example, the studies that have aroused the most academic attention are those related to public

perceptions of risk, like research on the climate debate (Pearce et al., 2014) or studies of health issues aimed at understanding the emotional stance of the public (Becker et al., 2016). To study the content of tweets, computational techniques are used in order to systematically analyse large volumes of data, using text mining, natural language processes, network analysis, etc., and qualitative approaches with the participation of a human encoder who is aware of the conceptual context of the communication being researched and is therefore able to draw subtle information out of the tweets (Uren & Dadzie, 2015). This study therefore combines a mixed methodology to leverage the potential of both types of analysis.

It is worth noting that due to the format of Twitter, users express themselves in very brief terms, carefully choosing relevant words to reflect their ideas, which in principle makes it easier to explore key elements based on frequently used words. In this sense, the content of tweets allows for a semantic representation (Narr et al., 2011) that facilitates the analysis both of elements central to the communication, and of peripheral elements in simple terms, assigning them levels of relevance. Another common approach is what is known as "sentiment analysis" applied to tweet content, and in this study I also attempt to measure the emotional charge of the communications, given that emotional messages on Twitter are more likely to be retweeted (Stieglitz & Dang-Xuan, 2013; Veltri & Atanasova, 2015) and reflect the emotional perceptions of users expressed in natural language (Dehkharghani et al., 2014), generally identified based on predetermined lists of words.

Finally, it is also important to acknowledge the studies that suggest users are more inclined to tweet about their personal daily activities than about informational publications (80% compared to 20%) (Dann, 2010; Naaman et al., 2010). Twitter is, after all, both an information network and a social network (Myers et al., 2014), and its use as a research tool can take a wide range of approaches, from studying the potential to engage audiences by retweets (Kwak et al., 2010) to the activity of scientific journalists on the platform (Arrabal & De-Aguilera, 2016), or even the role of teachers in motivating and engaging their students (Santoveña & Bernal, 2019). There is also a widely accepted idea that personal profiles work better than institutional accounts in terms of interactions with the public (Pérez-Rodríguez et al., 2018).

2. Material and methods

2.1. Methodological proposal

For this study I propose a methodology aimed at identifying trends among audiences of science communication through an analysis of communications that are openly available on Twitter. The set of tweets to be studied can be collected easily through the application programming interface (API) offered by the platform itself (Twitter, 2019), for example, using a simple algorithm programmed in R language. In this case, it is recommended to clean the text of the messages with the tidytext R package (Silge & Robinson, 2016), which processes the text and prepares it for analysis, eliminating words with no semantic value like connectors or stopwords. Then, to analyse the content of representative sets of tweets, an algorithm in Swift language has been designed. The functions of this algorithm are described in this section. Quantitative techniques for performing systematic analysis are combined with a qualitative approach for classification of terms into categories.

First of all, to determine what the content in the sample is about and how it can be quantified in order to estimate its impact, the basic, indivisible unit of analysis used in this methodology is the word or term (Blei et al., 2003). The measurements to estimate impact are based on its frequency of use and on the number of retweets and likes associated with it, appropriately standardised based on the number of times the word appears in the sample. In addition, to reveal the extent to which a particular type of information is more interesting to the receiving audience than another, two other coefficients are proposed: "popularity" and "polemicity". The idea underlying the popularity indicator is that the more a word is retweeted (i.e., the more retweets it accumulates) the more popular it is considered, also taking into account how often it appears in the sample. For example, an unusual word with a lot of retweets would be considered especially popular. To define this, the variable retweetRate (retweet ratio) has been used, providing a measurement of the interest aroused by the term, i.e., the extent to which it is shared. It is important to note that popularity may be either positive or negative, as content that a given user disapproves of may be retweeted and thus gain visibility. On the other hand, polemicity, understood as the degree of

controversy triggered by the information, is defined as the ratio of the retweetRate to the favoriteRate (like ratio), which will be higher if the content of the tweet is retweeted widely but receives fewer likes. The variables described above and the popularity and polemicity indicators for words and categories are presented in Table 1, being comparable by definition between different datasets.

Table 1. Variables integrated into the algorithm

Variable	Definition	Equation
Frequency (word)	Number of appearances of a word divided by the total number of classified words present in the user's communications	$freq(w_i) = \frac{wordCount(w_i)}{\sum_j^k wordCount(w_j)}$
favoriteRate	Number of likes received by a particular word divided by the number of tweets that word contains.	$favoriteRate(w_i) = \frac{favoriteCount(w_i)}{\#tweetsContaining(w_i)}$
retweetRate	Number of retweets received by a particular word divided by the number of tweets containing that word.	$retweetRate(w_i) = \frac{retweetCount(w_i)}{\#tweetsContaining(w_i)}$
Popularity (word)	Number of retweets (weighted) divided by the frequency of a particular word.	$popularity(w_i) = \frac{retweetRate(w_i)}{frequency(w_i)}$
Polemicity (word)	Number of retweets (weighted) divided by the number of favourites (weighted) of a particular word.	$polemicity(w_i) = \frac{retweetRate(w_i)}{favRate(w_i)}$
Popularity (category)	Number of retweets (weighted) divided by the frequency of a particular category.	$pop_{cat} = \sum_{cat} \frac{wordCount(w_i) * pop(w_i)}{wordCount(cat)}$
Polemicity (category)	Number of retweets (weighted) divided by the number of favourites (weighted) of a particular category.	$pol_{cat} = \sum_{cat} \frac{wordCount(w_i) * pol(w_i)}{wordCount(cat)}$

Note. Where w_i is a word or term in the sample and cat is a category.

On the other hand, to determine the level of interest triggered by scientific content either on its own or correlated with other types of information in the tweet, a classification of words by category is proposed. This method has been used before in other studies investigating the relative interest in science compared to other topics on Twitter (Zhao et al., 2011). For this study, the categories proposed (which are described in Table 2) are the following: "science", "culture", "political-social", "beliefs", "media", and "emotional". These categories have been defined using my own criteria inspired by previous studies. Specifically, the category "culture" is drawn from proposals that explore cultural factors in studies of public perceptions of science (Bauer et al., 2012; Pardo, 2001); "political-social" is based on Twitter studies that highlight concerns of this type in relation to scientific controversies, usually in the area of climate change (Pearce et al., 2014); "beliefs" refers to the frequent interactions between science and religion and to the growing interest in studies of pseudoscience (Moreno-Castro et al., 2019); "media" is included due to its relevance to communication studies; and "emotional" is derived from studies that apply sentiment analysis to tweets, along with the observation that "an emotional connection [...] can be a powerful 'way in' to a science experience for non-experts, capturing initial attention and increasing feelings of bonding with the communicator or other participants" (Kaiser, 2014: 28).

Table 2. Description of categories for analysis of communications on Twitter

Category	Description
Science	Words that refer to scientific issues, including: scientific concepts ("planet", "physics"), methodological terms ("deduction"), and scientists (both historical, like "Galileo", and contemporary, like "bgreene").
Emotion	Words containing an emotional charge, expressing feelings, including: emotions ("happy", "fear", "awesome"), expressions ("yup", "yeah"), and evaluations ("lovely").
Culture	Words referring to culture, including: the cultural industry ("film", "song"), popular figures ("ladygaga") and cultural activities ("football").
Political-social	Words referring to political content and sociological aspects ("electorate", "president", "Americans") as well as social indicators ("poverty").
Media	Words referring to different types of media, including: social networks ("Facebook") and mass media ("audience", "news").
Beliefs	Words referring to beliefs, including: religion ("faith"), pseudoscience, esotericism and ufology ("homoeopathic", "astrology").

The classification of words into categories is done manually based on their meaning. Computer-assisted research methods are not suited to this type of content analysis as such methods assume that the terms have the same meaning in any context (Matthes & Kohring, 2008), while the use of a human

encoder can ensure a better interpretation of the context of the discussion. Thanks to the algorithm design, this categorisation is relatively simple when the words are organised in order of relevance in a list based on frequency of use and cumulative likes and retweets. At the same time, the algorithm also generates two files with nodes and edges organised in a visual representation in the form of a semantic network (for example, using the popular software Gephi) that shows the relationships between the metrics proposed and the content of the tweets collected, such as depicting the weight of each category in comparison with the others, or showing whether the scientific concepts present in the data sample are central to the communication or merely peripheral. The tasks required for the analysis are detailed in Table 3.

Table 3. Tasks proposed for analysis of a sample of tweets

Tool	Task	Description
Algorithm in Swift	Statistics on terms	Various statistical parameters are defined based on frequency of use, retweets and likes: frequency divided by the total number of words; retweet ratios and like ratios (retweetRate and favoriteRate, respectively); and popularity and polemicity indicators.
	List of words	A CSV file is generated containing a list of words in order of relevance in the set of tweets using an approximate measurement calculated based on weighted variables: frequency, retweetRate and favoriteRate.
	Word associations	Word matches in the tweets are identified with an automated system.
	Depiction of semantic network	The data is prepared for a visual depiction of the matches between words in the tweets to assess the degree of centrality of the concepts that proved the most appealing.
Human encoder	Categorisation of words	Terms are classified manually into categories ("science", "culture", political-social", "beliefs", "media", and "emotional") in the CSV file with the word list.

It is important to note that the list of categorised words is cumulative, which means that it will always grow in size and thus favour subsequent analysis applied to new sets of tweets, for which much of the work will already be done, apart from the classification of the most relevant words in the new communication by executing the algorithm. This will provide increasingly refined analyses of science communications, easily reproducible by other researchers and at a low cost in terms of intellectual and financial resources compared to public opinion polls, which require extensive work and substantial funding, and which have static results. Of course, this algorithm design is not restricted to the area of science, as its variables are compatible with other conceptual spaces. This tool is available to any researchers who may need it, simply by sending me a request via email.

2.2. Reliability of categorisation

To validate the categorisation of words, six members of the ScienceFlows research group (ScienceFlows, 2019) worked independently to classify the set of the first 50 relevant words identified by the algorithm in the data sample (see Section 3.1) into the categories created. For each word, the degree of accuracy was calculated based on my classification, with any score above the minimum threshold of 75% considered valid. A reliability level of 82% was estimated for the manual classification, although it serves merely as an indicative estimate for exploring certain trends in the communications under study.

2.3. Limitations of Twitter for data extraction

Although Twitter's API is free and facilitates access to millions of tweets including metadata, each search returns around 3,000 tweets, which constitute random samples from larger datasets, and thus there are limitations on the information that researchers can collect. For keyword searches, it needs to be borne in mind that the sample returned by the API is from the last nine days, which means the performance of cross-sectional studies on this platform requires the implementation of a mechanism for systematic data extraction in real time to obtain samples covering longer periods. On the other hand, when tweets by specific users are collected, the random sample includes tweets dating back to when the profile was first created.

Another obvious weakness in the use of Twitter is the superficial distinction between countries offered by the tool, resulting in insufficient demographic data and a homogeneous audience description. In addition, some authors point out that social network users are only one subset of the general public and

should therefore not be taken as representative (Murphy et al., 2014). Nevertheless, it is clear that as internet access increases around the world, so too grows the number of people participating in social networks. In any event, as the objective of this study is to explore trends, this limitation is not a serious problem in this case.

3. Analysis and results: The impact of Neil deGrasse Tyson's public communications

3.1. Data

To test the tool, a set of tweets was extracted using the API for the account of a specific user, Neil deGrasse Tyson ("@neiltyson"). The resulting file contains the full text of the messages together with a series of properties stored in columns with their associated values, of which the number of likes and the number of retweets are of special relevance to the analysis of the impact of the information. The resulting sample, which only includes tweets written by the user (no retweets), contains 3,005 tweets posted between 2012-10-05 and 2019-06-19. This download represents 49.5% of tweets posted by Tyson on the dates of the search, out of a total of 6,974 tweets. After cleaning the text, a file with 24,484 relevant words and their associated statistics was obtained.

3.2. Analysis

After identifying the most relevant words with the algorithm, the top 1,250 terms were classified manually. These offer an idea of the thematic preferences of the user in question. Among the most frequently used words are scientific concepts like "Mars", "space", and "physics". This result is to be expected given that the account holder is a science communicator who works in the field of astrophysics. Also appearing frequently are concepts unrelated to science itself, such as the word "film", making reference to the cultural industry of cinema, and the word "happy", referring to an emotional state.

Figure 1 contains a series of pie charts graphically depicting the relative importance of each category in Tyson's communications, based on: 1) his own thematic preferences; 2) cumulative likes by category; and 3) cumulative retweets by category.

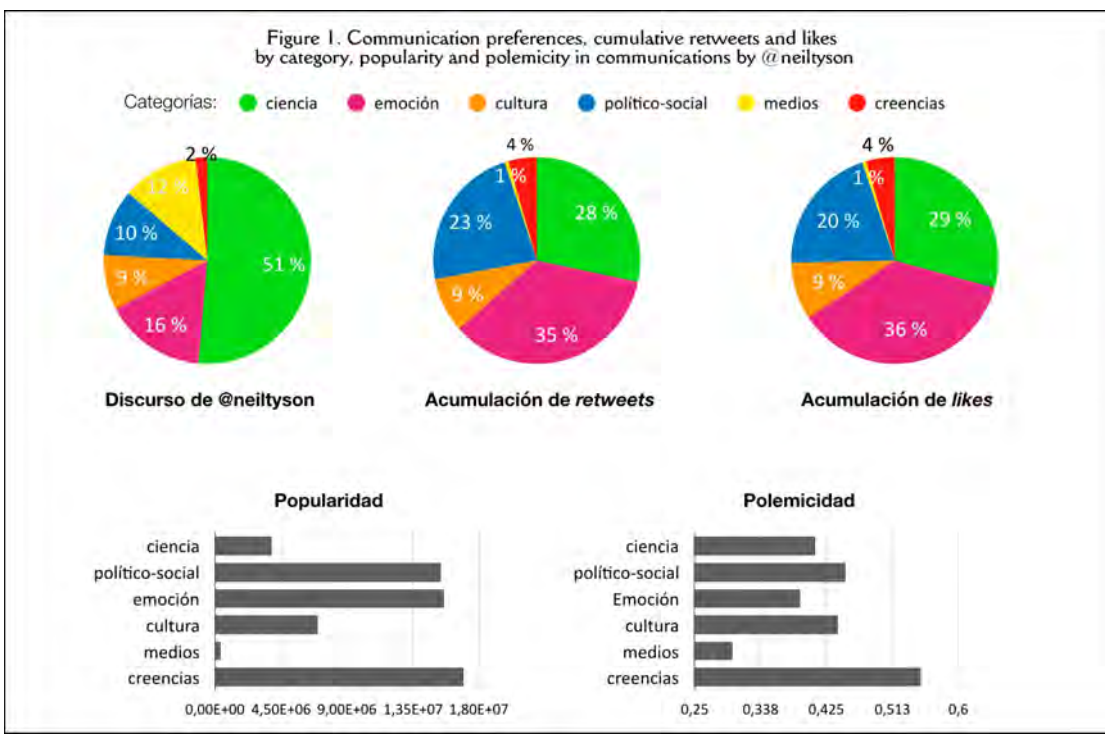


Figure 1. Communication preferences, cumulative retweets and likes by category, popularity and polemicity in communications by @neiltyson

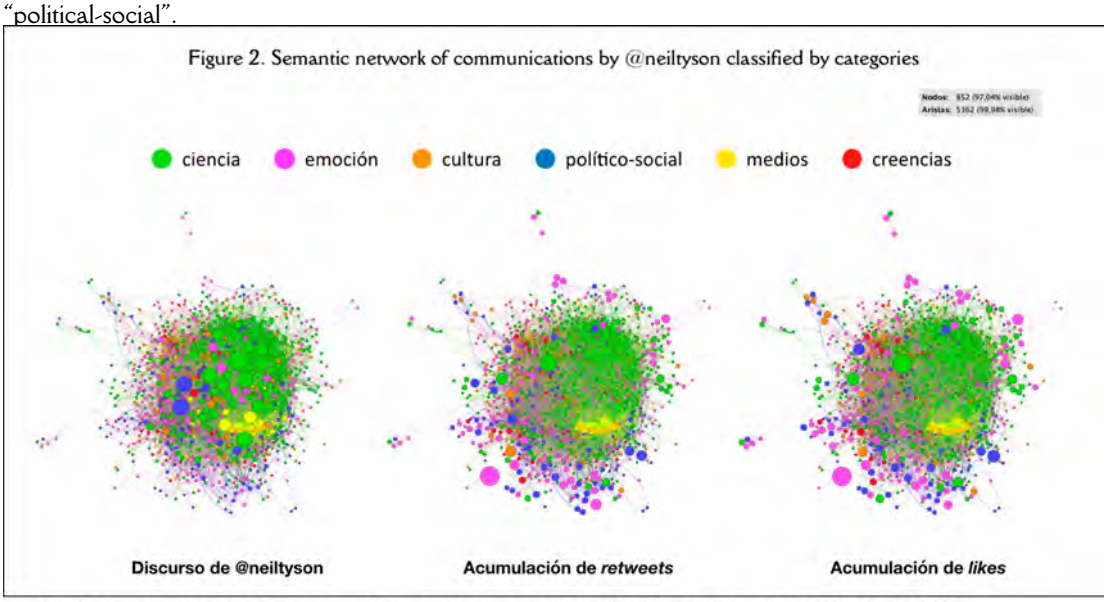
In the first chart, it is clear that the frequency of words with scientific content is high in Tyson's communications, making up more than half of the sample categorised (51%). Another 16% of his communications contain emotional expressions, 12% are words referring to the media (for example, citing his own radio program "StarTalk"), 8% are words with political and/or social content, 9% are words related to cultural issues, and 2% are related to beliefs.

To estimate the impact of his communications, the other two pie charts show how these thematic preferences trigger different quantities of likes and retweets for each category. Here we find that the impact of words containing an emotional charge (e.g. "joy", "shit", "hostile" or "cry") is markedly bigger than their representation in Tyson's communications would suggest. Words referring to social or political issues also have a much bigger impact, while the impact of scientific terms is smaller. On the other hand, words containing cultural information and those referring to beliefs have an impact in proportion with their relative presence in his communications. The percentages for cumulative likes are: "science": 28%; "emotion": 35%' "culture": 9%; "political-social": 23%; "media": 1%; "beliefs": 4%; while the percentages for cumulative retweets are: "science": 29%; "emotion": 36%' "culture": 9%; "political-social": 20%; "media": 1%; "beliefs": 4%.

Finally, in order to gauge how popular or controversial the content of Tyson's communications is, the popularity and polemicity coefficients were calculated for the different categories. These are also represented in Figure 1 with bar graphs (using comparative measurements whose values are not meaningful in themselves). The most popular communications are those related to beliefs, political or social issues and emotions, while the most unpopular are those related to media. Similarly, the level of polemical content in the communications is clearly higher in the category of beliefs than in any other category.

The final step was to find out what happens when scientific information is combined with other types of information, which was explored by representing the semantic network of Tyson's communications, also classified into categories, showing the relationships and connections between words. This depiction can be found in Figure 2, where the size of the nodes represents: 1) The communication preferences of the communicator (a node is bigger when a particular term appears more often in the sample); 2) The terms that received the most retweets; and 3) The terms that received the most likes. As can be seen, Tyson constructs his communication through central scientific concepts (network on the left), but it is evident in the other two conceptual network depictions that the impact of information on users is bigger for terms that are peripheral to the communication, especially for the categories of "emotion" and "political-social".

Figure 2. Semantic network of communications by @neiltyson classified by categories



Note. For this representation the Gephi program has been used, applying the Force Atlas algorithm to a sample of 852 nodes and 5,362 edges. In the network, the nodes repel each other and the edges attract each other.

4. Discussion and conclusions

The results discussed in the previous section have two dimensions: the strictly methodological dimension and the dimension related to the case chosen for this study. Based on the analysis of the case study with the tool proposed, the most striking result is that scientific content gives way to other types of information in the collected set of tweets by the science communicator Neil deGrasse Tyson. Although Tyson's communications are dominated by words associated with scientific content, the tweets with an emotional charge are the ones that receive the most attention from users, in terms both of likes and of retweets, followed by words referring to social and political content. Conversely, the media category is clearly the one with the weakest result in terms of the interest it arouses, and it also has the lowest popularity rate, despite the fact that its presence in Tyson's communications is quite high. This phenomenon is left open to interpretation.

In light of these results, this study constitutes a data-based approach that suggests that science on its own is not as interesting to the public as other subjects. Although it only studies one specific case, it is worth highlighting that Tyson is a science communicator with a huge influence and a large number of followers, and the sample used for this study contains half of his tweets. It should also be noted that messages posted by Tyson go first to his followers, an audience supposedly interested in science (although they are also subsequently disseminated via retweets).

The values generated for the two proposed indicators of popularity and polemicity reveal some clear differences between the two in the individual categories that may constitute points of interest. For example, the "science" category, despite not being particularly popular with receiving users, exhibits a certain level of polemical content, perhaps because of Tyson's social activism on issues like the climate crisis.

While the idea of polemicity is based on identifying which topics generate the most debate or controversy, popularity is a measurement of the attention they receive, regardless of whether that attention is positive or negative. The aspects revealed by these calculations might otherwise go unnoticed if there is a low incidence of words used in the sample in a particular category; this is the case, for example, of "beliefs", which proves an extremely popular and controversial category, despite its minimal presence in the set studied. Presumably due to their sensitive nature, these are issues that do not predominate in the communications of the user studied but that have a big impact in the Twitter ecosystem. It should also be noted that while the results based on likes and retweets are quite somewhat similar, an interpretation for this that seems plausible is that the action of retweeting gives the message greater visibility, thereby increasing the potential number of likes.

With respect to word matches in the semantic network, represented to evaluate the levels of centrality of terms with differing degrees of appeal, it is clear for the sample examined that concepts peripheral to scientific discussion, i.e., referring to adjacent issues, are of more interest than central concepts, and are for the most part non-scientific. One possible interpretation for this is that there are particular subjects that suddenly attract attention, but they are not subjects that normally appear in Tyson's communications. This question requires more in-depth analysis to identify the causes. On the other hand, the similarity between the two semantic networks depicting the cumulative number of likes and retweets in nodes may again be related to the fact that the spreading of a tweet on Twitter favours the accumulation of likes by giving greater visibility to it and exposing it to other users.

This case study thus hints at specific strategies for strengthening science communication: linking scientific information to socio-political issues and/or expressing it in emotional terms. Of course, as this study is limited to the particular case of Tyson's tweets, the results obtained cannot be extrapolated to the whole study universe of science communication, and my intention is certainly not to make such a generalisation, but merely to point to a trend that should be researched in greater depth.

Given that the results of applying the tool proposed here to the particular case of a famous science communicator are reasonably consistent, it is worth asking: Would studies of the communications of other science communicators offer similar results? What differences would be identified in the case of institutional accounts, or if current scientific issues are the focus instead of users? It would thus be worthwhile to apply this tool to other specific Twitter profiles and to general discussions that receive significant media attention. Another incentive for further research is the potential of the tool to provide

comparable periodic assessments and to support governments in the preparation of specific scientific communication plans or similar initiatives (to offer one example).

In short, due to the limitations of surveys to gauge public perceptions of science (Bauer et al., 2012; Pardo, 2001), this study has effectively considered a number of unexplored areas, confirming the potential of research on social networks to complement such surveys (Li et al., 2013). In particular, the confirmation with empirical data of the effect of emotional content in scientific communication is especially noteworthy (Kaiser, 2014).

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Construction of personalized learning pathways through mixed methods

Construcción de itinerarios personalizados de aprendizaje mediante métodos mixtos

Dr. Jesús Salinas, Full Professor of Didactics and School Organisation, Department of Applied Pedagogy and Educational Psychology, Palma, University of the Balearic Islands (Spain) (jesus.salinas@uib.es) (https://orcid.org/0000-0002-3043-8455)
Dr. Bárbara De-Benito, Associate Professor, Department of Applied Pedagogy and Educational Psychology, University of the Balearic Islands, Palma (Spain) (barbara.debenito@uib.es) (https://orcid.org/0000-0002-5868-7920)

ABSTRACT

This paper deals with the implementation of personal learning pathways in a technology-enriched environment to enhance learning experiences in initial teacher training. The study uses mixed-methods within a design-based research approach. In a first phase of the approach, the characteristics that personalised learning pathways should meet were identified. In the next stage, the learning sequences' structure for the pathways was designed, considering context, teaching-learning approach, tasks and assessment. The main result is an interchangeable learning sequence structure prototype that enables the configuration of personalised learning pathways by the students themselves, and the exchange and co-design of learning pathways between different teachers. The students select the sequences from a catalogue, organising their own learning pathways from the combination of different types of sequences offered. This strategy promotes students' autonomy and self-direction in the learning process, as well as their development of personal information management and collaborative work skills. The conclusion is that the proposed personalized pathways present an adequate balance between the structure, result of the learning design and / or co-design, and the necessary autonomy for the self-direction of their own learning process, whether in individual learning or in the collaborative construction of knowledge.

RESUMEN

Este trabajo se ocupa de la aplicación de itinerarios personales de aprendizaje en un ambiente enriquecido por tecnología para la mejora de las experiencias de aprendizaje en la formación inicial docente. Se utiliza un enfoque mixto aplicando investigación basada en diseño, para identificar las características que deben reunir los itinerarios personalizados de aprendizaje y diseñar la estructura de secuencias didácticas que configuran dichos itinerarios atendiendo al contexto, al enfoque de enseñanza y aprendizaje, a las tareas y a la evaluación. El principal resultado es un prototipo de estructura intercambiable de secuencia didáctica que permite la configuración de itinerarios personalizados de aprendizaje por parte de los propios estudiantes, al mismo tiempo que el intercambio y co-diseño de itinerarios entre distintos docentes. Los estudiantes seleccionan las secuencias de entre un catálogo de ellas, organizando sus propios itinerarios de aprendizaje a partir de la combinación de diferentes tipos de secuencias ofertadas, promoviendo la autonomía y autodirección del proceso de aprendizaje y el desarrollo de competencias de gestión personal de la información y de trabajo colaborativo por parte de los alumnos. Se concluye que los itinerarios personalizados propuestos presentan un adecuado equilibrio entre la estructura, fruto de la labor de diseño y/o co-diseño didáctico, y la autonomía necesaria para la autodirección del propio proceso de aprendizaje, ya sea en aprendizajes individuales o en la construcción colaborativa del conocimiento.

KEYWORDS | PALABRAS CLAVE

Learning sequences, curricular design, learning pathways, personalised learning environment, didactic strategies, self-regulated learning, design-based research, digital.

Secuencias de aprendizaje, diseño curricular, itinerario de aprendizaje, entorno personal de aprendizaje, estrategias didácticas, aprendizaje autorregulado, investigación basada en diseño, digital.

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1. Introduction and state of the art

One of the most commonly reiterated central ideas with regard to learning design is that students are active agents, which places them at the heart of the teaching-learning process. However, for this to happen, it must be noted that one of the keys to achieving learning goals lies in the autonomous management of a skill set that contributes to such an achievement. This is a set of transferable skills that are usually related to the concept of self-regulated learning or academic agency. Most importantly, it is the student who is in control of his or her own learning process.

In this context, a key element in the application of digital technologies in the teaching-learning process is the flexibility of the design. This flexibility should characterize the objectives, strategies, learning sequences and assessment methods, both formal and informal. All of these elements are closely linked to the idea of flexible learning, student-centred teaching, and learning approaches. (Adams-Becker et al., 2017; Gros & Noguera, 2013; Sharples et al., 2016). It is a question of adapting learning pathways and sequences to the individual student by promoting generic competencies for the management and transmission of knowledge, as well as autonomy and responsibility in learning processes, based on self-regulation or "agency". This is a concept that refers to the ability to act intentionally, and thus to achieve a purpose or goal, guided by the cognitive, self-regulatory, motivational and attributional factors that enable students to actively contribute to their own learning (Castañeda et al, 2014; Jääskelä et al., 2017; Jääskelä et al., 2020).

Increased autonomy, context affinity and greater interdependency in terms of agency provide enhanced interaction and the opportunity for the shared control of learning activities via intercommunication within a supportive and collaborative framework (Delfino & Persico, 2007; Sharples et al., 2016). In this sense, we need to look at the evolution of personalised learning environments (PLE) as one of the key processes in knowledge management systems in the field of learning (Castañeda & Adell, 2013; Marín et al., 2014; Tur et al., 2016). Personalised learning pathways are applied right from the point where teachers approach a subject from the perspective of course design, which is itself underpinned by the concept of personalised learning pathways. In effect, from the moment the student becomes involved, either through co-design or in terms of the configuration of some of the elements, s/he is effectively taking the design proposed by the professor and using it as a springboard for the construction of her or his own personalised learning pathway. A pathway is understood to comprise one or more learning sequences, with students being able to navigate through these different sequences.

The concept of a sequence of learning was initially developed by Taba in 1962. For this author, it was "a way of organising content, as well as a sequence of the reactions, behaviours and demands of learning". Both content and learning experiences must be staged appropriately in order to facilitate active comprehension" (Taba, 1974: 386). This concept has also been termed "didactic sequence", (Díaz-Barriga, 1997; Tobón et al., 2010). For these two authors "didactic sequences are simply articulated sets of learning and assessment activities that, through the mediation of a professor, seek to achieve certain educational goals, taking into account available resources" (Tobón et al., 2010: 20). In the context of this research, a learning sequence is a proposal for activities to be included in a teaching-learning cycle within a comprehensive structure, to be undertaken by both professors and students in order to create experiences that lead to meaningful learning.

On the other hand, a learning pathway is understood as a structure that acts as an organiser of both the concepts, themes, etc., to be learned, and the learning objects to be utilised, thus providing a full picture of what needs to be done in order to understand a particular subject, or to develop a particular competence. A flexible navigation system provides options or alternatives that can be followed when constructing personal learning sequence(s). In this case, navigation is adjusted in line with individual characteristics (needs, learning style, previous learning experiences, motivation, degree of autonomy, etc.), and when the control over these learning sequence(s) is passed to the student, we speak of flexible learning (Cañas & Novak, 2010; De-Benito et al., 2012). Therefore, a pathway can include one or more learning sequences. For De-Benito et al. (2012) a flexible learning pathway is characterised by:

- Being an organiser of concepts, topics to be learned, competences to be developed.
- Being an organiser of the learning objects to be utilised.
- Giving a comprehensive overview of what needs to be done in order to understand the topic in question.

- Offering options or alternatives to follow in the construction of each student's own learning sequence based on individual characteristics and needs.
- Making use of what is known as an expert map.

The aim is always to generate proposals for methodological strategies that respond to different approaches to teaching in virtual environments (Goodyear & Dimitriadis, 2013), both in relation to the representation of knowledge through learning materials delivered in different ways, and to the procedures for designing and producing those materials (Conole, 2013; Hernández-Leo et al., 2018; Laurillard, 2012; Marcelo et al., 2016). This is based on elaboration theory in terms of the importance of strengthening the initiative and student responsibility for the construction of their own learning (Reigeluth, 1999) and of making that learning meaningful (Ausubel et al., 1983; Novak, 1998).

The proposal presented in this paper has been developed on the basis of design-based research (DBR), understood as an emerging paradigm/methodology in educational research that constitutes a problem-oriented research framework and generally uses mixed methods (Creswell, 2014; Creswell & Plano Clark, 2018). This type of research has always been associated with technology and innovation in education (Wang & Hannafin, 2005), particularly as it evolved among researchers who were creating technology-enhanced learning environments.

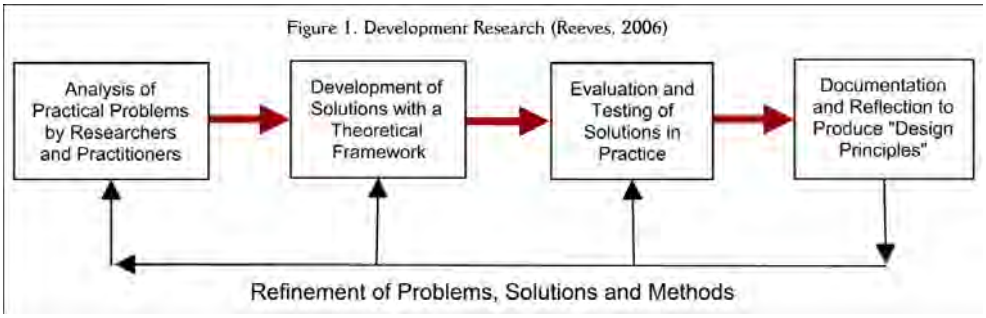
The objective of the study is to design a methodological proposal based on the construction of personalised learning pathways from a set of learning sequences offered to students and aimed at fostering student autonomy and responsibility within the teaching-learning process. It is about designing and validating didactic sequences for the construction of personalised learning pathways, identifying how the methodological proposal promotes student self-regulation and validating the use of concept maps as a tool for the representation of learning pathways. These objectives are aimed at answering the following question: What are the characteristics of learning sequences that contribute to the construction of personalised learning pathways, which promote student autonomy and responsibility within the teaching-learning process?

2. Material and methods

During the project, a methodological approach rooted in design-based research has been applied, since it concerns the improvement of educational design processes, and how they are developed and evaluated, geared towards resolving both specific and highly contextualised problems and generalised research procedures (Richey & Klein, 2014).

One of the key attributes of DBR is that it takes place in a real educational setting, validating the research and enabling the results to be used effectively to evaluate, inform, and improve practice not only within that setting, but potentially in others as well (Anderson & Shattuck, 2012).

Figure 1. Development Research (Reeves, 2006)



To achieve this, possible solutions are designed based on a theoretical framework of reference and the participation of stakeholders, in this case researchers and professors in education studies. This research follows the model developed by Reeves (2006), as represented in Figure 1, in which he proposes an iterative process consisting of four phases: the collaborative analysis of problems, the development of solutions, iterative cycles of assessment and fine tuning, and finally reflection and implementation of the

improved solution. In this paper, we are particularly concerned with the various improvement cycles that focus on developing solutions (didactic sequences, personalised pathways).

For Easterday et al. (2014) design-based research is a process that integrates design and scientific methods to enable researchers to generate useful outcomes, and an effective theory for resolving both individual and collective problems in education. Therefore, it is a question of thinking of education and educational technology as a science with a strong design component, emphasising its interdisciplinary and problem-solving approach. Design-based research is a valid methodological option that is being used increasingly often. This new approach arises from the need to put research findings into practice, and to incorporate them into the development of theory, focusing on the resolution of practical problems.

Consequently, this type of study takes place within a problem-oriented research framework and would fit into what Creswell (2014) defines as multi-phase mixed method research. This research involves the implementation of programmes in which several phases of the project are spread out over time and where the different types of methods used are mutually reinforcing when addressing a common program objective. In fact, most of the literature on design-based research agrees that the mixed methods approach is appropriate for the collection and analysis of data generated by this type of research project because it is able to maximise validity and increase the objectivity and reliability of ongoing research (Alghamdi & Li, 2013). Zheng (2015), in a review of the literature on design-based research published between 2004 and 2013, found that although qualitative methods were most frequently used, the use of mixed methods was growing (28.21%).

DBR and mixed methods share many of the characteristics that Teddie and Tashakkori (2010) propose for mixed methods, particularly in the sphere of education (Christ, 2010). One of these, the pragmatic approach, allows design-based researchers to be methodologically creative (McKenney & Reeves, 2012); but as with mixed methods, a pragmatic perspective should not be confused with ill-defined positions where everything is considered to be valid (Design-Based Research Collective, 2003): 6). In comparison with more positivist research paradigms, DBR is much closer to a vein of real-world pragmatism, where the problem/research question determines the methodology (Creswell, 2014; Creswell & Plano Clark, 2018).

As a result, design-based research takes an eclectic approach on the design and implementation of research methods by drawing on all research designs (preferably mixed methods) depending on the immediate need within the DBR study, assuming that each form of data collection provides a different type of information (open data in the case of qualitative data and closed data in the case of quantitative data) (Creswell & Creswell, 2018). This combination or integration of different methods results in a pooling of strengths or an offsetting of weaknesses if the aim of the research is for each to complement the findings of the other (Christ, 2010).

Table 1. Sources of information and data collection techniques

Variables	Data collection techniques
Didactic sequences	Nominal groups Student opinion questionnaire Seminars given by experts
Learning pathways and self-regulation	Student opinion questionnaire End of activity student feedback form Nominal groups
Technological environment	Initial questionnaire on technology use Student opinion questionnaire Nominal groups Activity log Teacher observation journal
Conceptual maps (representation of personalised learning pathway)	Interviews with students Map assessment via rubric
Follow-up and monitoring	Discussion groups with experts Student opinion questionnaire Nominal groups

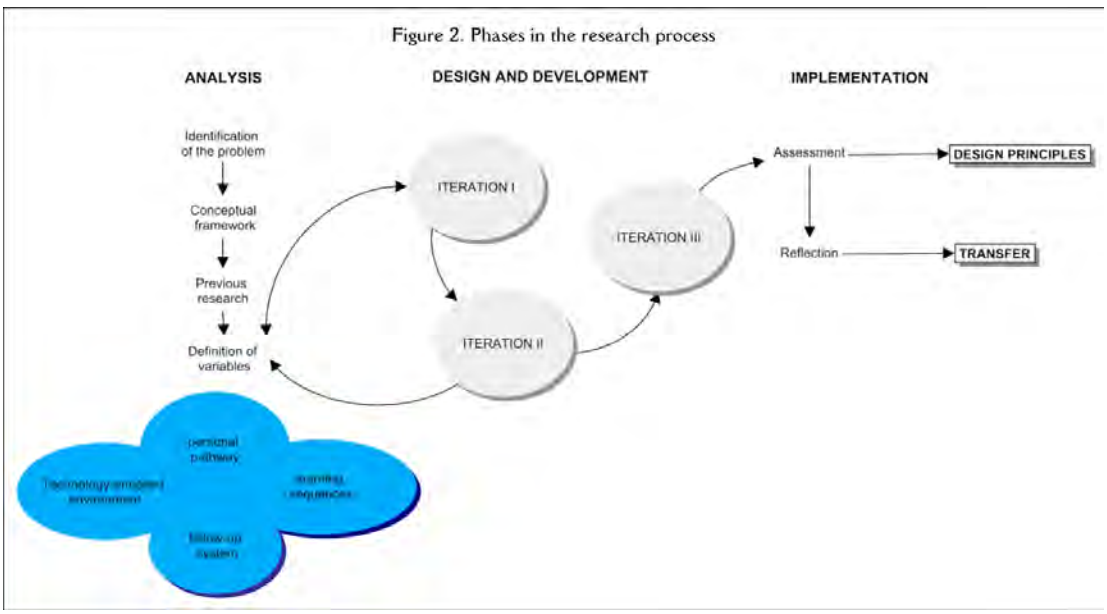
The research presented here addresses the design and testing of learning sequences that are integrated into different undergraduate subjects to facilitate the construction of personalised pathways. Together with the design of the structure that these sequences must follow, a study is made of the implications of

the integration of personal environments in terms of teaching and managing (e.g., student-tutor, student-student design and co-design). These sequences are placed in a catalogue in order to support the transfer and collaborative construction of learning, and self-regulation.

As described by Creswell (2014) in his definition of mixed multiphase methods, throughout the process there is a shift from quantitative to qualitative studies, and above all to a combination of the two, which are mutually reinforcing in addressing a common project objective. In this case, we have an exploratory sequential design, QUAL->QUAN, in the typology used by Creswell and Plano Clark (2018), which primarily seeks to generalise the findings of the qualitative study. A variety of sources of information and data collection techniques have been used in this research study, as is the case in the DBR. These techniques are presented in Table 1.

Using the framework developed by Reeves (2006) represented in Figure 1, the research carried out has been structured in different phases as shown in Figure 2 below.

Figure 2. Phases in the research process



- Phase 1. Analysis.

The first phase corresponds to the identification of the problem and the conceptual definition of each of the central elements or variables within the methodological strategy to be developed. These first two steps were developed based on a review of the documentation (design principles) and an analysis of earlier research carried out by the research group.

The objective in this first phase was an approach to the object of study involving the application of quantitative data collection techniques via the systematic review of research related to the variables, and qualitative techniques via "future workshops" led by experts aimed at the clarification of the nature of the problem and the definition of concepts, following nominal group technique.

- Phase 2. Design and development of methodological proposals.

This phase involved the design and development of the methodological strategy, and each of the iterative cycles that allow it to be readjusted and fine-tuned. Each iterative cycle was linked to the collection of quantitative and qualitative data based on the study variables: a) Personalised learning pathways; b) Didactic sequences; c) Technological configurations; d) Follow-up system and self-regulation.

With regard to the construction of personalised learning pathways, concept maps were used as a tool for students to represent these, using different data collection techniques. On the one hand, qualitative techniques via interviews aimed at obtaining valuable information from students regarding the creation and representation process of their personalised learning pathways were used. On the other hand, concept map analysis techniques were employed by adapting the rubric developed by Prats (2016) together

with student perceptions as expressed in end-of-course questionnaires. The design and validation of the structure of the learning sequences has been approached in two ways, through the "collaborative analysis of practical problems by researchers and participants", and via the "development of solutions based on design principles and technological innovations" as proposed by Reeves (2006).

These have each been addressed separately at seminars in the "future seminars" format, involving a group discussion forum to brainstorm future solutions to current problems: "Self-regulation and the flexibilisation of the Teaching-Learning process" and "Flexible learning pathways". The first was focused on reflection and decision making regarding the conceptual framework to be worked in relation to self-regulation, agency and the flexibilisation of the teaching-learning process. It included the monitoring and tutoring system aimed at the personalisation of learning pathways. The second was an international seminar aimed at reflection and decision making with regard to the structural aspects of the project related to the design of flexible pathways and their components.

A decision was made to use an adaptation of the nominal group technique for both seminars, since they involved identifying problems, generating solutions and making decisions (Miranda, 2017; Varga-Atkins et al., 2017). The data obtained was used in the generation of the first personalised learning pathways prototype. Once this prototype had been implemented, a questionnaire was administered that included items specifically related to the factsheets corresponding to each sequence.

In addition to the personalised learning pathways, the design of the technological configuration supporting them has adapted the methodological proposal to the institutional platform, which is the digital classroom. Student perceptions were obtained by means of a questionnaire, a nominal group with the teachers involved in the experience, and by looking at the different tools utilised based on information gathered from the system's activity log and the teacher observation diaries.

In the development of the monitoring system designed to support the implementation of personalised learning pathways, the opportunities that the institutional platform has to offer are being studied and adapted, extrapolating the results of earlier research. This system has been validated by means of record sheets, teacher interviews and nominal groups (with the participation of experts and teachers).

- Phase 3. Assessment and reflection.

The final iterative cycle corresponds to the development of the definitive prototype of the methodological strategy, its implementation and assessment. As in the previous phase, quantitative and qualitative data collection and analysis techniques were applied by looking at student opinion questionnaires, the analysis of personalised learning pathways, activity logs and incidents in the technological environment, as well as interviews with students and teachers.

- Phase 4. Documentation and generation of design principles.

This phase is concerned with documentation completion and preparation. It includes the description of the methodological proposal, dissemination via networks, conferences, meetings, publications, etc., and activities to enable the transfer of the proposal to different contexts.

3. Analysis and results

In this section, the results obtained from the first version shown in Figure 2 are presented in relation to the construction of didactic sequences and their use in the creation of personalised learning pathways.

3.1. Definition and types of didactic sequence

At the seminars mentioned above, the structure, types of sequence and factsheets containing information on each of the sequences were designed using the nominal group technique involving experts and teachers.

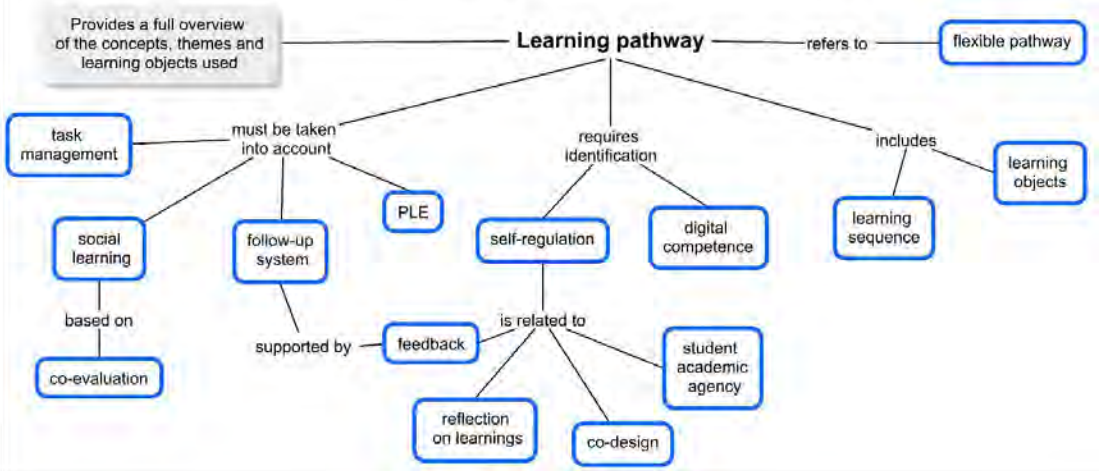
The nominal groups were made up of nine teachers of educational technology at the undergraduate level in the social education, early childhood education, primary education and pedagogy fields. In addition, two seminars were held with experts in order to define, and to delve into the project's key concepts. In the sessions with experts, different concepts such as personalised learning emerged, and there was a review of the associated concepts used over the last 60 years.

Related to this is technology-based adaptive learning, which has much in common with flexible or personalised pathways. Figure 3 shows the concept map and the connections that emerged from the seminars with the experts previously mentioned, and those that are considered key to the research are highlighted A larger version of the map can be accessed at https://bit.ly/35zbWQM.

From the information collected through the nominal groups, a working proposal has been developed to generate these pathways made up of compulsory sequences, sequences where the student is offered alternatives from which s/he needs to choose, and others that may be purely optional (which are not compulsory).

These sequences have different levels of granularity, and depending on the activity, the student group and the teaching method, five types of sequences are proposed in an exploratory way: conferences/exhibitions, workshops, projects, seminars and other sequences that can get the student actively involved with problem-solving tools such as guided research, discussion or debate with an expert, searching, locating and evaluating digital resources, etc. (De-Benito et al., 2020).

Figure 3. Representation of the concept map generated by the expert seminars and focus groups



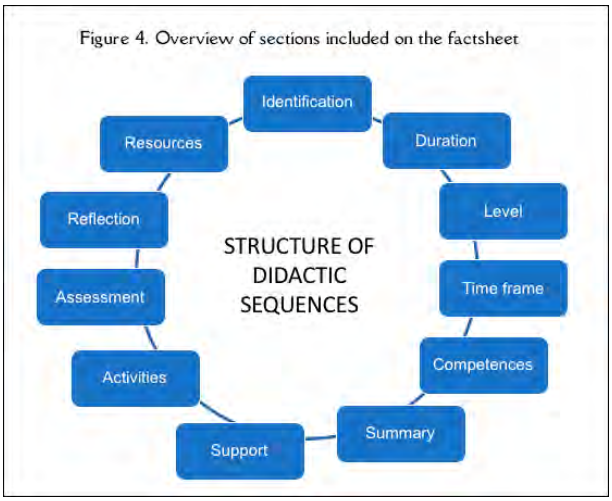
Another important aspect in the construction of flexible pathways is the need for a monitoring and assessment system that favours both the management of learning sequences, and student support and assessment. From the map, it is clear that this flexibility implies the use of technology enriched environments that on the one hand require self-regulation strategies that favour student academic agency, and on the other hand, need sufficient digital competence to be able to set up a personalised learning environment.

3.2. Creation of a repository of didactic sequences

Another research outcome has been the creation of a repository of learning sequences aimed at the transfer and collaborative construction of learning, while promoting self-regulation from the perspective of agency.

To achieve this, the elements proposed by Conole (2013) were taken into account: context, teaching and learning approach, tasks and assessment. Based on the results obtained from the nominal groups, a factsheet was designed for each sequence, in order to facilitate selection during the process of constructing personalised learning pathways, as well as exchange between the teachers in charge of different subjects (De-Benito et al., 2020), as shown in Figure 4. During the 2019-2020 academic year, around 70 teaching sequences of the different types described in 3.1 have been created.

Figure 4. Overview of sections included on the factsheet

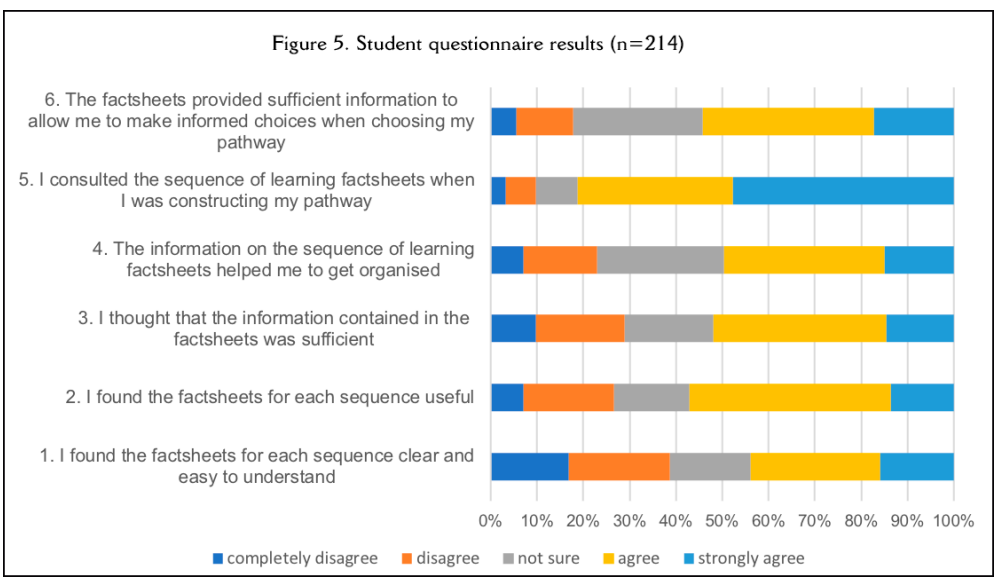


3.3. Student assessment of factsheets

Once the first prototype was launched, the opinions of the students participating were collected via a questionnaire on the information provided in the sequence sheets, asking them how useful they had found these when choosing their own pathways.

Figure 5 shows the results obtained and indicates that the vast majority consulted the factsheets when constructing a learning pathway. In relation to the information provided, around 50% thought that it was sufficient for them to be able to make informed choices when selecting the sequences that would make up their own pathways, and that it helped them to organise themselves and had been useful. To a lesser degree, they found the factsheets easy to understand.

Figure 5. Student questionnaire results (n=214)



3.4. Integration of results

The process of designing the sequences constituted the first version of the DBR project and was based on a review of the literature and of previous research along with the development of "future seminars", as described in 3.1. The validation of factsheets for each sequence had to be carried out taking the different variables into account and using different techniques and instruments for collecting information within the general framework of the study (Table 1).

The results of the student opinion questionnaire show that almost 80% of students said that they consulted the factsheets when constructing their pathway However, the answers to other questions related to the quantity, clarity and usefulness of the information contained on the factsheets indicate that improvement is required here. In addition to formal aspects, it is considered fundamentally important to take into account other variables such as how the selection of sequences is organised, the visualisation of the pathway's structure, or the assimilation of the methodological strategy based on the construction of personalised learning pathways by students. These variables are important as this methodology is new, and it is one that they are not accustomed to finding in areas where a more traditional form of teaching is used.

The following versions require, on the one hand, the factsheets to be revised by professors teaching on other courses unrelated to the subject in question, so that the clarity of the information can be assessed, and on the other, an improvement in the way that the methodological strategy underpinning the construction of personalised learning pathways is presented.

4. Discussion and conclusions

This paper describes the research process supported by DBR and the way that this methodological approach uses mixed methods for the data collection and analysis. A methodological proposal has been developed based on the construction of personalised learning itineraries based on the students' selection of the didactic sequences that are to make up their own pathways.

In the case discussed here, the outcomes are the design and development of a catalogue of didactic sequences to be used in the construction of the pathways, and their application in an initial version for the validation of the first prototype.

The results obtained show that the proposed personalised learning pathways present an appropriate balance between the structure (didactic design, didactic strategies, learning pathways and sequences, etc.) that characterises the work of didactic design and/or co-design, along the lines indicated by Conole and Oliver (2007), Conole (2013), Gros and Noguera (2013) and Prendes et al. (2018): on the one hand, the autonomy required for the self-regulation and self-direction of the learning process itself, or between the individual aspects of agency and self-regulation (autonomy, motivation) and on the other, the community, interdependence and collaborative construction of knowledge (Cabero, 2013; Sharples et al. 2016). Specifically, innovative methodological proposals have been incorporated, based on the tools provided by technology-enriched learning environments. Based on these, various skill sets have been developed. Personal information management skills (access, selection, distribution of information) have been encouraged as can be seen in Llorente (2013) and particularly in Marin et al. (2014), and competencies related to the autonomy and self-regulation of the learning process (organisation, motivation, assessment, etc.) (Jääskelä et al., 2020), together with communication and collaborative work competencies (communication between stakeholders through the transfer and collaborative construction of knowledge) along the lines indicated by Dabbagh and English (2015) or Dabbagh and Kisantas (2013).

Additionally, a great deal of information was obtained that has contributed to the redesign of some features of the prototype, and which has been incorporated into the second version that is currently being rolled out (De-Benito et al., 2020). The variety of data collection techniques used ensures that the results obtained can be effectively used to assess, inform and improve the practice in the context of research on personalised learning pathways, and possibly in other similar training contexts.

Hence, the use of DBR implies that the design of the intervention is a collaborative task undertaken by the researchers and professionals taking part. This task begins with an accurate assessment of the educational context and the identification of a problem, in order to be able to propose improvements in practice, as suggested in McKenney and Reeves (2012). In our case, the intervention in question was the testing of didactic sequences integrated into different undergraduate subjects in order to facilitate the construction of personalised pathways, and the professionals involved were university professors.

The present study, like all design-based research, has a practical focus. In this study, we have attempted to find a solution to a real problem in the training of future teaching professionals, and to develop a series of skills that have already been mentioned. However, at the same time, it has generated knowledge about

the characteristics essential to interventions associated with greater control and autonomy for students, as well as other forms of knowledge connected with the processes themselves involved in the design and implementation of personalised learning pathways, and the most appropriate ways to develop effective and feasible interventions underpinned by theory.

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Education, Big Data and Artificial Intelligence: Mixed methods in digital platforms

Educación, Big Data e Inteligencia Artificial: Metodologías mixtas en plataformas digitales

Beatrice Bonami, Ph.D. Candidate, University of São Paulo (Brazil) (beatrice.br@usp.br) (https://orcid.org/0000-0002-4012-8098)
Luiz Piazentini, Ph.D. Candidate, University College London (England) (luiz.piazentini.19@ucl.ac.uk) (https://orcid.org/0000-0003-2554-5739)
Dr. André Dala-Possa, Professor, Federal University Institute of Santa Catarina, Santa Catarina (Brazil) (andredalapossa@gmail.com) (https://orcid.org/0000-0003-1995-6670)

ABSTRACT

Digital technology has provided users with new connections that have reset our understanding of social architectures. As a reaction to Artificial Intelligence (AI) and Big Data, the educational field has rearranged its structure to consider human and non-human stakeholders and their actions on digital platforms. In light of this increasingly complex scenario, this proposal aims to present definitions and discussions about AI and Big Data from the academic field or published by international organizations. The study of AI and Big Data goes beyond the search for mere computational power and instead focuses upon less difficult (yet perhaps more complex) areas of the study social impacts in Education. This research suggests an analysis of education through 21st century skills and the impact of AI development in the age of platforms, undergoing three methodological considerations: research, application and evaluation. To accomplish the research, we relied upon systematic reviews, bibliographic research and quality analyses conducted within case studies to compose a position paper that sheds light on how AI and Big Data work and on what level they can be applied in the field of education. Our goal is to offer a triangular analysis under a multimodal approach to better understand the interface between education and new technological prospects, taking into consideration qualitative and quantitative procedures.

RESUMEN

La tecnología digital ha traído características de conexión que restablecen nuestra comprensión de arquitecturas sociales. Sobre la Inteligencia Artificial (IA) y Big Data, el campo educativo reorganiza su estructura para considerar a los actores humanos y no humanos y sus acciones en plataformas digitales. En este escenario cada vez más complejo, esta propuesta tiene como objetivo presentar definiciones y debates sobre IA y Big Data de naturaleza académica o publicados por organizaciones internacionales. El estudio de IA y Big Data puede ir más allá de la búsqueda de poder computacional / lógico y entrar en áreas menos difíciles (y quizás más complejas) del campo científico para responder a sus impactos sociales en la educación. Esta investigación sugiere un análisis de la educación a través de las habilidades del siglo XXI y los impactos del desarrollo de IA en la era de las plataformas, pasando por tres ejes de grupos metodológicos: investigación, aplicación y evaluación. Para llevar a cabo la investigación, confiamos en revisiones sistemáticas, investigaciones bibliográficas y análisis de calidad de estudios de casos para componer un documento de posición que arroje luz sobre cómo funcionan la IA y el Big Data y en qué nivel se pueden aplicar en el campo de la educación. Nuestro objetivo es ofrecer un análisis triangular bajo un enfoque multimodal para comprender mejor la interfaz entre la educación y las nuevas perspectivas tecnológicas.

KEYWORDS | PALABRAS CLAVE

Artificial intelligence, big data, education, mixed methods, multimodality, digital technology, platform society, digital connection.
Inteligencia artificial, macrodatos, educación, metodologías mixtas, multimodalidad, tecnología digital, sociedad de las pantallas, conexión digital.

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1. Introduction

In the early 20th century, connectivity studies sought to understand how socio-technical systems were driven. The aim was to make sense of the communication materiality embedded in the process and the diverse roles it played. Using the framework of communication materiality, scholars argued that humans have emerged from a physical world to inhabit a symbolic atmosphere where everything comprises material content (Habermas, 1985).

Reflecting on education not only entails considering the interface between teacher and student, it involves understanding that the terms assigned to this process carry meanings that can mask technology and the collective construction of knowledge. Technology is frequently associated with both solving and creating problems within education. This phenomenon is described by Mick and Fournier (1998) as the "paradox of technology" which can be simultaneously emancipating and enslaving.

One idea on how to define technology is the concept of "technium", which is a self-reinforcing ecosystem of artifact creation, tools and ideas embracing all technologies. According to this idea, technology depends on countless preceding advances. Kelly (2010) argues that technology predates humankind, suggesting that technium involves constructs such as complexity, diversity, specialization, mutualism, ubiquity, sentience and exotropia. Yet, Kelly (2010) warns that technology can also be seen as scientific knowledge used in practical ways in industry, for example in designing new machines.

This paper approaches the developments in Artificial Intelligence (AI) and Big Data and their intersection with Education. It presents the illustration of this interface as the platform society capable of promoting 21st century skills. Mixed research methods, their application and evaluation will be presented. This includes netnography, Competency Based Education (CBE), 4-dimensional modelling, compass models and multimodality, while taking into consideration the triangular approach as a complex and sophisticated method to perform analysis in this intricate environment.

1.1. State of the art: AI and Big Data

AI has been a topic on the radar of theorists and experts since the 1950s, and, to this day, no agreement has been reached as to its definition. Studies into AI began in 1956 when John McCarthy used the term at a seminar at Dartmouth University in the United States. Prior to McCarthy, starting in 1951, research studies on genetics within the field of biological sciences had also considered AI. Also, in 1950, Alan Turing published the study "Computing Machinery and Intelligence" where he presented the "Imitation Game" also known as the "Turing Test", which is a set of questions aimed at assessing whether the respondent is a human or a machine.

Russel and Norvig (1995) explored AI in four categories: systems that think like humans; systems that act like humans; systems that think rationally; and systems that act rationally. In the history of the study of AI, the four categories welcome theorists and followers, finding tensions at their edges between studies centered on "Humanity" or "Rationality".

Publications from 2014 reflected these distinctions on how AI can be applied. The International Telecommunication Union (ITU) released the reports "Artificial Intelligence for Development Series" (2017) and "AI for Good Summit" (2017 and 2018); where it described the developments in the concept of a system that does not replace human intelligence. Similarly, the Organization for Economic Co-operation and Development (OECD) in partnership with International Business Machines (IBM) in the document "AI: Intelligent machines, smart policies" (2018) positions AI as a structure that increases the potential of human intelligence.

Floridi (2014), on the other hand, discussed the applications of AI arguing that successful systems are those with a molded environment around them. In other words, systems that respond to specific purposes perform best —the author gives an example of a robot which may cut grass well is unlikely to also perform the role of a refrigerator just as well. This is known as a "frame problem". According to Floridi (2014), AI does not have a descriptive or prescriptive approach to the world; rather, it assesses the logical and mathematical coercion that makes it possible to construct artifacts and interact with them effectively.

The United Nations on the other hand, in their publication "Innovative Big Data approaches for capturing and analyzing data to monitor and achieve the SDGs" (2017) acknowledged that defining AI is

not a straightforward task. The initial problem is to define what "intelligence" means or which intelligence is executed by humans and non-humans. Despite various attempts, none of the involved disciplines, such as psychology or education science, has come up with a satisfying, mutually agreed upon definition of intelligence. Legg and Hutter (2018) provided an overview of the many definitions proposed over the years: "Intelligence measures an agent's ability to achieve goals in a wide range of environments". In terms of AI, the "agent" in this definition could be a human being (regular intelligence) or a system (AI). As such, a machine that exhibits intelligence, which equals human intelligence, can be referred to as having general AI.

1.2. Connection between AI and Big Data

AI happenedin the wake of the Zettabyte Era, which means that an intelligent performance from a machine is required as a consequence of Big Data. Generations since 2014 have experienced the Zetta flood that describes the byte tsunami that is taking over the environment where we live. While AI has become a natural development of an intelligent system that needs to deal with Big Data, this is why the terms are structurally connected. Despite the importance of the phenomenon, the definition of Big Data is still unclear. The term was first introduced in 1989 by Erik Larson in a piece published by The Washington Post on how to deal with junk mail. However, theorists attribute the concept of Big Data as we use it today to John R. Mashey's "Big Data and the next wave of infrastress" published in 1998, where he acknowledges a field that requires high capacity in running analytic models to cope with vast amounts of data. Many authors have contributed to the development of the term, and in 2012 one of the first legal regulations of public and sensitive data was launched.

The current law of the General Data Protection Regulation (GDPR - European Union Commission, 2020) contains legal requirements for the use of personal data for historical, statistical and scientific research purposes effective worldwide. Floridi (2014), who contributed to the launch of GDPR, warns of two common mistakes when talking about Big Data: one is misunderstanding "Big" to refer to physical size, and the other is misunderstanding the "Data" as being "Big" only when in perspective to computational power. These two mistakes, in turn, have two different sources: the epistemological problem when thinking that there is too much data; and the idea that the solution to this problem is technological (as if technology could synthesize/reduce data amount). The confusion lies in the fact that an epistemological problem requires an epistemological solution, rather than a technical one.

1.3. The problems in Big Data interpretation and basic features

Since the problem is not the increasing amount of data, the solutions need to be updated. It is not about our processing capacity (since this activity happens on demand), but about the epistemological question of small patterns analyzing Big Data. Small patterns represent a new frontier of innovation and competition, from science to business, from governance to social policies, from security to protection. The reason why patterns should be small is to improve their processing speed —since there is a large quantity of data, the small patterns group them to speed up their synthesis). A potential ethical issue concerning the use of small patterns stems from their ability to predict future events, as they can foresee choices and behaviors, which comes up against ethical principles of information.

Another feature of data is related to volume, and the Cloud Security Alliance (2014) in its report "Big Data Taxonomy" introduces three limits to the growing usage and storage of data: thermodynamics, intelligence and memory. This provides a concerning counterweight to the argument that AI is a solution to Big Data, since intelligence is one of Big Data's limitations. Big Data responds to data acquisition and storage, and humanity has not produced enough storage for the data we are producing, which is therefore a limitation in terms of memory.

Søe (2018) warns, however, that the main problem with this particular field is epistemological. The perspective of the amount of data being a problem is misleading, once the main question is how late people became aware of Big Data's existence. This analysis goes in the opposite direction of the idea of data as sets so large and complex that they become difficult to process using available database management tools for traditional data processing applications, which brings us to another misleading conception as mentioned

above: weak computational power. But why are small patterns such a big issue? Floridi, in a lecture in 2018 at Oxford Internet Institute, answered that question with a dot connection figure illustration: the more data points you have, the better the pattern must be, and unless you connect all the dots you will not see what the figure is really about. The question of Big Data is that, among zetta bytes of information, a pattern is required in order to conduct an analysis. Floridi compared it to finding a needle in a haystack. The integration between Big Data and AI is that data groups must create their own intelligence to identify the needle.

Yet, not every piece of data is important. Mantelero (2018) points out that perhaps half our data is insignificant, while the other half is valuable. The role of small patterns is to know which half is required. Once the valuable assets are mapped, and the needles found, an aggregation feature could be considered. This means that combining important data may drive a system to understand their customer and even to predict their choices. Thus, small patterns, as a methodological procedure, are significant when they correlate relevant data including the absence of data itself.

Collective intelligence and its ability to move forward with AI algorithms depend on a colossal historical database capable of generating insights into predictive behaviors and educational outcomes. Yet, one of the major challenges for the advancement of AI is the systematization and organization of useful data.

2. Material and methods: The age of platforms

Discussions arising from the application of AI and Big Data regarding the development of digital skills are partly due to the impact on work environments such as automation and the need for 21st century skills. Such competencies concentrate on socio-emotional aspects and anthropocentric character, which are considered complex constructs and difficult to automate. Cukurova et al. (2019) define 21st century skills as concepts composed of a group of other skills or knowledge and, for this reason, these competencies present high complexity for parameterization.

In this research, 21st century competencies in interface with AI will be explored between two aspects: elicitation and knowledge representation (Barrett & Edwards, 1995). Regarding the first aspect, Pearson conducted a study "The Future of Skills Employment in 2030" (Bakhshi, 2017) which gathered expertise and statistical data from the database of the United States Ministry of Labor (O'net) to design 120 competencies of the future composed of three sub-categories: competencies, knowledge and skills. Given its sophisticated quantitative character, AI enhances the operation, mapping and analysis of these new aspects within the interface of technology and education.

According to Scoular et al. (2017), AI makes it possible to analyze the multiplicity of facets of teaching and learning. From the point of view of knowledge representation by modeling, the construction of platforms gains depth in the interface between AI and education. Luckin et al. (2016) argue that AI enables the automation of parts of the educational process through three models: pedagogical, epistemological and student's context, which the author concludes as fundamental models for the creation of adaptive tutors.

When talking about future competencies, "deep scientific" and "deep artistic" are two profiles marked by repetitive routines without making unprecedented and complex decisions. These form part of the group of occupations that will be redesigned. Some skills will likely be extinguished altogether, while others will undergo adaptations. The gains of technological implementation should be invested in people, and countries like the US already deal with populations without an occupation, but with income (using less economy).

As a response to this issue, online platforms, such as learning management systems, language mobile applications, adaptive tutors, among others are prevalent nowadays. They are capable of providing personalized benefits, and they put pressure on public services (Van-Dijck et al., 2018). Also, they affirm that platforms are neither neutral nor value-free constructs; they come with specific norms and values inscribed in their architectures. These values do not always reflect the cultural values where those platforms are operating such as privacy, accuracy, safety and consumer protection. Yet, other values such as fairness, equality, solidarity, accountability, transparency, and democratic control are relevant in public discussions. After all, platforms are not always mere reflections of the social; they can create it too. Platform-based societies have social and economic traffic increasingly channeled by a global online

platform ecosystem that is driven by algorithms and fueled by data. Further evidence is how the number of mobile devices (8.3 billion) (ITU 2020) has outstripped global population (7.8 billion) (UN, 2020). However, according to the ITU study, approximately 87% of the population in developed countries have internet access while just 47% in developing countries share the same privilege (ITU, 2020). The explosion of mobile applications (colloquially "apps"), together with increases in global internet access and mobile devices to access these platforms, characterizes the questionable concept of technological ubiquity we inhabit.

2.1. 21st century competencies: Mixed methods to apply and evaluate them

The platform society has the potential to demand new competencies from citizens, which brings the discussion to 21st century competencies. It is necessary to clarify concepts such as competence, capacity, capability, ability and skill, considering that these words are generally used interchangeably. Some definitions from Oxford English Dictionary can help to address this task:

- Ability: The fact that somebody/something is able to do something.
- Capability: The ability or qualities necessary to do something
- Competence: The ability to do something well.
- Knowledge: The information, understanding and skills that you gain through education or experience.
- Literacy: The ability to creatively and culturally read and write on any surface.
- According to this dictionary, ability, capacity and capability are synonyms, as well as skill and competence.
- The O'Net database defines the terms as follows.
- Ability: enduring attributes of the individual that influence performance (cognitive, physical, psychomotor and sensory abilities).
- Skills: developed capacities that facilitate learning or the more rapid acquisition of knowledge (complex problem solving, resource management, social, system and technical skills).

According to Zabala and Arnau (2015), competence is defined as the capacity or ability (which means having the cognitive structure) to perform tasks and engage in diverse situations such as the ones from political, social and cultural life, in an effective and conscious way and adapted to a certain context. It is necessary to mobilize attitudes, skills and knowledge orchestrating and interrelating them. Similarly, the OECD (Rychen & Salganik, 2003) defined competence as the ability to successfully meet complex demands in a particular context through the mobilization of knowledge, skills, attitudes, and values. In this case, values were added as a new element to the construct. In this article, we will use the umbrella concept of competence from the OECD, in which skills will be considered a subset of competence. Ability, capability and capacity will be considered synonyms exactly as defined by the OECD.

The emergence of proposing frameworks for 21st century education structures a globalized and technologically driven mindset in the information age. For instance, Fadel and Groff (2019) proposed the four-dimensional education model in which knowledge, skills, character, and meta-learning competencies are dimensions that need to be explored to successfully redesign a curriculum. The traditional mindset of thinking and designing a curriculum is centered on knowledge transfer. Wilson (1999) points out that humankind is drowning in information while starving for wisdom. The world henceforth will be run by synthesizers. These are people who are able to put together the right information at the right time, think critically about it, and make important choices wisely. Next, we will present three methodological cohorts that can help explain the interface between Big Data, AI and Education: research, application and assessment.

2.2. Research, application and assessment

Experiments in education necessarily entail the systematic study of particular forms of learning. This context undergoes research, test and revision; and in this research, we offer netnography as a research method, followed by three examples of application that may be seen by the methods Competency Based Education (CBE), the Four-dimensional Model and the OECD Compass Model.

2.2.1. Research: Netnography

a) Netnography

In netnography, methodological strategies for understanding the communicational behavior of stakeholders can be set out in two ways: first, inspired by the classics of traditional ethnography such as Bronislaw Malinowski (1922) and Mead (1979); and second, considering the innovative and still recent netnographic thinking - based on Kozinets' (2014; 2015) research principles. To describe the presence of emerging 21st century competencies of the participating population, Kozinets (2014) sought to conduct field research in the ever-decreasing contrast between what can be called street school experiences (traditional and institutionalized).

Due to the diversity of approaches and theoretical affiliations that dialogue between perspectives better linked to marketing or anthropology, netnography emerges as a necessary concept. According to Kozinets (2014) the scientific body of 21st century communication has indeed given way to a neologism, which cannot be used as an obstacle to the use of the term, nor can it determine the end or total reinvention of traditional ethnography. The author's argument explains that neologisms are part of the cyclic evolutions of science and concepts, as instruments of discourse that serve to explain observed realities and undergo transformations. Reassuring the reader, therefore, about the various nomenclatures that the method has assumed, Kozinets (2014) refers to seminal studies from the turn of the century that began the research of mapping and describing communicational behaviors in cyberspace.

Hine (1994) proposed an alignment of different terminologies such as: netnography, virtual ethnography, webnography, cyberanthropology and digital ethnography. Despite the occasional indiscriminate use of juxta position, researchers must pay careful attention to maintaining the original conception behind the netnographic method. Assuming that the term virtual ethnography was appropriate for the initial phase of the internet, Hine (1994) questioned whether to apply the concept of ethnography exclusively, given the recurring claims of the process of overcoming the dichotomy between online and offline experiences.

In terms of procedure, netnography drives the researcher to understand the kind of stakeholders who are engaged in network and platforms and how they behave with knowledge production dynamics. AI can be applied on two levels: to disseminate the educational experience; and to personalize the learning experience. AI collects data cohorts that, once synthetized, may mirror the user's preferences, strengths and weaknesses.

2.2.2. Application: Competency-based education model, four-dimensional model, and compass model

b) Competency based education model

Gervais (2016) provides, based on a systematic review, the definition of competency based education (CBE), which is an outcome-based approach to education that incorporates modes of instructional delivery and assessment efforts designed to evaluate mastery of learning by students through their demonstration of the knowledge, attitudes, values, skills, and behaviors required for the degree sought.

The history of CBE dates to 1862 with the Morrill Land-Acts in the United States which "provided the basis for an applied education oriented to the needs of farm and towns people who could not attend the more exclusive and prestigious universities and colleges of the eastern United States" (Clark, 1976). According to Clark, higher education degrees, before the industrial revolution, were for the privileged classes preparing students to be thinkers, not doers. The CBE foundation advocated that education needed to focus on preparing a student for their role in society (Riesman, 1979).

c) Four-dimensional model

In Fadel and Groff's (2019) understanding, in many curricula the knowledge dimension has a central focus characterized by a lack of real-world relevance, resulting in low engagement and low student motivation. Clearly, it is still important to learn mathematics and language, but they insist this must be integrated within larger individual competencies in an interdisciplinary way, emphasizing topics such as robotics, bio systems, social systems, wellness, entrepreneurship and media. In this model, the skill dimension is mainly seen as the compendium of higher-order skills such as what Fadel and Groff term the "Four C's": communication, collaboration, critical thinking and creativity.

Considering the ethical dimension, it is noteworthy that there are ethical implications to most of the global challenges we face today such as climate change, corruption, terrorism and income inequality. The main six elements of the ethical dimension from this model are mindfulness, curiosity, courage, resilience, ethics and leadership. The last dimension is meta-learning, understood as "learning how to learn"—specifically how to reflect on and adapt our learning composed by mindset growth and metacognition. Meta-learning, when effectively implemented enables knowledge, skills, and character competencies to be transferable across multiple disciplines, which is the ultimate goal of all education.

d) OECD Compass model

The OECD Compass model (OECD, 2020) uses the metaphor of a learning compass composed of seven elements: core foundations, transformative competencies, students' agency and co-agency as well as an anticipation-action-reflection cycle. Core foundations are treated as a new way of including the curriculum in an educational model by relating it with knowledge, skills, attitudes and values. This new curriculum also includes subjects such as digital literacy, physical and mental health, and social and emotional skills. Transformative competencies involve creating new values, reconciling tensions and dilemmas and taking responsibility. Finally, the anticipation-action-reflection cycle, according to this model is an iterative learning process whereby learners continuously improve their thinking and act intentionally and responsibly in the interest of collective well-being.

2.2.3. Assessment: Multimodality

e) Multimodality

According to Nigay and Coutaz (1993) a multimodatily system is defined as one that supports communication with the user through different modalities or "modes" such as video, voice, text and gestures. "Multi" means more than one and "modalities" or "modes" refer to the communication channels. This possibility is especially important for educational platforms where there is a lack of understanding of the underlying processes and the majority of theories are imported from social sciences and psychology. Educational platforms are constantly processing multimodal inputs and outputs, for example: text (self-reports), voice (think aloud), video, biological measurements (such as eye tracking, facial expressions) to understand affection states; clickstream or trace data to track user behavior and navigation. Qualitative and quantitative methods of analysis can be applied to narrow multimodal data into information that can help effective decision making. Multimodality is the foundation of the new discipline learning analytics by providing educators and other education stakeholders with analysis and indicators that help them control educational processes and their outcomes.

3. Discussion

First, it is important to emphasize the difference between multimedia and multimodality. Both systems use multiple communication channels. A multimodal system is able to automatically model informational content at a high level of abstraction, striving for meaning. In education, multimodal EdTech (educational technology) is an emergent area of study. With the so-called Internet of Things, wearable sensors, cloud data storage, increased computational power for processing and analyzing Big Data sets, sensors can be used to gather high-frequency and fine-grained measurements of micro-level behavioral events. For example, micro-levels can be movement, speech, body language, or physiological responses, providing a panacea of data, able to mitigate the streetlight effect.

A complex educational setting requires sophisticated levels of measurement and for that, mixed methods of application and assessment are accurate and suitable to deal with this prospect. Complexity here is supported by Edgar Morin (2015), and his formulation of Complexity as a new way of thinking about relations in an environment that is no longer systemic and unifying. It introduces three principles (dialogic, organizational and hologrammatic) to think about a network as a complex structure instead of a systemic overview. The network becomes informational architecture, still playing its material role (in reference to Habermas' work on communication materiality).

This subtle materiality provides methods from knowledge fields, which can be seen as a benefit of working in a transdisciplinary area. However, that scenario requires researchers and stakeholders to pay

more attention to what technologies are, how they are defined and how they can be applied- while avoiding superficial approaches in education. When compiled, the three axes (research, application and assessment) in education can thrive with a digital endeavor in terms of time and quality. However, contextualization of research is recommended since the experience of AI or Big Data communities can be diverse. This is why netnography is considered as the first group of procedures since it empowers the educator to understand their target behaviors regarding digital technology. Application can vary through models, and the model used is relevant according to the netnographic study. Multimodality concludes this process by providing a tranche of aspects that can be considered evidence to assess the impact of an education through platform.

4. Final considerations

Applications of technology in education can have a close relationship to pedagogical models, such as technology as a means of information storage and exchange. The discussion surrounding digital culture and contemporary technologies in education has different perspectives. Here, three dimensions have been explored including the challenges in research, application and evaluation of platform proposals. To illustrate these perceptions and to support reflections of this ongoing digital transformation, studies introduce techniques such as learning analytics (data mining in educational environments) and AI applications as examples of new methods incorporated into the education field.

Since Alan Turing's Imitation Game and the early stages of AI, techniques in data management software processing, indexing and analysis have evolved at different rates. In public security, for example, the use of facial recognition technology and surveillance with Big Data regulations (e.g. GDPR). In education, on the other hand, ethical arguments raise issues about the significant contributions made by technological developments. Whether in public safety, education or elsewhere, the digital shift opens paradoxical issues insofar as these dilemmas still need reasoning, investment and professional qualifications to be considered culturally present. Despite the volume of references required, this research uses both multimodality and netnography to approach the impacts both AI and Big Data on education. The methodological cohort combines variations in theory and in practice.

Designing a research experiment or a platform is a praxis to manage data shortcuts and data representativeness. When analyzing incomplete datasets or complex constructs (such as competencies), especially those which have missing data (e.g., due to hardware failures), the information overlap across multiple modalities (triangulation of data) is convenient as it allows their overall meaning to be preserved (Bosch et al., 2015). Cukurova et al. (2019) made it evident when, in their study with AI to analyze human decision making, they compared unimodal and multimodal approaches to observe students' sensitive data as eye movement tracks and body postures.

In sum, data triangulation, in the context of multimodality approach, has the ability complement analysis in two different ways: when data faces incompleteness to analyze a construct, and when partial data forces one to make inferences from other data parcels. For example, it is possible to analyze anxiety with educational technology among students by using very different sources of data, from neuronal activity measurements and heart rate, to questionnaires. The data triangulation process offers a reliable and secure method that makes it possible to infer evidence based on conclusions drawn.

This paper attempted to offer both settings: a deep understanding of technology in its correlation to education and an exploration of methods used to research, apply and assess those features. There is an apparent turning point in the theoretical background of education that no longer considers only human factors (educators and students) but introduces a cartography of new stakeholders who embrace transdisciplinary concepts and technical entities. The challenge of pursuing research within this field comes from aligning academic elaborations with a pragmatic context: empowering citizens to understand the implications of what appears to be a new possibility for knowledge philosophy. Perhaps the age of platforms will bring a new paradigm or perhaps not; we shall see.

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The role of supporting technologies in a mixed methods research design

El rol de las tecnologías de apoyo en un diseño de investigación de métodos mixtos

Francesca-M. Dagnino, Researcher, Institute for Educational Technologies, National Research Council, Genova (Italy) (dagnino@itd.cnr.it) (https://orcid.org/0000-0002-2416-702X)
Dr. Yannis Dimitriadis, Full Professor of Telematics Engineering, Department of Telematics Engineering, University of Valladolid, Valladolid (Spain) (yannis@tel.uva.es) (https://orcid.org/0000-0001-7275-2242)
Dr. Francesca Pozzi, Researcher, Institute for Educational Technologies, National Research Council, Genova (Italy) (pozzi@itd.cnr.it) (https://orcid.org/0000-0002-3592-2131)
Dr. Bartolomé Rubia-Avi, Professor, Department of Pedagogy, University of Valladolid, Valladolid (Spain) (brubia@pdg.uva.es) (https://orcid.org/0000-0002-4963-4552)
Dr. Juan-I. Asensio-Pérez, Full Professor, Department of Telematics Engineering, University of Valladolid, Valladolid (Spain) (juaase@tel.uva.es) (https://orcid.org/0000-0002-1114-2819)

ABSTRACT

Nowadays, technologies play a key role in educational research processes, especially in the context of complex designs or integrative perspectives (qualitative and quantitative). Affordances provided by new tools and technological devices are constantly impacting the way educational research is carried out. Consequently, this growing importance (and dependence on) technology for educational research calls for a deeper reflection, not only about its clear benefits, but also about its potential drawbacks and limitations. This paper explores this tension in a specific mixed-methods research design aimed at understanding the barriers preventing the adoption of Learning Design (LD) tools/methods, a significant problem in the research field of Technology Enhanced Learning (TEL). Different actors (teachers and researchers) were involved in the research design, which included a systematic literature review, a Delphi study and a case study. Such an articulated design required the adoption of technologies to support the process in all its phases. The paper describes the main methodological implications of the employed technologies in the research. The conclusions of the paper highlight that while technologies definitely support a higher level of complexity and articulation of the research design, they might also lead to superficial or biased results.

RESUMEN

En la actualidad las tecnologías desempeñan un papel fundamental en los procesos de investigación educativa, especialmente cuando se realizan diseños complejos o desde perspectivas integradoras (Cuantitativas y Cualitativas). Las facilidades ofrecidas por nuevas herramientas y dispositivos tecnológicos influyen constantemente en la forma en que se lleva a cabo la investigación educativa. Por consiguiente, esta creciente importancia de la tecnología para la investigación educativa exige una reflexión más profunda, no sólo sobre sus evidentes beneficios, sino también sobre sus posibles inconvenientes y limitaciones. En este artículo se explora esa tensión en un diseño de investigación desde una estrategia mixta centrada en la identificación y comprensión de las barreras que impiden la adopción de herramientas/métodos de Diseño de Aprendizaje, un problema importante en el campo del aprendizaje mejorado por tecnología (Technology Enhanced Learning). Diferentes actores (profesores e investigadores) han participado en el diseño de la investigación, que incluye una revisión sistemática de la literatura, un estudio Delphi y un estudio de caso, generando un diseño muy articulado con tecnologías para cada fase. En el documento se describen las principales repercusiones metodológicas de las tecnologías empleadas en la investigación. Las conclusiones del documento ponen de relieve que, si bien las tecnologías apoyan en gran medida un nivel alto de complejidad y ayudan a articular el propio diseño, también pueden dar lugar a resultados superficiales o sesgados.

KEYWORDS | PALABRAS CLAVE

Mixed-methods, e-research, technologies, learning design, educational research, case study, literature review, Delphi study.

Métodos mixtos, e-investigación, tecnologías, diseño de aprendizaje, investigación educativa, estudio de casos, revisión de literatura, estudio Delphi.

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1. Introduction

Technology-Enhanced Learning (TEL) is the research field that aims at "improving the quality and outcomes of learning, in all those varied circumstances where technology plays a significant supportive role" (Goodyear & Retalis, 2010: 7). The TEL research field is intrinsically interdisciplinary, nurtured by different technological and socio-cultural scientific areas (Balacheff et al., 2009).

Research in TEL covers a wide range of educational technologies, learning theories and pedagogical approaches, that address the needs of different educational stakeholders (students, teachers, institutions, policy makers, etc.), thus giving birth to multiple research sub-fields: Computer-supported collaborative learning, mobile learning, Ubiquitous Learning, Learning Analytics, among others (Duval et al., 2017; Rubia-Avi & Guitert-Catasús, 2014). As a consequence of this interdisciplinarity and wide scope, radically different research worldviews and methodological approaches can be found in TEL research works. However, and in most cases, research data in TEL not only includes ethnographic observations, increasingly coming from digital sources, but also data coming from the supporting technologies that are the focus of TEL interventions.

This complexity in the data gathering and analysis techniques in TEL research is alleviated by the use of technological tools. The technological support for TEL research not only refers to increasingly powerful and open software packages for statistical analysis, but also to tools specifically aimed at qualitative analysis (Duca & Metzler, 2019; Hai-Jew, 2015). The role of technological support for TEL research becomes even more relevant in the case of mixed-methods research designs (Greene, 2007).

In such designs, TEL researchers need to incorporate analysis techniques that enable the effective and efficient triangulation of data coming from both qualitative and quantitative sources. In many cases, such analysis techniques would not be feasible without the support provided by technological tools (Hesse-Biber & Griffin, 2013; Hai-Jew, 2015).

However, this increasing reliance on technological tools for research calls for a deeper reflection on how research processes in TEL, and especially those based on mixed methods designs, are being influenced by the choice and particular usage of these technological aids. Therefore, this paper explores the above-mentioned concerns by addressing the following research question: What are the advantages, disadvantages, and limitations of employing research-supporting technologies in a complex mixed-methods TEL research?

In order to answer the above-mentioned research question, the paper explores a particular long term mixed-methods TEL research design, in which the authors are currently involved. This research design aims at understanding the adoption (or lack thereof) of changes in teaching practice implied by the so-called Learning Design (LD). The LD research community focuses on the development of tools and methods aimed at supporting teachers in designing educational interventions with technology (Lockyer et al., 2009; Persico, et al., 2013). Although LD research is at the core of TEL, the adoption of LD tools and methods by teachers is still very limited and remains a research challenge (Mor et al., 2013; Hernández-Leo et al., 2018). However, research on LD adoption tends to be limited in short term studies and is mainly focused on single tool evaluations, where the issue of adoption is not thoroughly explored (Dagnino et al., 2018).

Understanding the adoption of the changes (or lack thereof) in teaching practice implied by LD goes beyond the analysis of a specific type of technological tool, as in (Katsamani & Retalis, 2013). LD adoption deeply affects the very role of teachers (Laurillard, 2012) in the complex path towards Information and Communications Technologies (ICT) integration in teaching practice which requires, among other factors: understanding and overcoming contextual, cognitive, and affective obstacles faced by teachers (Ertmer & Ottenbreit-Leftwich, 2013), and adapting Teacher Professional Development (TPD) approaches (Asensio-Pérez et al., 2017) to LD principles.

Exploring and understanding these context-dependent factors calls for an interpretive research stance (Orlikowski & Baroudi, 1991) that can be adequately supported by a mixed-methods research design following an explanatory strategy (Creswell, 2014). Indeed, mixed-methods research designs have previously been employed in other similar research projects aimed at understanding teachers' decisions to adopt new technologies (Sugar et al., 2004), or in the research track of ICT and Education in the 2020 international symposium of mixed methods on social research and education (https://bit.ly/3fDbtSf). This

is the reason why the authors believe that a mixed-methods research design on this topic is a good example for exploring the role of research-supporting technologies. The research design carried out by the authors addresses two categories of stakeholders (teachers and experts in the field) and makes use of different research methods, namely: Systematic Literature Review, Case Study and Delphi Study.

The paper presents the methodological decisions made by the authors in the explored research design and focuses on the role played by supporting technologies in the associated research process, without depending on a single theoretical framework for the study. From the beginning of the research design it was clear that the authors would need to address a considerable amount of data, and to approach different stakeholders. For these reasons, technologies were extensively used in order to support the various phases of this research, as it will be illustrated in the paper.

Given the research question of this paper, it should be made clear that we do not aim at presenting here the results of the specific mixed-methods research, but rather we will reflect on the implications of using technologies in the overall research design. In the following section we present the research design, as well as the technologies that were employed to support this research process. Then, lessons learned regarding the role of research-supporting technologies are discussed, concluding with reflections for those researchers who need to implement mixed-methods designs supported by technologies.

2. Mixed-methods research design and supporting technologies

As explained in the introduction, the authors are involved in a research process aimed at understanding the adoption of the changes (or lack thereof) in teaching practice implied by LD. Thus, the authors are progressing along a mixed-methods research design, making intensive use of supporting technologies for research data gathering and analysis. The following subsections introduce the main characteristics of the ongoing research design, highlighting how research supporting tools were employed. This section sets the foundation and context for the discussion that is presented in the third section.

2.1. The overall research design

The issue of LD methods and tools adoption is complex and multifaceted, while research in the field often remains parcelled. The literature reports attempt to understand the factors limiting the adoption that remain very focused on single methods and tools and take into account teachers' specific experiences or expert opinions (Neumann et al., 2010).

Asensio-Pérez et al. (2017), in an effort to outline factors affecting adoption, identify three main points for analysis: 1) Characteristics of LD tools, e.g., tools should be flexible, support all the phases of the design process and support teachers as members of designer communities (Hernández-Leo et al., 2013); 2) Teachers' mindset (Dimitriadis & Goodyear, 2013), in the sense that teachers should be equipped with an LD mindset adequate to their contexts; 3) Adequate training (Bennett et al., 2017), referring to the need for an appropriate training to make teachers drivers of innovation.

This initial analysis, conducted by the authors at the beginning of the research project, highlighted the need to involve actors belonging to different categories (researchers and teachers) and called for a comprehensive approach aimed at integrating results. Moreover, it was evident for the authors that different kinds of data could probably enrich the comprehension of the phenomenon: if a systematic analysis of the literature could provide with an initial framework, the in-depth analysis of a real case study could represent a useful source for exploring the issue, from both quantitative and qualitative viewpoints.

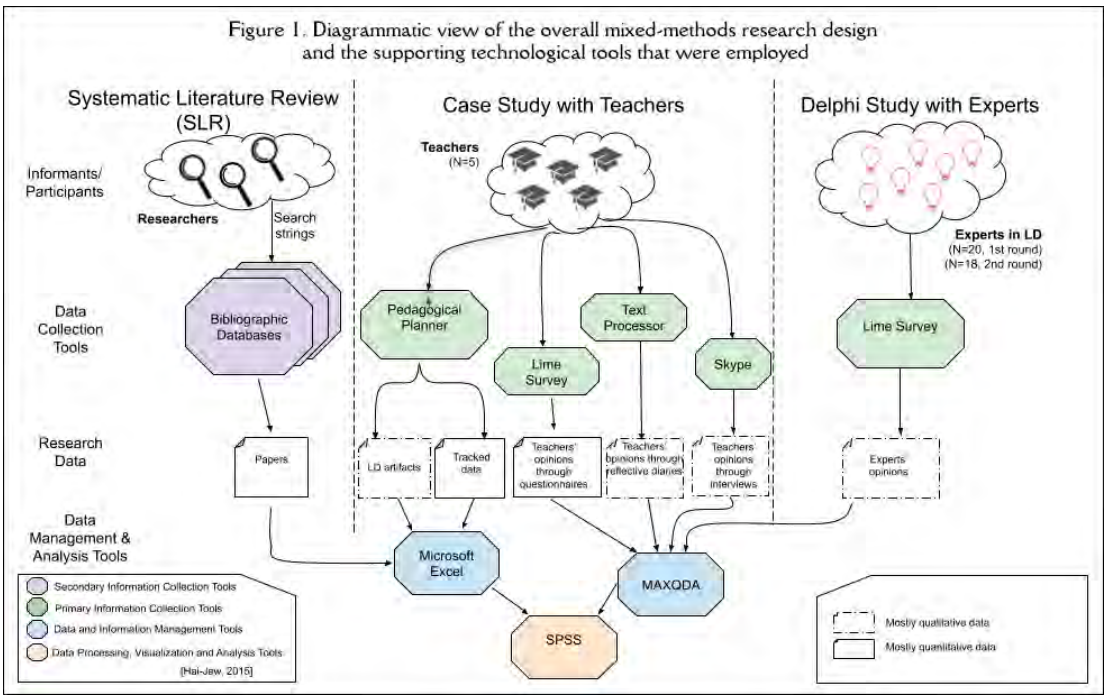
Finally, directly involving experts in a Delphi study might complement the findings, providing both quantitative ratings and possibly explanatory qualitative views.

The above-mentioned considerations led the authors to design a mixed-methods research. Figure 1 provides an overview of the research design.

The diagram shows the three main methods adopted (SRL, Case Study and Delphi Study), the stakeholders/participants involved at each step (researchers, teachers, and experts, respectively), as well as the research data. Moreover, the diagram shows the technological tools used for data collection, management, processing, analysis and visualization. In particular, we borrowed a classification of possible research supporting technologies by Hai-Jew (2015), who distinguishes among:

- Technological tools for secondary information collection, as (in our case) online bibliographic databases for literature reviews.
- Technological tools for primary information collection. These can be different in nature, but in our case, we used: tools for the delivery of online questionnaires (Limesurvey (https://bit.ly/3bn8MRp)), video-conferencing systems (Microsoft Skype (https://bit.ly/2WkimjA)) to manage online interviews, text processors for writing diaries, and TEL systems (in our case it was an LD system, called the Pedagogical Planner, PP (Bottino et al., 2011; Pozzi et al., 2020)) to track participants' actions and store participants' artefacts (in our case learning designs).
- Technological tools for data management. In our case we used Microsoft Excel (https://bit.ly/2yE8DvL) and MAXQDA (https://bit.ly/2WKQeFs).
- Technological tools for data processing, visualization and analysis. In our case, it was mainly SPSS (https://ibm.co/2WlQs6L).

Figure 1. Diagrammatic view of the overall mixed-methods research design and the supporting technological tools that were employed

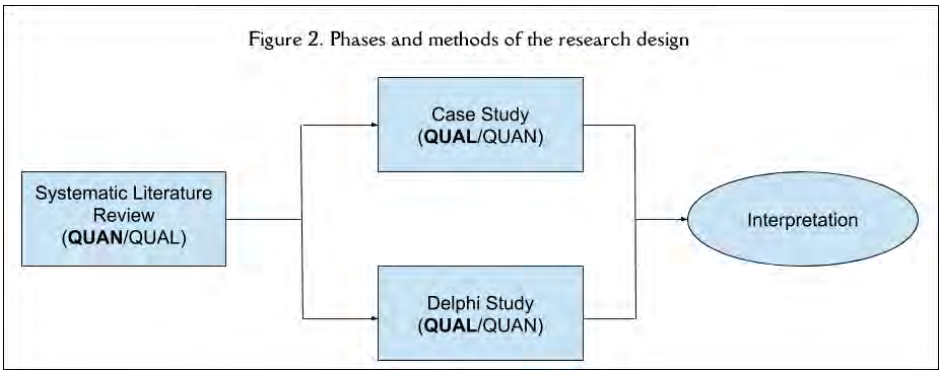


Overall, the authors adopted a design that may be mostly understood as an "explanatory sequential design", according to Creswell (2014), in which qualitative methods aim to elaborate on quantitative results obtained in an initial phase. In other words, the 'explanatory sequential design' envisages a 'quantitative-qualitative-interpretation' sequence.

As shown in Figure 2, the authors followed the sequence as they adopted a quantitative research method first (the Systematic Literature Review) and then proceeded with two more qualitative methods, i.e., the Case Study and the Delphi Study.

Nonetheless, the authors partially deviated from the original model, as they actually implemented methods that were inherently mixed, i.e., the Systematic Literature Review was mostly quantitative but also contained qualitative aspects, and the Case Study, as well as the Delphi Study, were mostly qualitative but with some quantitative components, as it will be further described.

Probably, this research design might also have been classified as an "embedded design", but an "explanatory sequential design" category fits better, since the overall research was oriented to detect generalisable teachers' needs and barriers to LD adoption. Hereunder, a more in-depth description of each one of the methods is provided.



2.1.1. The Systematic Literature Review (SLR)

The review was carried out in 2017 in accordance with the guidelines proposed by Kitchenham and Charters (2007) for SLR, and covered all the phases: planning, conducting and reporting. As suggested, the authors established a review protocol including: the research questions driving the SLR; the search strategy for retrieving primary studies (including search strings and databases to be searched); the study selection criteria (inclusion and exclusion criteria) and the related procedures; the data extraction and synthesis procedure. The search was carried out in five academic databases frequently used by the TEL community (ACM digital library, IEEE Xplore, Scopus, SpringerLink, Web of Science). 2,408 records were initially retrieved, including journal and conference papers, and book chapters.

A first selection round was carried out by reading title and abstract, checking the relevance of the contribution to the topics explored and the inclusion criteria. 26 papers out of 423 passed this round and were selected. These works were read, and 20 papers finally met the inclusion criteria. These works were analysed following both inductive and deductive strategies. Papers were read and tagged: some key themes were already acknowledged and discussed in the literature (e.g., the issue of flexibility of tools in relation to educational contexts of learning theories) and were used to set up pre-existing categories for tagging. Others (e.g., teachers' motivation) emerged from the analysis and were added to the list of themes. The review provided a systematic overview of the knowledge developed in the LD field, focusing especially on a) teachers' needs for LD tools; b) main barriers to the adoption of LD tools and design practices. The results of the complete SLR are available in (Dagnino et al., 2018). These results informed subsequent phases of the research design.

2.1.2. The case study

The authors, as part of the overall research design, set up and carried out a single instrumental case study (Stake, 2005) aimed at getting a deeper understanding of the barriers for LD methods and tools adoption, that were identified during the SLR, based on the opinions and visions of in-service teachers. This specific Case Study was chosen on a 'convenience' basis, since the involved school asked for training on TEL to some of the authors. The context was a Vocational Training School for bakers and graphic designers which is located close to Milan (Italy). The school is small, with eight groups of students (one for each year of the two areas of study: bakery and graphics). The teaching staff is composed of trainers and professionals (in charge of teaching the subjects that are specific for the professions), tutors and support teachers (helping students with cognitive disabilities and special needs). Trainers have different backgrounds: some of them are just working professionals without teaching training, while others have a background in education or pedagogy. Such heterogeneity was acknowledged by the Principal, who contacted the authors asking for specific training. Teachers were enrolled in a training course in TEL, that started in spring 2017 and was carried out till September 2019. LD was one of the topics taught during the first sessions of the training (May-June 2017). Participants received lessons about theoretical foundations of LD and had also the possibility to use a particular LD tool (the Pedagogical Planner). There was a follow-up and recap in November 2017 and, afterwards, teachers were involved in a design task assignment that they carried out between December 2017 and February 2018.

Since the training covered three school years, the cohort of involved teachers partially changed. The initial cohort of teachers was composed of 12 teachers, among which only five teachers followed the whole training; one additional teacher was included in November 2017.

According to Stake (2005), in order to reach a comprehensive understanding of a phenomenon in real life, researchers should collect and analyse varied sources of data, so to obtain multiple perspectives. Therefore, in this study teachers' use of the proposed LD tool and their opinions were monitored through: questionnaires to teachers (at the beginning, middle and at the end of the training); data tracked by the Pedagogical Planner during usage, as well as artefacts produced by teachers and stored by the tool during the learning design process; reflective diaries, written by teachers during the learning design process; and, interviews to teachers, close to the end of the training.

2.1.3. The Delphi Study

The Delphi Study is a group technique designed to obtain "the most reliable consensus of opinion of a group of experts" (Dalkey & Helmer, 1963:1). The authors carried out a Delphi Study, as part of their research design on LD adoption, with the goal of getting a reliable opinion from a panel of experts (Landeta, 2006) in the field of LD research. The authors' ultimate motivation was confirming/rejecting the findings obtained during the SLR and Case Study phases of the research design in relation with the barriers for LD adoption.

In a Delphi Study, experts are usually consulted individually and separately several times. The answers are analysed by the study proponents and feedback regarding the position of the whole group is returned to the participants, so they can reconsider their initial opinion in view of the results from the previous iterations. If the first round is usually exploratory and based on open questions, the questions of the final rounds are formulated to carry out a statistical analysis of the results at group level.

The Delphi Study carried out by the authors involved two rounds. Due to the availability of the results of the SLR (see subsection 2.1.1) the authors got in advance a clear literature base from which they developed the questionnaire for the first round. In the second round, the experts were contacted again to answer the same questions in the light of the feedback regarding the position of the group during the first round. Questionnaires included both closed and open-ended questions. Experts were required to: 1) Express their opinion about the relative importance of three categories of factors (teachers' needs, extrinsic and intrinsic barriers) with respect to the adoption of LD tools and methods; 2) Express their opinion about the extent to which specific needs and barriers affect the adoption of LD tools and methods.

In the second round, experts were additionally asked to propose possible solutions for overcoming the identified barriers.

The experts involved were recognized LD researchers, who had authored publications in peer-reviewed journals on the topic and who were active in the LD community through participation in conferences and expert networks. The experts were mainly researchers working in European institutions with backgrounds in education, engineering, computer science or both: 25 experts were involved in the first round (20 filled in the questionnaire); 20 experts participated in the second round (18 filled in the questionnaire).

2.2. Use of supporting technologies along the research design

As Hesse-Biber and Griffin (2013) highlighted, technologies may bring considerable advantages to mixed-methods research. They can be used in various phases and with different purposes, ranging from statistical processing in quantitative methods, to transcription and coding in qualitative methods; their potential can be exploited in terms of communication, as well as data interpretation, just to mention a few. Thus, technology was extensively adopted in this research and used in the different steps.

Regarding the Systematic Literature Review, academic databases represented the "secondary information collection tools" (Hai-Jew, 2015), while data management occurred through Excel, that was used for analysing abstracts and titles, thus supporting the selection process to reduce the numbers of the relevant papers. The software was chosen because the authors involved in the SRL had not a strong technological background; they were already familiar with Excel and thus they judged it sufficiently easy to use, but able

at the same time to manage the initial big amount of literature. Regarding the Case Study and the Delphi Study, in terms of "primary information collection tools" (Hai-Jew, 2015), an online system for delivering questionnaires (Limesurvey) was used. This was chosen, because it is featured with an easy and user-friendly interface both from the administrators' and the participants' side. In the context of the Case Study, the proposed tool for LD, the Pedagogical Planner, was also used for the primary data collection. It is a scalable cross-browser web-based application developed in PHP, MySQL, and javascript; the database module of the tool tracks the interaction logs and stores the artefacts produced by teachers.

To manage the data tracked and stored by the Pedagogical Planner, Excel was again used, as it allowed an easy way to handle the data, through data filtering and queries. Moreover, the interviews to the teachers involved in the Case Study were carried out online, by means of Skype calls. The software in this case was chosen because teachers who were to be interviewed said they were familiar with it. During the calls, the authors shared the screen with the interviewee, thus showing from time to time selected keywords (presented in slides) that had the objective of introducing the various topics covered and of triggering the discussion about key issues. In terms of technological tools to manage data, in this case the transcriptions of the interviews were tagged by two independent coders using MAXQDA, a software that allowed the analysis of different kinds of data (such as texts, images audio/video files, etc.) and triangulation of data coming from different sources. The same software was also used to manage other qualitative data coming from the teachers' reflective diaries, as well as from the open-ended questions both in the teachers' questionnaires and in the Delphi Study.

Finally, the main technological tool adopted for data processing, analysis and visualisation was SPSS, that was especially used in this research to carry out descriptive and inferential statistical analysis.

3. Results and discussion

The use of technologies to support the study had an impact both at the level of single methods and on the whole process. In the following section we present the main lessons learnt and organize them according to the Hai-Jew's classification (2015) of the technological tools, so that we can reflect on the main implications of technology through technology.

In terms of tools for "secondary data collection", in our SRL, technologies undoubtedly allowed for richer and more reliable results, since the authors were able to search exactly what they were interested in within a mass amount of literature stored in online databases; additionally, the literature of interest was in almost all cases directly accessible. Searching freely through a browser provided a big amount of papers and also grey literature (like project reports), whose existence might have remained hidden and that might be difficult to retrieve differently.

On the other hand, the authors had to face the challenge of managing the big amount of data returned by the databases; this brings us to another category of tools in the Hai-Jew's classification (2015), i.e., technologies for data management. As already mentioned, in our research we have often relied on Excel for this phase, which usually has turned out to be easy to use. Nonetheless, as far as the SRL was concerned, we need to say some technical capabilities were required to automatically merge the datasets (which was done through a software script). Thus, in this particular case, data management required the authors to ask for technical support from other colleagues, who were not originally included in the team. The other software used for data management and processing was MAXQDA. As a matter of fact, as Fielding (2012) underlined, software tools like MAXQDA enable the integration of qualitative data with quantitative data, matching, for example, the interview analysis with information from rating scales or survey responses. In other terms, these kinds of software allow to build a bridge between the qualitative and the quantitative dimensions, support comparisons of different data sets, thus paving the way for data triangulation and ultimately providing insights for new research directions. In our research, this tool was used to manage the data coming from the questionnaires, interviews and the reflective diaries of the teachers of the case study, as well as the data coming from the Delphi Study. The software also sped up the coding process, since two coders were able to tag text and had their codes recorded. Consequently, MAXQDA can be considered a technology in between the two categories of "data management" and "data processing, visualization and analysis". Moreover, even if it is not as common as Excel, still, it combines

good usability features with quite advanced data processing features. In terms of "primary data collection tools", as we mentioned above, we used different technologies.

Let's start with Limesurvey, which was used to collect data from teachers in the Case Study and from the experts during the Delphi. Especially during the Delphi, the software turned out to be very useful, as it helped manage some aspects that are usually considered time consuming in these kinds of studies, such as, managing communications with the panellists, administering multiple survey rounds, and then gathering and organizing participants' responses. In our case, Limesurvey relieved the authors from tasks like sending invitations and questionnaires or registering the answers in a database. As Cole et al. (2013) highlighted, the e-Delphi is also effective and efficient in overcoming geographical barriers, saving time and money, as this was also true in our experience.

Other aspects coming from the online nature of the study were the perception of anonymity, as Limesurvey automatically assigned a code to participants, and the accuracy of data collection, that were registered directly by the system (Roztocki, 2001). On the other hand, the online Delphi Study wasn't free of challenges. The email sent from the system was sometimes blocked by the SPAM functionalities of the recipients' mail providers and in any case risked being disregarded more than a personal invitation. These automatic features created quite 'impersonal' interactions between panellists and authors. Even more importantly, we cannot exclude that some Hawthorne effect occurred: the open-ended answers provided in Limesurvey by the panellists were often very short and sometimes difficult to interpret. The impersonality of the situation might have affected participants' contribution. This particular aspect would deserve further research in the future, since, to the best of our knowledge, very limited attention has been paid so far to the way participants' change their behaviours when observation and data collection happens through technology. Finally, some issues were also raised by respondents regarding Limesurvey at technical level, like the impossibility to modify previously answered questions.

Another tool used for primary data collection was Skype. In this case, the authors took advantage of a type of technology that provided a synchronous communication channel for the interviews with teachers in the Case Study. In this case, one of the main advantages was the possibility to organize the calls at the interviewees' convenience, while the authors did not need to travel to reach the teachers' workplace. Moreover, thanks to the use of a videoconferencing system the authors were able to show visual prompts and to collect non-verbal indexes, even though the medium might alter perceptions. Additionally, the possibility to watch the interview records several times, allowed an in-depth analysis. On rare occasions, technical problems (mainly due to the low quality of Internet connection) were annoying.

The last employed primary data collection tool was the Pedagogical Planner, used by teachers to make their learning design during the case study. This gives us the opportunity to make a general reflection about the role of technology in the research field itself, i.e., Technology Enhanced Learning (TEL). Since the learning design was performed through the Pedagogical Planner tool (which is itself digital), such use of technology allowed the authors to collect and observe concrete artefacts produced by the teachers, and thus analyse the decisions taken during the design process. Had not the technology been available, only paper-based artefacts would have been produced and the authors would have been able to analyse only the final result of the process. Instead, in this case, it was possible to observe also half-baked artefacts, thus allowing a more in-depth understanding of the overall teachers' design process. This is true for any process in the TEL research field, where usually digital platforms (like for example Learning Management Systems) can provide learning analytics, thus shedding light on the students' learning process.

To conclude, we would like to propose some more transversal reflections about methodological decisions taken in the overall research design. Firstly, the possibility to carry out an SLR as a first step of the research, had a considerable impact on the whole research process, since it provided a reliable starting point that allowed to skip a preliminary phase of barriers' identification that otherwise should have been carried out by interviewing teachers directly, possibly with an already existing experience in LD. Clearly, this represented a methodological decision that sped up the process but, at the same time, influenced, and maybe 'biased', the progression of the research. Moreover, the teachers involved in the case study were quite a small sample with a varied experience in LD. This might have affected and biased some of the results. However, having integrated both the SLR and the Case Study in the same research, and then

having also enriched the findings with the Delphi Study by looking for confirmation/rejection of the initial results, the authors could find a balance and overcome the limits of one single method.

4. Conclusions

The use of technologies in the presented mixed-methods research design implicated several advantages, some of them already pointed out by Hesse-Biber and Griffin (2013) or Hai-Jew (2015). Overall, the support of technologies affected the research in terms of complexity and articulation: the affordances of technologies and their capabilities to manage big amounts of data made it possible to include several methods along multiple iterations in a relatively small research project, something that was almost impossible in previous 'traditional' research. The decision in itself to adopt a mixed-methods overall approach, where also the single methods are innerly mixed, was possible mostly because nowadays technologies allow to manage quantitative and qualitative data in a relatively easy and fast way, to reach different and distant stakeholders, and to easily integrate data coming from different sources (Fielding, 2012).

On the other hand, there are serious implications for research and the related results. First, online research implies a lack of a direct relationship with participants that often generates low participation rates or inaccurate responses. Moreover, online surveys often limit the possibility of participants to ask clarifications about questions, thus increasing the risk of misunderstandings and biased responses (Roztocki, 2001). Therefore, researchers should find the right balance between automation and relation with participants. This element shouldn't be overlooked during the design phase of research projects and in any case the results should always be analysed taking these elements into the due considerations.

Another element is that the complexity of technology-supported research continuously calls for a redefinition of the researcher's required competencies, both at a methodological and technological level. As Hesse-Biber and Griffin (2013: 3) highlighted: "Accessing new modes of data collection may challenge a researcher to come out of his or her methods 'comfort zone' and to develop new skills in both data collection and analysis". Being competent about all the possible methods, along with the related technological tools, is almost impossible for one single researcher and would instead call for research projects conducted by multi-disciplinary teams. Obviously, this is not always possible, often due to funding restrictions. Moreover, unfortunately in many contexts this is also prevented by a competitive view of research, where researchers' evaluation rewards individual endeavour more than group work. The result can be that a very complex research, if conducted by a single researcher instead of a team, can contain methodological or technology driven mistakes that might seriously affect the results.

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Online parental mediation strategies in family contexts of Spain

Estrategias online de mediación parental en contextos familiares de España

Dr. Gemma Martínez, Associate Researcher and PhD, Department of Social Communication, University of the Basque Country, Biscay (Spain) (gemma.martinez@ehu.eus) (https://orcid.org/0000-0001-6463-4238)
Dr. Miguel-Ángel Casado, Associate Professor, Department of Audiovisual Communication and Advertising, University of the Basque Country, Biscay (Spain) (miguelangel.casado@ehu.eus) (https://orcid.org/0000-0003-1264-9336)
Dr. Carmelo Garitaonandia Full Professor of Journalism, Department of Journalism, University of the Basque Country, Biscay (Spain) (carmelo.garitaonandia@ehu.eus) (https://orcid.org/0000-0003-1662-4566)

ABSTRACT

This article explores online parental mediation strategies in Spain and their association with sociodemographic and family context factors. The results of a survey conducted at the end of 2018 are presented herein, based on a sample of 2,900 Spanish minors between 9 and 17 years of age who use Internet. The impact of the diverse parental mediation strategies applied to Internet use has been calculated by taking into account the sociodemographic factors of the participating minors (age and gender). Association analysis was performed using the SPSS statistical analysis programme. In this case, an extra analysis was carried out with regard to the relationship of influence between different strategies and the rules of behaviour and family support in the household context as perceived by the minor. Findings suggest that enabling and restrictive mediation strategies are very common in Spanish families, while technical mediation strategies have a very limited presence. It is noteworthy that restrictions and security strategies generally apply more to girls than to boys. Household rules related to the behaviour of minors have a positive correlation with an increase of influence of nearly all strategies. However, there is no relevant association between family support perceived by children and restrictive strategies and techniques applied by parents.

RESUMEN

Este artículo explora las estrategias de mediación parental online en España y cómo los factores sociodemográficos y del contexto familiar se asocian con ellas. Se presentan los resultados de una encuesta realizada a una muestra de 2.900 menores españoles usuarios de Internet, entre 9 y 17 años encuestados a finales del año 2018. La incidencia de las diferentes estrategias de mediación parental en el uso de Internet se ha calculado atendiendo a factores sociodemográficas de los menores (edad y sexo). Mediante un análisis de asociación realizado con el programa de análisis estadístico SPSS se explora también la relación de la incidencia de las diferentes estrategias con las reglas de comportamiento y el apoyo familiar en el contexto del hogar percibidas por el menor. Las estrategias de mediación habilitantes y restrictivas tienen una presencia importante en las familias españolas, mientras que las técnicas tienen una presencia muy limitada. Es remarcable que las restricciones y las estrategias de seguridad, generalmente se aplican más a las niñas que a los niños. Las reglas del hogar relacionadas con el comportamiento de los menores se correlacionan positivamente con el aumento de incidencia de casi todas las estrategias, sin embargo, no existe una asociación significativa entre el apoyo familiar percibido por niños y niñas y las estrategias restrictivas y técnicas aplicadas por los padres y las madres.

KEYWORDS | PALABRAS CLAVE

Internet, mediation, strategies, behavior, family, children, parents, intervention.
Internet, mediación, estrategias, comportamiento, familia, menores, padres y madres, intervención.

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1. Introduction and state of the art

Internet, social networks and mobile devices are all part of the Internet of Things (Mascheroni & Holloway, 2019), and an integral part of children's daily lives. Children access the web autonomously in increasing numbers and they tend to identify more with their own peer group (Ito et al., 2010; Shin & Lwin, 2017; Vincent, 2015). Over the last decade, access and domestic use of the Internet and other digital communication technologies within Spanish families has varied significantly from the point of view of parental mediation (López-de-Ayala & Ponte, 2016; Ramos-Soler et al., 2018; Torrecillas-Lacave et al., 2017).

According to O'Neill (2014), the search for the "magic strategy" of parental mediation that allows the child to take maximum advantage of online opportunities, while avoiding harmful online risks is a "shared responsibility" of parents, teachers and other representatives responsible for formulating Internet policy or regulations. Such regulations must ensure a media environment that respects children's rights and is adapted to their needs and competencies, as well as to the values and priorities of their parents (Helsper et al., 2013; Mascheroni et al., 2016; Torrecillas et al., 2017).

The definition of "parental mediation" is subject to various interpretations, depending on the approach used for its research. Warren (2001: 212) defines it as "any strategy that parents use to control, supervise or interpret media content for both children and adolescents". Sasson and Mesch (2019) view parental mediation as the variations of the different interactions established between parents and children that revolve around the use and consumption of different media.

This paper considers the classification of Livingstone et al. (2017) as a reference, which is an evolution of previous models of mediation strategies (Livingstone et al., 2011) based on the standard classification of parental mediation of television use posed by Valkenburg et al. (1999). The proposal by Livingstone et al. (2017) groups the strategies into two macro-categories: enabling mediation and restrictive mediation and adds a new category that considers the child's agency as an active element in parental mediation on the Internet, which involves requesting help from parents and offering it as well.

On this basis, the present study is set forth with two differences. Firstly, the child's agency has not been analysed as a strategy in order to focus exclusively on the strategies initiated by parents. Secondly, technical mediation is analysed independently to obtain specific information on the use of technical strategies by families, a relevant aspect for promoting awareness campaigns (Ponte et al., 2019) with regard to Spain, where the level of influence of these strategies is very low (Martínez & Casado, 2018).

Another fundamental aspect in the latest work on online parental mediation is the child-centred approach (Clark, 2011; Lobe et al., 2008; Smahel & Wright, 2014), a perspective that gives high regard to the possibility of divergence between adults and children in relation to interests and concerns such as the autonomy of minors, privacy, their way of playing, and their right to self-expression (Shin & Lwin, 2017).

Based on this approach, this research aims to analyse the impact of mediation strategies (enabling, restrictive, and technical) by taking into account, on the one hand, the predictive factors such as age and gender of the child, and on the other hand, the establishment of factors of behavioural control and family support perceived by the child in the household context.

Previous results in Spain show that the demographic characteristics of Spanish children (gender and age) influence the way in which mediation takes place. With regard to gender, mediation has a higher level of influence on girls than on boys (Düerager & Livingstone, 2012; Livingstone et al., 2011; Garmendia, et al., 2016; Ramos-Soler et al., 2018; Smahel et al., 2020). This is due to the fact that parents worry more about girls, yet this can also be a "digital disadvantage" (Bartau-Rojas et al., 2020; Hasebrink et al., 2011). In terms of age, younger children experience more mediation than older children, as parents recognize differences in digital competency and resilience to risks, as well as the right to privacy and autonomy as age increases (López de Ayala et al., 2019, Martínez & Casado, 2018; Livingstone et al., 2017).

Relationship patterns between different household members can also influence parental mediation (Dedkova & Smahel, 2019; Eynon & Helsper, 2015; López de Ayala et al., 2019; Shin & Li, 2017). Several studies have observed a relationship between parenting styles -which include authoritarian, authoritative, permissive and laissez faire- from the dual perspective of control levels (or demand) and

involvement (warmth) (Baumrind, 1991), plus the types of strategies applied to online use (Livingstone et al., 2017; Valkenburg et al., 2013). Specifically, Eastin et al. (2006) and Valcke et al. (2010) demonstrate that authoritarian parents apply the most restrictive strategies on their children. In contrast, authoritative and permissive styles are associated with fewer restrictions and tend to combine more strategies, with a strong preference mainly for those that are active.

2. Materials and methods

The results of this work are based on a survey conducted in schools using a representative sample of 3,107 minors from 9 to 17 years of age. The age range was deliberately broad so as to allow for the observation of how parental mediation strategies are modified in families according to the degree of maturity of the children. In order to carry out the surveys, an interviewer was present in each classroom while the interviewees answered the questionnaire. To guarantee representativeness on a national level, the most populated Autonomous Regions were chosen as follows: Madrid, Catalonia, Andalusia, Valencia Region, Galicia, Basque Country, and Extremadura. Ten schools, either public or subsidised, were selected in each autonomous region except for Extremadura, where nine centres were chosen. The sample was also stratified by habitat: 80% of the schools were located in capital cities, and 20% were in smaller municipalities. School ownership was also considered, maintaining proportionality between the two predominant models in Spain: in Primary Education, 77.84% of the schools were public and 22.16% were subsidised, and in Secondary Education, 60.37% were public and 39.63% were subsidised. The fieldwork was carried out between October and November of 2018. In total, students from 138 classrooms were surveyed using two classes from different courses at each school. Finally, the surveys of minors who had not declared their gender and those who had not indicated their age, or who were more than 17 years of age, were taken out, reducing the final sample to 2,900 children. Just over half of the children surveyed (51%) were boys, and 49% were girls. The figure of 53% of the minors were aged 9-12, and 47% were aged 13-17. A total of 98% of the children lived with their mother, father, or both. The confidence level of the survey was 95.5% and the sampling error was ± 1.87%.

These results are part of a larger survey on children's relationship with the Internet that was carried out in 18 other European countries and was previously conducted within the international research project known as Global Kids Online.

The original survey underwent diverse cognitive tests in order to establish its validity. In an initial phase, 20 interviews (14 with children and 6 with parents) were conducted in England using the original English questionnaire. Once the necessary adjustments had been made, the questionnaires were translated into the languages of the different countries involved in the research, and four additional interviews were conducted with minors from different age groups to ensure that all of the issues raised were correctly understood. A pilot survey was carried out prior to the fieldwork in order to test all of the survey procedures. The questionnaire (2017-18) was revised by taking into account all technological advances and validated through previous tests with minors of different ages. The questionnaires used, as well as more complete information on their development, can be found at www.eukidsonline.net

Before carrying out the survey, the collaboration and approval of the school's administration was requested, and the parents' permission was obtained. The researcher informed the children about the objective and protocol of the study. They were informed that they had the right to refuse to participate or to withdraw at any time. Their anonymity was maintained throughout the process, and the questionnaire included the options of "I don't know", or "I prefer not to answer", in the event that a child felt uncomfortable with the questions asked. The data presented in this article have been obtained by using the SPSS programme, as well as by conducting variable association tests using chi-square non-parametric statistical analysis. In those cases, in which three variables were used, the analysis was carried out through the procedure of variable neutralisation.

The variables "support of the child in the home", and "rules of behaviour" of the child in the home, around which part of the analysis revolves, have been developed using the answers the children gave to different questions posed on the questionnaire. To assess whether the children felt supported in their homes, they were asked, "How true are the following statements about your home and family? 1) "When

I talk at home, someone listens to what I say"; 2) "My family really tries to help me"; and 3) "I feel safe at home".

For the purpose of this research, family support is considered to exist when the child answers true, or very true, to at least two of the three questions. Fully, 88.8% of the children answered affirmatively, compared to 11.2% who did not acknowledge any, or only one, of these kinds of support.

Similarly, when considering children who have rules of behaviour, the extent to which the following statements are true for the child is considered: 1) "My father/mother/caretaker appreciates my good behaviour", and 2) "My father/mother/caretaker establishes rules about what I can do". An answer is considered to be affirmative when the child says that both statements are true either always, or very frequently, which is 61.6% of the cases as opposed to 38.4%, who say that none, or only one, of the two statements is true.

3. Analysis and results

In general, the influence of enabling strategies -related to the positive use of the Internet and including forms of active mediation and online security- is higher than that of restrictive and technical mediation. The frequency of influence of all the strategies is higher for older minors.

3.1. Enabling mediation

In enabling mediation (Table 1), which involves primarily communicative strategies that promote or assist the online safety of the minor, two relevant aspects can be identified. Firstly, all strategies involve a significant association (though not in all age groups) between gender and the impact of mediation, except for the strategy described as, "they encourage me to discover things on the Internet", which despite not being widespread (approximately one in five minors), is more prevalent among boys than among girls. In the rest of the mediation strategies, there is a greater influence on girls than on boys, which is more accentuated in the 13-17 age group. In other words, in those strategies more directly linked to internet safety, girls receive more mediation, while boys are encouraged to "discover and learn new things on the internet" more often than girls.

Age is also shown to be a relevant factor in mediation. A decline in mediation among boys can be observed with a significant association with all strategies. Among girls, however, even though mediation strategies such as, "they talk to me about what I do on the Internet", and "they help me when something bothers me", decrease somewhat with age, this decline is not significant. These results suggest that for girls, the influence of these mediation strategies is higher and more sustained over time.

Table 1. Enabling mediation strategies by gender and age

Mediation strategy (frequently or very frequently)	Gender	Age (two groups)		Total	P (age)
		9-12	13-17		
They encourage me to discover things on the Internet (N=2,560)	Boy	25.6%	18.6%	21.9%	.002
	Girl	20.9%	16.2%	18.5%	.035
	Total	23.2%	17.5%	20.3%	.000
	P (gender)	.050	.268	.034	
They suggest ways for me to use the Internet more safely (N=2,554)	Boy	43.3%	32.5%	37.7%	.000
	Girl	54.9%	40.6%	47.7%	.000
	Total	49%	36.4%	42.6%	.000
	P (gender)	.000	.002	.000	
They talk to me about what I do on the Internet (N=2,547)	Boy	27.1%	18.2%	22.5%	.000
	Girl	31.6%	29.1%	30.3%	.332
	Total	29.3%	23.4%	26.3	.001
	P (gender)	.082	.000	.000	
They help me when something has bothered me (N=2,423)	Boy	42.1%	27.5%	34.5%	.000
	Girl	50.4%	46.0%	48.2%	.132
	Total	46.2%	36.3%	41.1%	.000
	P (gender)	.004	.000	.000	

With regard to the relationship between enabling mediation strategies and the presence of behavioural rules and family support in the home, Table 2 shows a significant association (.000 in all cases). The presence of both rules and family support is associated with a higher impact of all mediations. The

distribution of percentages also shows that in all cases in which the male or female child receives behavioural rules or family support, the influence of mediation is higher than in those households in which the child does not perceive the presence of such rules or support. For example, it can be pointed out that in those households where the child feels family support, 48.8% of the children are given suggestions on safe ways to use the Internet, while in those homes where the child does not feel that same support, the percentage drops to 28.6%. This is a notable difference, since the average influence of this mediation is 42.6%, as shown in Table 1. Similarly, in households where more rules of behaviour are detected, 55.1% of the children receive suggestions for safe ways to use the Internet, yet 30.6% do not receive such advice. This suggests consistency between online rules applied by parents and those established in the family context, as well as in the support offered to children. Children in households where they perceive that their parents talk more with them about what they do online and offer them advice on how to use the Internet, or encourage them to discover new things online, also feel that there are more rules of behaviour and family support. In any case, despite the presence of rules and family support perceived by the children, when this mediation is reduced, there is a very high percentage of children who do not experience enabling mediation strategies.

Table 2. Enabling mediation by household type

Mediation strategy (frequently or very frequently)		Rules of behaviour			Family support		
		No	Yes	p	No	Yes	p
They encourage me to discover things on the Internet (N=2,483)	%	13.5%	27.7%	.000	13.4%	23.4%	.000
	n	173	334		102	408	
They suggest ways for me to use the Internet more safely (N=2,476)	%	30.6%	55.1%	.000	28.6%	48.8%	.000
	n	388	666		217	853	
They talk to me about what I do on the Internet (N=2,469)	%	15.7%	37.6%	.000	16.8%	30.9%	.000
	n	199	452		127	537	
They help when something has bothered me (N=2,353)	%	29.6%	53.5%	.000	23.4%	49.2%	.000
	n	355	618		170	813	

3.2. Restrictive mediation

Restrictive mediation strategies show a similar pattern. As the age of the child increases, the prevalence of restrictions decreases, with a significant association (p .000) for both girls and boys. Table 3 shows that between the two age ranges, the number of children allowed to do these activities increases with age, and the percentage of restrictions decreases as well.

Table 3. Restrictive mediation strategies

Mediation strategy (frequently or very frequently)	Gender	Age (two groups)		Total	P(age)
		9-12	13-17		
My father/mother/caretaker allows me to use the camera on my mobile phone or computer at all times (N=2,423)	Boy	35.7%	58.0%	47.4%	.000
	Girl	27.4%	57.9%	42.9%	.000
	Total	31.5%	57.9%	45.2%	.000
	P(gender)	.002	.965	.025	
My father/mother/caretaker lets me download music or films at all times (N=2,516)	Boy	51.4%	77.6%	65.2%	.000*
	Girl	46.8%	78.6%	62.8%	.000*
	Total	49.1%	78.1%	64%	.000
	P(gender)	.109	.679	.217	
My father/mother/caretaker allows me to use social networks at all times (N=2,496)	Boy	35.9%	69.1%	53.3%	.000
	Girl	30.8%	68.0%	49.6%	.000
	Total	33.3%	68.5%	51.4%	.000
	P(gender)	.062	.669	.063	

As far as gender is concerned, although a significant association can only be found in the case of permission to use the camera among children between 9 and 12 years of age, remarkable differences do appear. In the 9 to 12-year age group, the percentage of boys allowed to carry out the different activities is higher than for girls, while in the 13 to 17 age group, these percentages are nearly equal. These results suggest that parents are developing a strategy that focuses more on protection for girls than for boys by

prohibiting them from engaging in activities that they believe may be potentially harmful to girls, especially at younger ages.

In Spanish households, where more rules exist, the percentage of children with permission to use these technologies is lower than in households with fewer rules, with a significant association in all cases except in the use of the mobile phone or computer camera. The average number of children with permission to use the camera on their mobile phone or computer is always 45.2%, yet, among those children with rules, this percentage drops to 42.6%, and among those who do not have rules, it rises to 48.1%. Among those with rules, 61.3% can download music or films, as compared to 67.5% among those without rules, with the average percentage of those with permission standing at 64%. Finally, 47.1% of those with rules can use social networks at all times; this percentage is lower than for those without rules, which is 57.1%. The average stands at 51.4% (Table 4).

However, in relation to the sense of family support, no significant relationship can be observed with the imposition of rules for the use of technologies. In all cases, there are very similar percentages among those children who answered affirmatively to questions related to family support and those who did not.

Table 4. Restrictive mediation by household type

Mediation strategy (frequently or very frequently)		Rules of behaviour			Family support		
		No	Yes	p	No	Yes	p
My father/mother/caretaker allows me to use the camera on my mobile phone or computer at all times (N=2,326)	%	48.1%	42.6%	.008	47.7%	44.7%	.177
	n	573	483		338	735	
My father/mother/caretaker lets me download music or films at all times (N=2,405)	%	67.8%	61.3%	.001	64.2%	64.7%	.818
	n	833	721		472	1.098	
My father/mother/caretaker allows me to use social networks at all times (N=2,386)	%	57.1%	47.1%	.000	53.6%	51.5%	.322
	n	697	549		390	869	

3.3. Technical mediation

Regarding the use of technical mediation strategies, there is no significant association in relation to gender, although a significant decrease does occur with age in both boys and girls with the use of "programs to control or block certain online content" and "programs to monitor content or applications". The only case in which this decline is not significant is in the use of technology "to track where the child is located" (Table 5).

Table 5. Technical mediation strategies

Mediation strategy (frequently or very frequently)	Gender	Age (two groups)		Total	P (age)
		9-12	13-17		
My father/mother/caretaker uses a programme to monitor or block certain online content (N=2,285)	Boy	18.3%	11.2%	14.5%	.001
	Girl	22.0%	11.3%	16.4%	.000
	Total	20.1%	11.3%	15.4%	.000
	P (gender)	.134	.968	.199	
My father/mother/caretaker uses some tracking programmes to monitor the content or apps I use (N=2,260)	Boy	16.1%	9.7%	12.6%	.001
	Girl	17.1%	9.9%	13.3%	.000
	Total	16.6%	9.8%	13%	.000
	P (gender)	.650	.911	.618	
My father/mother/caretaker uses technology to keep track of where I am (N=2,315)	Boy	16.7%	14.5%	15.5%	.304
	Girl	14.6%	11.7%	13.1%	.154
	Total	15.6%	13.2%	14.3%	.094
	P (gender)	.349	.150	.102	

The existence of rules in the home has a significant relationship with parents' use of tools to monitor what their children are doing on the Internet, or even the child's own activities beyond the Internet through the use of technology such as tracking applications to locate the child. Although the presence of these technical mediation strategies is not very high in Spain, in all cases they have a greater presence in households where there are more rules (Table 6).

The average percentage in the use of control or blocking programmes for certain online content is 15.4%. In households where children perceive more rules it reaches 18.9%, and then falls to 12.3% when

there are fewer rules. In the use of programmes or apps to monitor content, the average is 13%. In households with rules, the percentage rises to 15.9%, while in those with fewer rules it falls to 10.2%. Finally, tools to track location are used in 14.3% of households, a percentage that reaches 16.9% when there are more rules, and drops to 12.1% when there are fewer rules.

On the contrary, the variable of family support felt by the child is not significant in any case, and the percentages of the presence of these mediation strategies are very similar.

Table 6. Technical mediation by household type

Mediation strategy (frequently or very frequently)		Rules of behaviour			Family support		
		No	Yes	p	No	Yes	p
My father/mother/caretaker uses a programme to monitor or block certain online content (N=2,203)	%	12.3%	18.9%	.000	15.2%	15.4%	.893
	n	140	202		103	240	
My father/mother/caretaker uses some tracking programmes to monitor the content or apps I use (N=2,182)	%	10.2%	15.9%	.000	13.2%	13.1%	.931
	n	114	170		88	202	
My father/mother/caretaker uses technology to keep track of where I am (N=2,236)	%	12.1%	16.9%	.001	13.9%	14.3%	.799
	N	139	184		94	228	

4. Discusion and conclusions

In line with previous results for Spain (Bartau-Rojas et al., 2020; Garmendia et al., 2011; Garmendia et al. 2016; López de Ayala et al., 2019; Martínez, 2018; Martínez & Casado, 2018; Ramos-Soler et al., 2018), and as pointed out by Livingstone et al. (2017), in comparison with other European countries, Spanish parents prefer enabling mediation to restrictive or technical mediation.

Coinciding with previous evidence in the Spanish context, a higher incidence of mediation has been detected for girls than for boys (Bartau-Rojas et al., 2020; Martínez, 2018; Martínez & Casado, 2018), especially for restrictive and enabling strategies related to internet safety (Garmendia et al., 2016). This can be interpreted as increased parental concern for the online safety of their daughters, which may also imply a digital disadvantage for them. Moreover, this disadvantage has to be taken into account when designing inclusive digital educational policies. With increased age, the incidence of mediation strategies decreases (Dürager & Livingstone, 2012; Helsper et al., 2013; Sonck et al., 2013). This may be an indicator of greater respect for the privacy and autonomy of older children, and may also suggest that they are considered to be more digitally literate (López-de-Ayala et al., 2019; Ramos-Soler et al., 2018).

The results also show a link between contextual factors in the home and online mediation. If there are more rules in the home, the incidence of all of the strategies is higher. This indicates that those parents who exercise more control offline also do so in the online environment. Specifically, a significant difference has been found between all enabling strategies and households where the child perceives that there are more rules of behaviour and family support. These results, which are in line with the existing literature (Clark et al., 2011; Shin & Li, 2017; Shin & Lwin, 2017; Valcke et al., 2010; Valkenburg et al., 2013) are relevant in the Spanish context, due to the fact that the child's feeling of support in the home and his or her perception of the rules imposed is positively linked to those mediation strategies in which there is a communication relationship with the family and taking advantage of online opportunities.

The results for restrictive and technical strategies show a different trend. While restrictive and technical mediation is more related to rules in the home, there is no significant relationship between restrictive and technical mediation and the perception of family support. These results are not very encouraging for the Spanish context, because in addition to being detrimental to taking advantage of opportunities, restrictions are more often applied in households where the child feels a lack of family support. This demonstrates the importance of homes based on the concept of the democratic family and models of mediation by distance or deference, pointed out by López de Ayala et al. (2019), in which there is a supportive environment for the child together with control of his or her behaviour, as these aspects are related to a more positive online mediation that is better for the child. In the Spanish context, there is still a need for digital literacy initiatives aimed at parents and children that stress the importance of enabling

strategies (Helsper et al. ,2013; O'Neill, 2014), with special emphasis on girls (Bartau-Rojas et al., 2020; Smahel et al., 2020), thereby avoiding possible digital disadvantages.

It should be noted that the data presented in this paper are only from surveys of children, thus excluding parents, which is a limitation. Although some studies indicate that the answers given by parents may overestimate their real mediation activity in search of social acceptance (Rideout et al., 2010), studies of adolescents' point to an underestimation of the impact of mediation strategies for the purpose of demonstrating a higher degree of independence from their parents (Ergin & Kapci, 2019).

This research provides new evidence with regard to the family context and its influence on online mediation that shows the complexity of the mediation process, and points to the need for further study of the effectiveness of these strategies through multivariate analysis, focusing primarily on promoting opportunities for minors.

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Perceived sexualization in girls' fashion stylings: A Spain-China cross-cultural analysis

Sexualización percibida en los estilismos de moda de niñas: Un análisis transcultural en España-China

Dr. Mónica Díaz-Bustamante-Ventisca, Associate Professor, Business Organization and Marketing Department, Complutense University of Madrid, Madrid (Spain) (mdiaz-bu@ucm.es) (https://orcid.org/0000-0002-8256-0209)
Dr. Carmen Llovet-Rodríguez, Lecturer, School of Communication, International University of Catalonia, Barcelona (Spain) (mdcllovet@uic.es) (https://orcid.org/0000-0002-7743-9332)
Dr. María-José Narros-González, Professor, Business Organization and Marketing Department, Complutense University of Madrid, Madrid (Spain) (mjnarros@ucm.es) (https://orcid.org/0000-0003-1299-1561)

ABSTRACT

Many institutions, social and political groups are warning of the risks associated with the early sexualization of childhood. These agents appeal to the responsibility of the media to avoid creating content that may lead to childhood sexualization and that is easily accessible to all audiences. Responding to this demand and through a cross-cultural Spain-China approach, this work focuses on the analysis of the perception of girls' sexualization in the fashion stylings disseminated by the media. A survey of 750 Communication and Advertising university students in Spain (N=449) and in China (N=301) was carried out. Five latent sexualization factors identified confirm that perceived sexualization in girls' fashion styling is a multi-dimensional phenomenon that occurs from the combined use of multiple sexualizing attributes. The country of origin (Spain or China) has been associated with the perception of sexualization and the identified latent sexualizing factors. Finally, an explanatory and highly effective predictive model has been obtained for this type of childhood sexualization in terms of the factors and country of origin. Conclusions suggest that it is necessary to reinforce the training of communication professionals and minors to avoid creating images of sexualized girls through certain styling codes.

RESUMEN

Numerosas instituciones, grupos sociales y políticos están alertando de los riesgos asociados a la temprana sexualización de la infancia. Estos agentes apelan a la responsabilidad de los medios para evitar la creación de contenidos que puedan derivar en sexualización infantil y que son fácilmente accesibles para todos los públicos. Respondiendo a esta llamada y con un enfoque transcultural España-China, este trabajo se centra en analizar la percepción de sexualización de las niñas en los estilismos de moda difundidos desde los medios. Se ha realizado una encuesta a 750 estudiantes universitarios de Comunicación y Publicidad en España (N=449) y en China (N=301). Se han identificado cinco factores de sexualización latentes que confirman que la sexualización percibida en los estilismos de moda de niñas es un fenómeno multidimensional que se produce por el uso combinado de múltiples atributos sexualizantes. Se ha corroborado que el país de origen (España o China) se asocia con la percepción de sexualización y de los factores latentes sexualizantes identificados. Finalmente, se ha obtenido un modelo explicativo y de elevada eficacia predictiva de la percepción de este tipo de sexualización infantil en términos de los factores y del país de origen. Se concluye que es necesario reforzar la formación de los profesionales de la comunicación y de los menores para evitar la creación de imágenes de niñas sexualizadas a través de determinados códigos estilísticos.

KEYWORDS | PALABRAS CLAVE

Childhood, sexualization, cross-cultural study, media literacy, advertising, fashion, sexism, media convergence.
Infancia, sexualización, estudio transcultural, alfabetización mediática, publicidad, moda, sexismo, convergencia de medios.

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1. Introduction and state of the art

The sexualization of women and girls is a global problem (Barzoki et al., 2017) that must be explored from different approaches and in all its dimensions (American Psychological Association, 2007).

In Spain, the growing concern about the increase of early sexualization of children (The Family Watch, 2018) has led to the approval of Proposition of Law No. (PNL for its initials in Spanish) 161/002716 on the necessary advancement of measures to combat the hypersexualization of children (Congress of Representatives of Spain, 2018). This regulation urges the Government, in cooperation with the Autonomous Communities, NGOs and other agents involved, to "convey to advertising and communication companies in our country the need to produce advertising content that respects gender equality and to avoid all sexist advertising" (Spanish Congress, 2018: 57) and to "promote measures to raise public awareness of the risk of early sexualization in children" (2018: 58). Therefore, it is necessary to make future professionals in advertising and commercial communication aware of the risks associated with child sexualization, and to provide them with tools and training to avoid the creation and dissemination of images of sexualized minors.

1.1. Child sexualization, media and mobile devices

This paper identifies sexualization as the act of being sexualized or sexualizing oneself (self-sexualization) to reduce an individual's physical attractiveness to being sexy, valuing someone based solely on their sexual attractiveness, or treating someone as a sexual object rather than a person. It also focuses on the sexualization that occurs through the media and the fashion industry, affecting girls. In this context, child sexualization involves imposing adult sexualization on children from the media (Starr, 2015).

The sexualizing imaginary is present in the commercial communication of multiple sectors and is spread through various media (Gunter, 2014; Daniels & Zurbriggen, 2016). In this media environment, it has been shown that magazines publish images portraying sexualized women and girls more frequently than content depicting sexualized men or boys (APA, 2007). This can influence adolescent girls to choose sexualizing clothes, hairstyles and makeup, or to adopt early sexual behavior (McCall, 2012). In this sense, fashion and lifestyle magazines are archetypical in their dissemination of images of highly sexualized individuals who represent the prototype of the ideal man or woman (Gunter, 2014; Speno & Aubrey, 2017). However, today, content is no longer exclusive to certain media and platforms, since the Internet has enabled the same content to circulate through different media (Islas, 2009), while new technologies and advances in mobile devices have democratized access to such content (López-García et al., 2019) allowing audiences themselves to generate content and disseminate it with an unlimited reach (López-Cepeda et al., 2019). In fact, the growing and widespread use of mobile devices with Internet access by children and adolescents (Mascheroni & Ólafsson, 2016) from increasingly younger ages (Kabali et al., 2015) allows them to access all kinds of content and to create and disseminate their own (Eleá & Mikos, 2017). Therefore, in the field of media literacy, it is important to educate children in the responsible production of media messages (García-Ruiz et al., 2014).

1.2. Sexualizing attributes

Sexualizing attributes identified in the academic literature can be grouped into three categories: 1) Those related to people's dress codes and nudity; 2) Those related to the expressions and illustrations that sometimes appear alongside images of people or on the clothes they wear; 3) Those associated with people's gestures and postures. Hatton and Trautner (2011: 256) conducted a content analysis of 1,006 "Rolling Stone" magazine covers published between 1967 and 2009. They used a scale with 11 variables to measure the intensity of sexualization of individuals appearing on those covers. The results revealed that "74% of the women were hypersexualized, showing not just one or two signs of sexualization, but a multitude of them". Therefore, the authors speak of a cumulative effect of hypersexualization that occurs when multiple sexualizing attributes are combined: tight clothing, nudity, posture, erotically or sexually charged words, and objectifying imagery.

Smolak et al. (2014) concluded that sexualization among college youth is mainly related to clothing that highlights or reveals the body (tight pants or very short skirts and dresses) or emphasizes sexual areas of the

body (e.g., padding for male or female underwear). Also, women's self-sexualization (Blake et al., 2016: 483) is often associated, among other things, with the use of "extremely sexualized clothing (e.g. visible underwear as a fashion trend)". With regard to children, Bailey (2011) points out as sexualizing elements the same ones that sexualize adults and that are reproduced in children's fashion products (animal prints, deep necklines, high-heeled shoes, clothes with slogans or illustrations with erotic meaning, etc.) and in the postures and gestures adopted by minors in commercial photographs and in fashion styles. In that context, Graff et al. (2013) developed a scale to measure how clothing, footwear and hairstyle sexualized or highlighted childlike aspects in girls featured in magazines.

1.3. Negative effects of child sexualization, responsible advertising and cultural values

Numerous studies warn of the negative consequences that the sexualization of minors can have on their cognitive, psychological and social development. Exposure to sexualized images has been shown to decrease children's cognitive abilities and to promote self-objectification and loss of self-esteem (Barzoki et al., 2017). Self-sexualization among adolescent and pre-adolescent girls (who internalize the belief that it is important to be sexually attractive) has also been shown to decrease their academic performance and their motivation to achieve (McKenney & Bigler, 2016). Girls who appear sexualized in different settings have been found to be perceived as less competent, intelligent, capable, determined, athletic, nice or friendly (Jongenelis et al., 2016; Díaz-Bustamante & Llovet-Rodríguez, 2017). In this regard, several authors (Zotos & Tsichla, 2014; Gunter, 2014) have pointed out that advertising, especially in fashion magazines, promotes gender stereotypes that can be harmful to women and girls.

Faced with this situation, it is necessary to appeal to the social responsibility of the media, to avoid the dissemination of images that sexualize children, and to the responsibility of advertisers, in order to avoid the creation of these images that are harmful to minors. Proof of this is PNL 161/002716 (Congress of Representatives of Spain, 2018: 57) which, pointing to sexist advertising as one of the causes of child hypertextualization, urges the Government to "Develop a regulation code for sexist advertising which tackles, defines and allows a clear evaluation of gender bias in commercial communication... Working with self-regulatory bodies in order to implement, disseminate and enforce this code. To convey to advertising and communication companies in our country the need to produce advertising content that respects gender equality and to avoid all sexist advertising". In line with this PNL, this work can help communication professionals to identify the specific elements whose insertion in children's commercial creations can lead to child sexualization. However, the sexual imagery used in different countries varies according to the cultural values and social norms prevailing in them (Mueller, 2010). Indeed, Nelson and Paek (2005) conclude that the intensity of sexual content published by the same magazine in different countries differs, among other things, according to the sexual freedom prevailing in each country.

Thus, it seems logical to think that the perception of child sexualization also varies according to the cultural values of different countries. Precisely, the concept "transcultural" implies the existence of the same concept or phenomenon in different countries or cultures, which can be interpreted differently in each of them due to their intrinsic characteristics (Welsch, 1999). Therefore, Duffy (2014) points out the need to carry out transcultural studies in the field of social sciences, since the meanings given to the concepts studied scientifically differ across the different cultures.

In this sense, we find it interesting to compare the perceptions of some images developed in the context of Western culture and values and in accordance with Western stylistic, beauty and sexuality canons, in two very different cultural environments: Spain (integrated into Western culture itself) and China (integrated into Eastern cultures). The differences between both environments are remarkable and diverse. Li (2019) points out that individualism prevails in the West while collectivism reigns in China. Sanz-Pérez and Rosso (2016) stress that creativity, in the West, is focused on innovation and breaking with tradition, while in the Chinese model it is seen as a way of imitating nature and contributing to social progress. Yaqing (2012) stresses that, in the West, the analysis of social reality is based on rationalism, while in China it is based on Confucianism. With regard to women's equality in society, data on the gender gap index place Spain in position 29 worldwide and China in position 103 (World Economic Forum, 2018). Therefore, with a cross-cultural Spain-China approach, the general objective of this work

is to analyze the perception of girls' sexualization in fashion styles disseminated by the media. This main objective is divided into the following specific objectives: 1) To identify the latent sexualization factors in the fashion styles of girls disseminated through the media; 2) To analyze if there are differences between Spain and China regarding the perception of girls' sexualization and the latent factors that sexualize them in fashion stylings; 3) To develop an explanatory and predictive model of the perception of girls' sexualization in fashion stylings from the latent sexualization factors found in them and from the audience's country of origin (Spain or China).

2. Methodology

The research carried out follows a descriptive and causal approach, based on a non-experimental cross-sectional analytical design.

2.1. Participants

An Internet survey was administered to 750 Communication and Advertising university students in Spain (N=449) and in China (N=301). The sample of students in Spain was comprised of 61.7% women and 38.3% men, with an average age of 22 years (SD=1.5 years). The sample of students in China consists of 69.4% women and 30.6% men, with an average age of 22 years (SD=1.7 years). Quota sampling was conducted with students of two of the authors: one, a university professor in Madrid teaching various degrees related to Communication and Advertising; the other, a two-year university professor in Beijing teaching in the "Bachelor of Arts in Advertising and Public Relations" ("New York Institute of Technology-Beijing Campus").

The distribution of the sample by country has considered that the proportion of university students (Ministry of Science, Innovation and Universities of the Spanish Government, 2017-2018) in the population residing in Spain (National Institute of Statistics, 2018) is 40% higher than that of China (National Bureau of Statistics of China, 2018). The gender distribution was established on the basis of the available data on students of Advertising and Marketing in Spain (as no gender-based data on university students are available in China). According to these data, 63.1% of Advertising and Marketing students in Spain, in the period 2017-18, were women, and the remaining 36.9% were men (Ministry of Science, Innovation and Universities of the Spanish Government, 2017-18).

2.2. Instruments

A structured "ad hoc" questionnaire was used to obtain information on the personal characteristics of the respondents (gender, age and country of origin), the perceived sexualization of girls in fashion magazine styles and the perceived sexualizing power of the attributes in these images. Four images of girls' stylings (all under 12 years old, three with Western features and one with Eastern features) published in fashion magazines were chosen to illustrate different levels of sexualization (from very high to very low) according to the number of sexualizing attributes appearing in them. The attributes considered for these were those identified and validated by Hatton and Trautner (2011), Graff et al. (2013) and Smolak et al. (2014). The first image selected was published in the "Cadeaux" editorial of "Vogue Paris" no. 913 (Bellver, 2011), described in academic literature as a "paradigm of highly sexualized girls" (Gunter, 2014: 86; Moloney & Pelehach, 2013: 123), which generated a strong debate in public opinion around the world for showing hypersexualized girls (Bellver, 2011), with wide online dissemination of the image selected in this study. This image shows a girl with 18 of the sexualizing attributes considered in the study.

Subsequently, images showing girls with fewer sexualizing attributes were sought to illustrate proportionally lower levels of sexualization: with 12, 6, and less than 6 sexualizing attributes. Thus, the second and third images, published in "Telva Niños" No. 17 (Telva, 2014), each show a girl with 12 and 6 sexualizing attributes respectively. The fourth image chosen, published in "Hola Especial Niños" n. 3,658 (Hola, 2014), shows a girl with four sexualizing attributes. Once the four chosen images were shown, the participants were asked about the perceived sexualization (1=None, 2=Slight, 3=Moderate and 4=High) in each of them. To measure the perceived sexualizing power of the elements or attributes exhibited by girls in the stylings of fashion magazines, a scale with 35 items was used (α by Cronbach =0.95) whose sexualizing power was also measured with the scale: 1=None, 2=Slight, 3=Moderate

and 4=High. The scale's items are also based on the sexualizing attributes used by Hatton and Trautner (2011), Graff et al. (2013) and Smolak et al. (2014). Before administering the survey via the Internet, the questionnaire was given to a small group of students (15 in Spain and 15 in China) to verify the correct understanding of the questionnaire and its items.

2.3. Procedure

In the participant selection process, each individual (identified by their ID card or passport number) was asked for express authorization to participate in the study and to receive the link to the survey website by e-mail. They also provided their authorized e-mail address and their data concerning their university studies, gender and age. After compiling the list of participants, the link to the survey website was sent to each participant's authorized e-mail address.

2.4. Data analysis

The statistical analysis of the data was carried out with the SPSS v25 program. Starting from the basic univariate and bivariate descriptive statistics, other more complex inferential and multivariate statistical analyses were performed. Thus, the following techniques were applied, which will be detailed in the results section: principal component analysis, analysis of variance (ANOVA), Mann-Whitney U test, Chi-square test, discriminant analysis and Huberty test.

3. Results

This section presents the findings obtained from the specific objectives set out in this study.

3.1. Latent sexualization factors in girls' fashion styles reported in the media

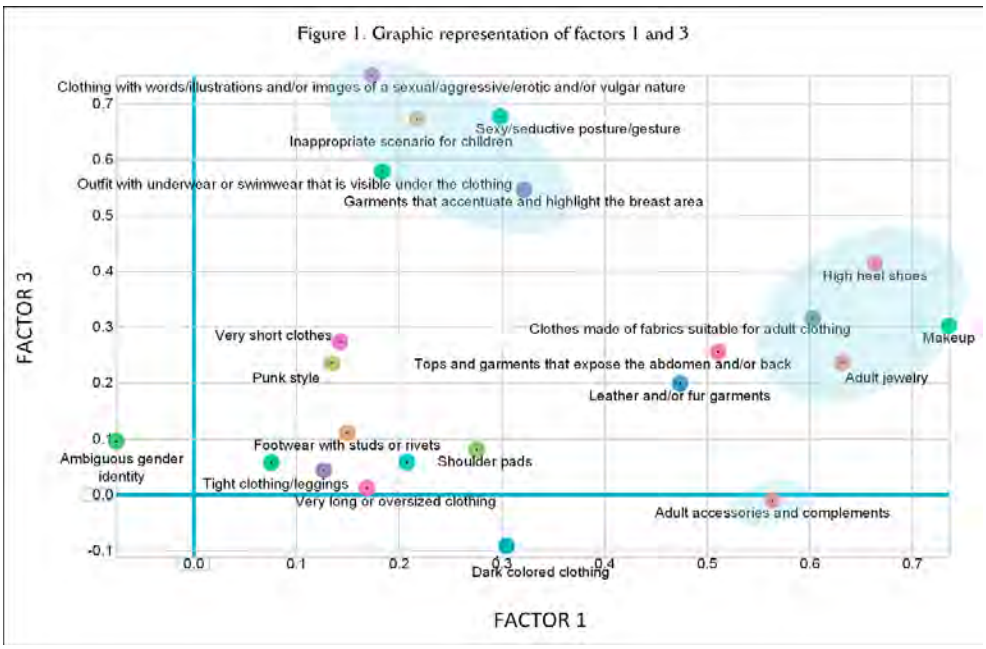
To identify latent sexualization factors from the 35 originally tested attributes displayed by girls in fashion styles, a Varimax Rotation Principal Component Analysis was performed. In this analysis, those attributes that showed, after extraction, values lower than 0.4 in the matrix of communalities and significant factor loads in several components were removed from the initial scale. Table 1 shows that the 22 final sexualizing attributes selected are reduced to five clearly defined latent factors of similar importance, which together explain 61.98% of the total variance contained in the original data.

Table 1. Latent factors that sexualize girls in fashion stylings

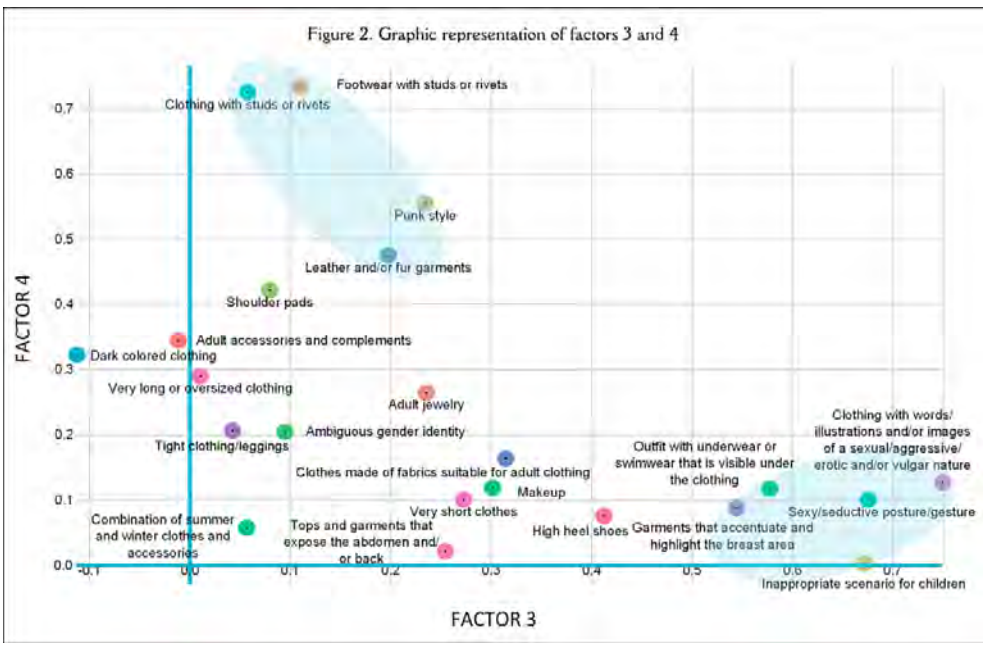
Factor	Factor interpretation	% of variance explained total	Sexualizing attributes that are included in every factor
F1	Eroticizing accessories	14.43%	Makeup
			High heel shoes
			Adult jewelry (e.g. long necklaces, chokers, oversized earrings...)
			Clothes made of fabrics suitable for adult clothing (e.g. lingerie, silk, velvet...)
			Adult accessories and complements (belts, handbags, glasses)
F2	Adult clothing	14.03%	Combination of summer and winter clothes and accessories
			Ambiguous gender identity
			Very long or oversized clothing
			Dark colored clothing (black, grey...)
			Shoulder pads
F3	Sexual symbolism	12.74%	Clothing with words/illustrations and/or images of a sexual/aggressive/erotic and/or vulgar nature
			Sexy/seductive posture/gesture
			Inappropriate scenario for children (creepy, gruesome... e.g. a girl in a public men's room)
			Outfit with underwear or swimwear that is visible under the clothing
			Garments that accentuate and highlight the breast area
F4	Punk Styling	10.62%	Footwear with studs or rivets
			Clothing with studs or rivets
			Punk style
			Leather and/or fur garments (e.g. black or red leather)
F5	Body exposure	10.13%	Very short clothes (skirts, dresses, shorts...)
			Tight clothing, "leggings"
			Tops and garments that expose the abdomen and/or back

Note. Factor Extraction Method: Principal Component Analysis Rotation Method: Varimax with Kaiser standardization. The rotation converged in 12 iterations. Barlett's sphericity test = 7081.27, p= 0.000. Kaiser-Meyer-Olkin Index =0.948.

Factor 1 (F1), called "Eroticizing accessories" (Table 1; Figure 1), is defined mainly by the attributes related to the accessories usually worn by adult women to increase their erotic attractiveness or power of attraction through them.

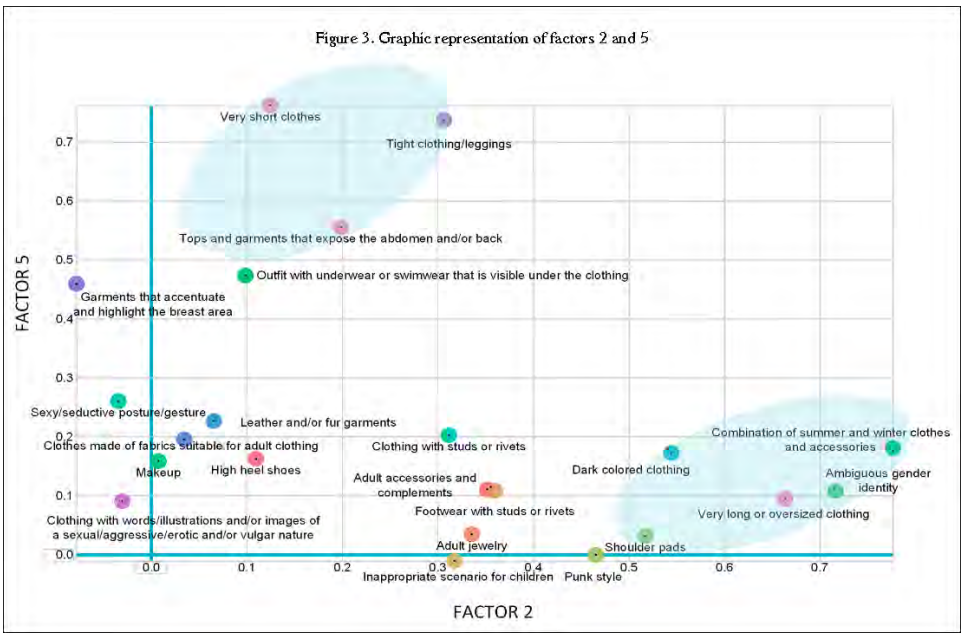


Factor 2 (F2), called "Adult clothing" (Table 1; Figure 3), is defined mainly by attributes related to stylistic codes worn by adults, but without any erotic connotation.



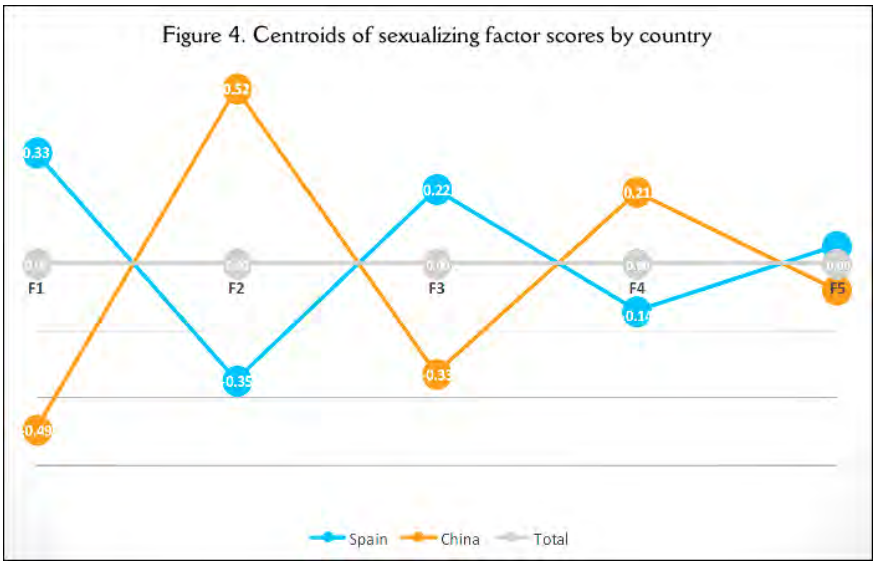
Factor 3 (F3), called "Sexual Symbolism" (Table 1; Figure 2), is defined by attributes related to clothing that highlights the breasts and environmental elements, postures, words or illustrations with sexual meanings. Factor 4 (F4), called "Punk Styling" (Table 1; Figure 2), is defined by attributes related to punk style clothing and accessories.

Factor 5 (F5), called "Body exposure" (Table 1; Figure 3), is defined by attributes associated with the display of naked body parts or garments that highlight body shapes.



3.2. Differences between Spain and China in the perception of girls' sexualization and sexualizing factors

After extracting the perceived latent sexualization factors, the authors compared whether there were statistically significant differences in them according to the respondents' country of origin (China or Spain).



As the factorial scores for the five factors are used as the starting point, the homogeneity of the variance of each factor in the comparison groups has been checked (test required in the parametric contrasts). The analysis of variance (ANOVA) was then performed, verifying the absence of heteroscedasticity and calculating the contrast statistic F. In the case of non-homogeneous variances, nonparametric contrast testing was performed with the Mann-Whitney U test. Figure 4 illustrates the existence of significant

differences in the perceived sexualization factors according to the country of origin of those studied. The Spanish subjects considered factors 1, 3 and 5 to be more sexual, while the Chinese subjects opted for factors 2 "Adult Clothing" and 4 "Punk Styling". Although the differences in factor 5 "Body exposure" are not statistically significant, they are close to it ($p=0.000$ in all the statistical tests performed for the different factors except for factor 5 with $p=0.058$).

With regard to the perceived sexualization in the images tested, the results obtained show that Image 1 - published in the "Cadeaux" editorial of "Vogue Paris" no. 913 (Bellver, 2011) - is considered as being sexualized by the majority of those surveyed (59.7%) as opposed to images 2, 3 and 4 which they are only perceived as being sexualized by 12.7%, 8.7% and 8.3% respectively.

Thus, focusing the analysis on Image 1, we observe that the perception of sexualization for this image differs significantly between Chinese and Spanish subjects (Chi-Square=13.137; $p=0.000$), in such a way that the sexualized perception is associated with Spanish nationality, and the absence of sexualized perception is associated with Chinese nationality.

3.3. Explanatory and predictive model of girls' perception of sexualization in fashion stylings

In order to provide a model to explain and predict the perception of girls' sexualization in fashion stylings from the identified sexualization factors and the audience's country of origin, a discriminating analysis has been conducted using the stepwise method. The results of this analysis show, for the joint model of both countries, the following significant discriminant function (Chi-Square=191.133; $p=0.000$) with Wilks' Lambda=0.723:

Perceived sexualization=2.061-1.419 Country of origin+0.454 F1+0.406 F3+0.366 F5+0.203 F2

The study of the standardized coefficients reveals that the most important independent variable for predicting the perception of sexualization is the audience's country of origin, followed by the factors 1) "Eroticizing accessories"; 3) "Sexual symbolism"; 5) "Body exposure"; 2) "Adult clothing", respectively.

Most of the independent variables (with positive signs) are positively associated with the perception of the image tested as sexualized. The only variable with a negative sign is the audience's country of origin, which means that the Chinese origin of participants predicts less perceived sexualization.

Finally, to validate the previous model, the sample has been divided into two groups: training sample (595 cases; 79.3% of the total) and test sample (155 cases; 20.7% of the total), in both, the selection of the individuals was performed through a random procedure. In addition, the cross-validation method was used, leaving one case out of the training sample.

The overall classification results obtained in the training sample are 73.1% of correctly classified cases. By groups, for the training sample that enabled the generation of the model, the percentage of accuracy for the group of individuals who perceive sexualization is 72.3%. In the cross-validation model, the overall percentage of accuracy is 72.3%, and for the group of subjects who have perceived sexualization, 72% is correctly predicted. Finally, in the test sample (155 cases; 20.7% of the total), more satisfactory results were obtained, with 83.9% overall hits and 87.6% hits for the group of subjects who perceived sexualization. In all cases, it was found that the overall percentage of hits was statistically significant and higher than the classification expected solely by chance (Huberty test; $Z>1.96$, $p=0.005$), which suggests that the model has a high level of predictive effectiveness (Huberty, 1984).

4. Discussion and conclusions

In terms of the first objective, this study found five latent factors of girls' sexualization in fashion styles published in magazines. Thus, it has been proven, for the first time, that this type of sexualization is not only related to revealing girls' bodies or to the make-up, clothes and accessories they wear, as other authors have already pointed out (Graff et al., 2013; Smolak et al., 2014), but it is also highly determined by the gestures and postures they adopt, by the scenario surrounding them and by the words or illustrations they display on the clothes or accessories they wear. This contribution confirms that: 1) The attributes of adult women's sexualization identified in the academic literature equally sexualize girls when they use them; 2) The sexualization of girls, like that of adults, is a multidimensional phenomenon produced by the joint interplay

of multiple sexualizing attributes. As for the second objective, this work shows that cultural differences, associated with the audience's country of origin of a medium that disseminates children's fashion styles, significantly condition the perception or lack thereof girls' sexualization shown in that medium. Likewise, the country of origin influences whether or not the attributes used in these styles -and therefore the latent factors resulting from them- are considered to be sexualizing for girls. This result is in line with Nelson and Paek (2005) when they point out that the cultural values and political-economic systems of different countries determine the intensity of the sexual content published by the same medium in each of these countries. In this sense, we could conclude that Chinese subjects are less sensitive to the Western sexualizing codes used in the stylings analyzed or confer upon them a less sexualizing meaning.

In relation to the third objective, this work defines, for the first time, an explanatory and predictive model of girls' sexualization present in fashion styles, on the basis of the latent factors of sexualization present in those styles and the country of origin (Spain or China) of the viewer. In addition to their academic value, the contributions of this study have an eminently practical value to combat child sexualization produced and disseminated by the media. From this approach, the latent factors of sexualization identified are associated with the use of some very specific attributes when creating a fashion style for girls. Advertising creatives, fashion stylists and media outlets themselves can avoid creating and disseminating content that is harmful to children by being aware of the effect, in terms of sexualization, of incorporating these elements in the content they are creating, depending on the country where it is distributed.

However, the usefulness of this model is conditioned by the very willingness of communication professionals to combat child sexualization.

In this sense, we recommend that they be made aware of the phenomenon and the harmful effects it has on minors, especially through deontological training already provided by many universities and schools for future communication professionals (Martín-Llaguno & Hernández-Ruiz, 2010). We also recommend that this training be extended to the minors themselves and to other social groups that generate content and disseminate it through new technologies (Eleá & Mikos, 2017; López-Cepeda et al., 2019). In particular, within the scope of media literacy for minors in the field in question, and following the guidelines set out by García-Ruiz et al. (2014), we recommend training focused on the damage that minors themselves can cause through the dissemination of sexualized images of themselves or other children, and on how to avoid creating such images.

In terms of limitations, it should be noted that the conclusions of this work are valid in relation to the researched population: university students of Communication and Advertising in Spain and China. Without a doubt, this is a group of special interest considering the object of study, since it incorporates future professionals responsible for the design and dissemination of media messages. However, it would be useful to analyze whether other audiences exhibit the same sensibility to girls who are sexualized in fashion styles and to the attributes of sexualization used in those styles. In this regard, it is worth asking whether other personal or intrinsic household characteristics (such as having children or the type of parental education) may affect the perception of childhood sexualization. It would also be appropriate to broaden the geographical analysis to consider other cultures that may also influence that perception.

Other possible studies could focus on analyzing possible gender differences in the perception of the phenomenon studied, and on identifying and delving deeper (with qualitative methodology) into the specific cultural factors that explain the differences in perception between China and Spain. Finally, we consider it essential to explore the phenomenon of child sexualization (of girls and boys) in other commercial communications not linked to fashion and in all types of audiovisual products (such as video games, films, television series, cartoons, etc.).

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Video game usage time in adolescents' academic performance

El tiempo de uso de los videojuegos en el rendimiento académico de los adolescentes

Dr. Fernando Gómez-Gonzalvo, Assistant Professor, Department of Education, University CEU Cardenal Herrera, Valencia (Spain) (fernando.gomez4@uchceu.es) (https://orcid.org/0000-0002-3877-1228)
Dr. José Devís-Devís, Full Professor of Physical and Sports Education, Department of Physical and Sports Education, University of Valencia, Valencia (Spain) (jose.devis@uv.es) (https://orcid.org/0000-0003-4599-3782)
Dr. Pere Molina-Alventosa, Professor, Department of Physical and Sports Education, University of Valencia, Valencia (Spain) (juan.p.molina@uv.es) (https://orcid.org/0000-0001-6957-147X)

ABSTRACT

Video game usage among young people has generated great concern due to its possible negative effects on their health, socialization and academic performance. Regarding this last aspect, there are studies that point out that video games have negative consequences for academic performance while others emphasize their positive effects. Therefore, the present study deals with the relationship between the video game usage time and the academic performance in adolescent schoolchildren from the Valencian Autonomous Community. An ad hoc questionnaire was used and validated through expert judgment (0.8 validity and reliability) to develop this cross-sectional and ex post facto study. A stratified and proportional representative sample was designed for the ESO student population of this autonomous community and 1,502 questionnaires were collected. Adolescents spend an average of 47.23 minutes a day playing video games, with less time spent during the week than at the weekend. Those who devote more time to videogames during the week fail more subjects and those who spend more time on weekends get better school grades. In addition, frequent, moderate and many of the occasional players obtain good academic results, while the opposite happens to the intensive players. As many of the occasional players achieve good academic performance, a moderate time devoted to video games seems not to affect academic performance.

RESUMEN

El uso de los videojuegos entre los jóvenes ha generado una gran preocupación por sus posibles efectos negativos para su salud, socialización y rendimiento académico. Respecto a este último aspecto, existen estudios que apuntan a que los videojuegos son negativos para el rendimiento académico mientras que en otras investigaciones se encuentran efectos positivos. Por esto, el presente trabajo se ocupa de las relaciones entre el tiempo de uso de videojuegos y el rendimiento académico de los escolares adolescentes de la Comunidad Valenciana. Se utilizó un cuestionario ad hoc, validado a través de juicio de expertos (0,8 validez y confiabilidad) para realizar este estudio transversal ex post facto. Se diseñó una muestra representativa estratificada y proporcional a la población de alumnado de ESO de dicha comunidad autónoma y se recogieron 1.502 cuestionarios. Los adolescentes dedican una media de 47,23 minutos al día a jugar a videojuegos, menos entre semana que en fin de semana. Aquellos que dedican más tiempo a los videojuegos entre semana suspenden más asignaturas y los que dedican más tiempo los fines de semana sacan mejores notas escolares. Además, los jugadores frecuentes, moderados y muchos de los ocasionales obtienen buenos resultados académicos, mientras que les ocurre lo contrario a los jugadores intensivos. Muchos de los jugadores ocasionales obtienen buen rendimiento, por lo que la dedicación de un tiempo moderado a los videojuegos no parece afectar al rendimiento académico.

KEYWORDS | PALABRAS CLAVE

Video games, academic performance, gamers, secondary education, adolescents, survey, ICT, digital leisure.
Videojuegos, rendimiento académico, videojugadores, educación secundaria, adolescentes, encuesta, TIC, ocio tecnológico.

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1. Introduction

Today, leisure and free time activities have been greatly diversified allowing us to invest our time in multiple ways. One of them is the so-called digital leisure, which includes new leisure possibilities involving digital technology (Internet, consoles, mobile phones, digital platforms, etc.). The arrival of this type of entertainment in today's society is modifying interpersonal relationships and is also causing a transformation in people's leisure habits, especially among young people (Valdemoros-San-Emeterio et al., 2017).

Video games, in particular, have become the leading industry in sales and growth in the global leisure and entertainment market (Newzoo, 2018). According to the latest report published by the Spanish Video Game Association, in Spain they are the number one choice for audiovisual leisure, with a turnover of 1.35 billion euros in 2017 and ranking 9th in the world video game market. According to the data in this report, there are 15.8 million players in Spain, 75.94% of whom play every week (AEVI, 2018). Consumers spend more time than ever with video games, and this is especially true among young people (AEVI, 2018; Newzoo, 2018). The report of Youth in Spain 2016 states that 8 out of 10 young people play video games (Benedicto et al., 2017).

The vast amount of time adolescents spends playing video games has become a concern among educators, parents and administrations (Gonzálvez et al., 2017). It seems necessary to explore the effects that dedicating a large part of their time to video games can have on adolescents. In the first place, because it is a sensitive stage for the construction of their identity, since a large part of the behavior established at this stage conditions life in adulthood (Pedrero-Pérez et al., 2018). Secondly, knowing how adolescents invest their time is convenient as certain activities are incompatible with others due to mere time constraints, i.e. playing video games takes time away from other activities that may be of greater interest to adolescents (Aguilar et al., 2010).

In this sense, video games have occupied part of the scientific and public debate due to several concerns emerging around them. These concerns have focused on several aspects, among which the cultural scarcity of their contents, their relationship with addictions (Toker & Baturay, 2016), sedentarism and its negative health outcomes (Valencia-Peris et al., 2014), the perpetuation of gender disparities (Gómez-Gonzalvo et al., 2020) or the development of skills (Gros, 2007) stand out. In this paper, we focus on the relationship between time of video game use and the academic performance of adolescent students.

According to data from the Ministry of Education, Spain has a high rate of early school dropouts which, in 2017, accounted for 18.3% of students in Compulsory Education (Primary and Secondary) (MEFP, 2018). This percentage places us at the end of the line of most European Union countries, only ahead of Malta (18.6%) and far from the European average (10.6%). According to various studies, behind these numbers lies the time students spend on technological leisure. The vast majority of these studies indicate that there is an inverse relationship between time spent using video games and academic performance, so that those adolescents who spend the most time playing are those who obtain the worst academic results (Badía et al. 2015; Schmitt & Livingston, 2015; Adelantado-Renau et al., 2019). In a recent study, it was found that the higher the academic performance, the less time spent on technological activities such as video games (Lizandra et al., 2016). In another study, it was noted that the inverse relationship between time spent playing video games and academic performance was only found when the time spent playing video games was more than two hours a day (Valencia-Peris et al., 2016). Others suggest that science, mathematics or language subjects are not negatively affected by the use of video games (Drummond & Sauer, 2014). Other authors indicate that young people who play during the week have worse academic results than their peers who only play on weekends and, furthermore, they point out that the context of the game has a great influence on academic results (Hartanto et al., 2018). In this sense, Drummond and Sauer (2020) indicate that the time of day in which they play is fundamental, highlighting that the worst academic results are those of young people who play during the week before going to school.

Meanwhile, Jackson et al. (2011), through a longitudinal study, suggest that adolescents who perform well academically maintain their performance over time, regardless of the time they spend using video games. In other words, previous academic performance is the best predictor of future academic performance, so the emergence of video games is not a determining factor in school success. There are a number of studies that indicate the existence of positive relationships between the use of video games

and academic performance. For example, Badia et al. (2015) point out that students who play video games longer have better academic performance compared to those who spend time in other technological leisure activities (cinema, television, mobile phone, etc.). Gros (2008) indicates that video games can improve academic performance because both video games and classrooms use problem-solving strategies to approach the challenges faced by adolescents. These strategies, due to their cross-cutting nature, can be examined from different areas and video game designers use them to develop games stories. This requires adolescents to search for online tutorials, ask for help from peers, review books for extra information and use creative and divergent thinking to solve the problem posed in the same way as in educational contexts (Harlem, 2014). In this sense, it has been shown that through video games, skills such as reading and writing, psychomotor skills, social skills, cognitive and metacognitive skills are developed (Rosas et al., 2003; Gee, 2004; Gros, 2007; 2008).

Time spent on video games and its relation to academic performance has yielded both positive and negative results that converge in a paradox (Ventura at al., 2013). A negative interaction has been found between video game use and academic performance, but at the same time, there is a positive interaction between moderate video game use and general knowledge testing (Anand, 2007). Other authors indicate that positive relationships are shown for academic performance with moderate video game use, between 10-50 hours per week (approx. 86-429 minutes per day), compared to students who played less or played excessively and obtained worse academic performance than the former (Ventura et al., 2012). In this sense, the informal learning that young people undertake through technological interaction has been shown to be related to academic performance, despite the differences that exist between informal and academic learning (Pereira et al, 2019).

Despite the fact that there is evidence on the educational capabilities of video games, even in formal educational settings (Gros, 2008; Young et al., 2012; Badia et al., 2015), it is not clear how they affect academic performance, since the scientific literature offers contradictory results. In view of these contradictions between the use of video games and academic performance, it is necessary to delve deeper into these relationships. Therefore, the purpose of this article is to find out the relationship between these variables, the variation in time of use according to the type of day (weekday or weekend) and academic performance, as well as the differences in the temporal usage profiles of school adolescents according to academic performance.

2. Methodology

2.1. Design and sample

This ex post facto study was carried out through a survey of a sample of students in Compulsory Secondary Education (ESO) in the Valencian Community. For the calculation of the sample, a proportional and stratified sampling strategy was followed, according to sex, academic year, province and type of center from the population indicated by the National Institute of Statistics (2014) for the academic year 2012-13, the latest data available. The sample size was set at 1060 students, based on a <95% confidence level and a ±3% sampling error. However, a total of 1502 questionnaires were obtained, after discarding 12 of them during the screening process.

By gender, 49.4% were boys, 49.9% were girls and 0.7% reported as others. In terms of age, we found a range of 11 to 19 years old with an average age of 13.98 years old (SD=1.397 years old). 95.7% of the student body was between 12 and 16 years old, ages that would correspond to the Compulsory Secondary Education level, and 4.3% would correspond to other ages. 29.4% were students in the first year of secondary education, 27.5% in the second year of secondary education, 24.8% in the third year of secondary education and, finally, 18.2% were students in the fourth year of secondary education. By province, 40.24% came from Alicante, 15.02% from Castellón and 44.74% from Valencia. Of the total number of students, 66.11% attended public schools and 33.89% private schools.

2.2. Instrument

The instrument used was a survey to collect information on the use of video games in adolescent school children and other psycho-educational variables. The survey was developed especially for this study based

on previous work on the subject (Alfageme & Sánchez, 2003; Parra et al., 2009; ADESE, 2011) and was validated through expert assessment (Lynn, 1986). For this purpose, the help of 10 experts (7 men and 3 women) in education, information technologies and video games was requested. Based on a first draft created by the research team, the experts were asked for their opinion. Based on their comments and suggestions, the research team reworked the survey. The survey was then re-sent to the same experts to show their level of agreement/disagreement with the appropriateness of the questions in the instrument to obtain information on the topic of study. Finally, the experts gave their opinion on the survey and showed a level of agreement of 80%, that is, 0.8 agreement out of 1, so the questionnaire was considered valid for use (Polit et al., 2007). Reliability was determined by standardizing the survey administration protocol and limiting its application to a single researcher to avoid differences in the way it was administered among the different times and groups to which it was applied.

The survey consisted of 24 questions aimed at finding out about the use of video games in leisure time among adolescents in secondary education. The most common types of questions were multiple choice, yes/no, single choice and single entry ("How much money do you spend on video games each month?"; "Do you think that active video games can help you develop any of the following skills/abilities?"). To collect the data on academic performance, a simple answer question was asked in which young people had to indicate, among the 4 options offered, the one that was most suitable for their academic performance ("With respect to the last year, which of the following statements is closest to your academic level? I have failed 4 or more subjects; I have failed between 1 and 3 subjects; I have passed everything and have an average of adequate or good; I have passed everything and have an average of notable or outstanding). For the question of usage time, young people had to indicate the time they spent on video games in a typical week by providing the value in 15-minute intervals ("In a typical week, how much time do you usually spend playing video games? Indicate it in fractions of 15 minutes. For example: 15', 30', 45', 1h., 1h15',1h30', etc.").

2.3. Procedure

Ten schools in the Community of Valencia participated in the study. Prior to contacting them, the corresponding official permit was requested from the Regional Ministry of Education, which is required by regional regulations. Prior to the survey, informed consent was sent to the parents and legal guardians of the students, informing them of the objectives of the study. It was also explained to them that the study respected the principles of the Declaration of Helsinki and the Spanish laws on data protection, throughout the process and the possible subsequent publications that derived from it.

The survey was administered during one of the school hours that the students had in their schedule, trying to avoid interrupting the dynamics of the school. The teachers in charge were always present in the classroom where the questionnaires were administered. The students were told what the objectives of the study were and how they had to fill in the questionnaire. The data were collected between January and June 2015.

2.4. Analysis

The descriptive analysis of video game usage time involved providing the averages, maximum and minimum values, and standard deviation. A two-factor ANOVA was performed, 4 (academic performance) by 2 (weekday/ weekend) with repeated measures in this last variable for the comparison of means of usage time according to the mentioned factors, followed by post hoc tests with HSD Tukey. In addition, a Spearman correlation was performed to explore the relationship between both variables. Finally, a Chi-square analysis was performed to see if there were significant differences in player profiles (non-gamer 0h/day; occasional >0 and <1h/day; moderate 1-3h/day; frequent 3-5h/day; intensive >5h/day) according to academic performance. Since the sample did not follow a normal distribution, a transformation of the variables was performed using the logarithmic procedure in base 10 and the asymmetry and kurtosis were smoothed out. The significance level to determine if there are significant differences was set at $p<0.5$.

3. Results

3.1. Descriptive results

Teenagers play video games for an average of 47.23 minutes a day (DS=94.945min). The average time on weekdays is 26.83 minutes per day (SD=52.77min) and on weekends it amounts to 74.34 minutes per day (SD=102.97min). Table 1 shows the average values for the use of video games during the week and for the type of day of the week (weekdays and weekends). In this table we can also see that 45 minutes of average weekly use of video games is the maximum time for students to avoid failing all subjects and to obtain at least a passing grade (adequate).

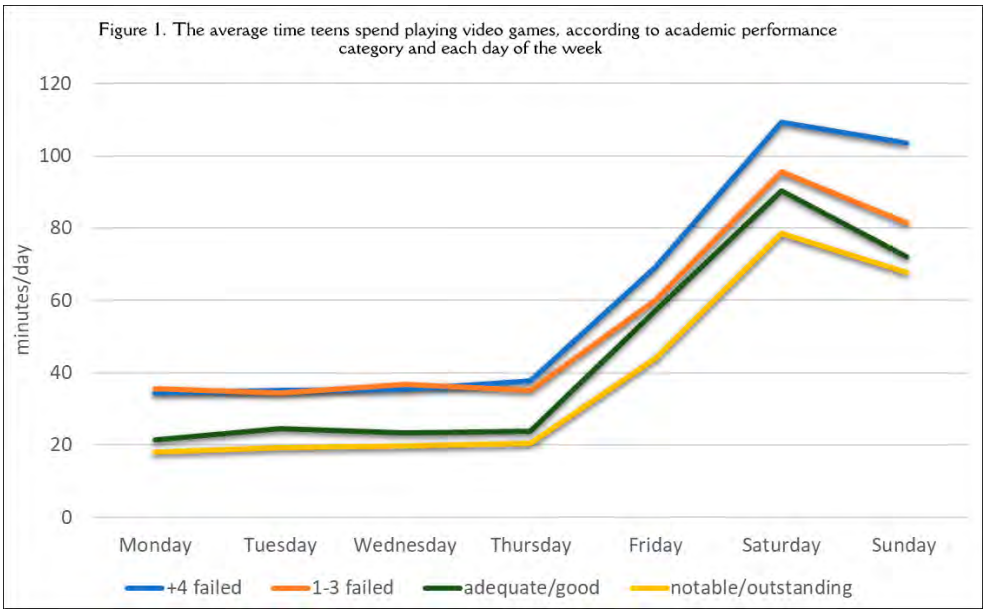
Table 1. Average time of video game use by type of day

	Weekday	Weekend	Weekly mean
+4 failed subjects	42.40 (67.01)	106.36 (149.40)	60.68 (83.58)
1-3 failed subjects	40.38 (72.99)	88.60 (115.01)	54.16 (80.37)
Adequate/Good	30.07 (46.07)	81.25 (114.10)	44.69 (60.84)
Notable / Outstanding	24.31 (38.11)	73.19 (102.22)	38.29 (51.75)

* Time shown in minutes. Standard deviation values in parenthesis.

Figure 1 shows average video game usage by day of the week for each academic performance category. This figure shows a similar pattern for each of the academic performance categories, characterized by an increase in weekend time with the peak on Saturday. It also shows that the higher values of time spent playing video games correspond to the category of academic performance with the highest student failure rate, while the lower values correspond to the category of best academic performance. The differences in usage time between these two categories of academic performance range from 16.48 minutes on Monday to 30.81 minutes on Saturday.

Figure 1. The average time teens spend playing video games, according to academic performance category and each day of the week



On the other hand, it was found that 3.2% of adolescents did not play video games, while 74.2% of adolescents played occasionally, 17.7% played moderately, 3.6% played frequently and 1.4% played intensively.

3.2. Correlation between playing time and academic performance

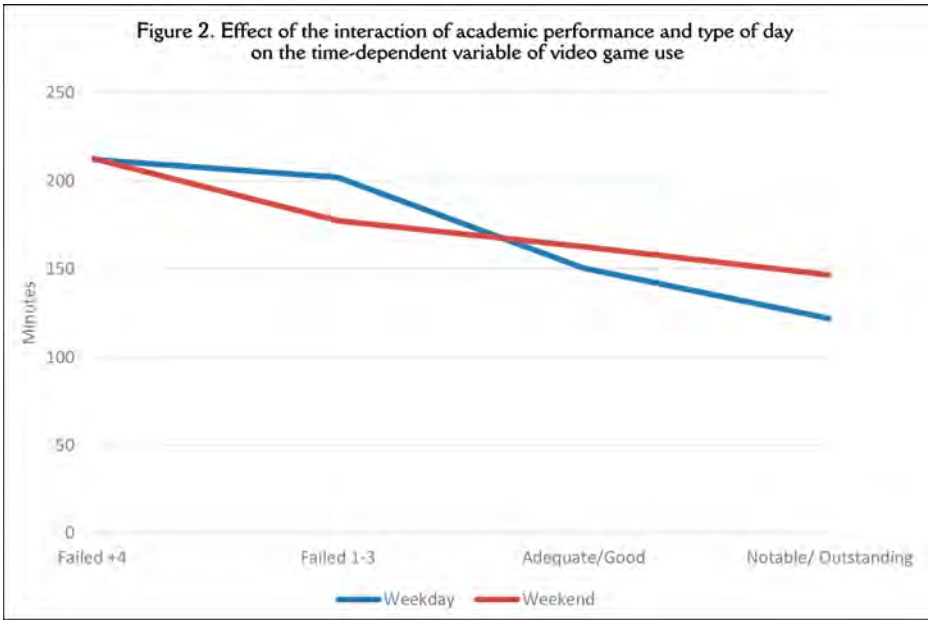
In order to explore the possible linear relationship suggested by the previous tests between the time of video game use and academic performance, a Spearman correlation was performed. This test shows a significant negative relationship between both variables, but with a low correlation and effect size (rs=-0.108; p=0.000), i.e., as the time of video game use increases, academic performance worsens.

3.3. Time of video game use according to academic performance and type of day

A 4 x 2 ANOVA test was performed, with repeated measurements on the latter factor, to find out if there were significant differences according to academic performance and type of day (weekday/weekend). A significant difference was found in the main effect by academic performance ($F(3)=8.197$; $p=0.000$; $\eta 2=0.017$).

Post-hoc tests, using Tukey contrast, indicate that differences in video game usage time are obtained between the best performing adolescents (notable and outstanding) and their worst performing peers (more than four failed subjects and 1-3 failed subjects), with such differences being -78.40 and -55.60 minutes per week respectively. In other words, adolescents who spend less time playing video games perform better academically.

Figure 2. Effect of the interaction of academic performance and type of day on the time-dependent variable of video game use



The above ANOVA also indicates that there is a significant interaction effect on the time of video game use between the type of day and academic performance ($F(3)=4.688$; $p=0.003$; $\eta 2=0.010$).

In other words, it can be seen that the time of use of video games by adolescents with lower academic performance is similar or greater on weekdays than on weekends, while for adolescents with higher academic performance it is precisely the opposite, they play longer on weekends than on weekdays (Figure 2).

3.4. Play profiles according to academic performance

A Chi-square test was performed to find out how the use profiles of the players (non-gamers, occasional, moderate, frequent and intensive) varied according to academic performance and significant differences were observed ($\chi 2(12)=29.742$; $p=0.003$; $=0.082$). The corrected standard residuals indicate (see Table 2) that non-gamers are distributed in significant percentages between those who fail more than four subjects (34.8%) and those who obtain scores of notable-plus (26.1%). In contrast, there is a higher percentage of occasional players (42.3%) with high grades (notable and outstanding) than occasional players (16.1%) with very low grades (failing more than four subjects). These percentages are reversed with intensive players, as the highest percentage (38.1%) is among those who fail more than four subjects and the lowest percentage (14.3%) among those who achieve the notable-plus. No significant differences were found for the moderate and frequent type of player.

Table 2. Video game player profiles according to academic performance				
	+4 failed	1-3 failed	Adequate - good	Notable - outstanding
Non-gamers	34.8%*	19.6%	19.6%	26.1%*
	3.0*	-0.7	0.4	-2.0*
Occasional	16.1%*	23.6%	18%	42.3%*
	-3.6*	-0.8	0.9	2.8*
Moderate	22.1%	24.7%	14.8%	38.4%
	1.8	0.2	-1.2	-0.7
Frequent	20.8%	32.1%	18.9%	28.3%
	0.5	1.4	0.3	-1.8
Intensive	38.1%*	33.3%	14.3%	14.3%*
	2.4*	1.0	-0.4	-2.4*

Note. * show groups where the classified residuals are ±1.96.

4. Discussion

The results of this study indicate that teenagers spend an average of 47.23 minutes a day playing video games. These values are somewhat higher than those found by other Spanish studies indicating substantially lower average values of use when giving values of 24 and 27 minutes (Callejo, 2016; Valencia-Peris et al., 2014). In contrast, other studies have reported much higher mean values, such as 73.2 minutes per day for American youth (Lucas & Sherry, 2004), 125.1 minutes per day for American adolescents (Phan et al., 2012), or even 280 minutes per day for Australian adolescents (Forrest et al., 2015). This variation in the means of the aforementioned studies may be due to several contextual and methodological factors such as the way in which young people are asked about the time and the order of the questions, as indicated by Sierra (2003). In addition, we must consider that video games have not developed and expanded uniformly, in fact they have been more accelerated in highly industrialized countries with a significant consumption system (Newzoo, 2018). In any case, the 47.23 minutes represent a considerable amount of time if we take into account that young people also spend, as part of their lifestyle and social identity (Buckingham, 2008), more time on other technological media available to them, including television, computers and mobile phones. This would presumably exceed the maximum time of two hours per day beyond which the overall health risks to the young segment of the population increase, as suggested by various associations (Barnett et al., 2018; Devís-Devís et al., 2015; OMS, 2019).

There is also an inverse relationship between academic performance and time spent playing video games whereby teenagers with less playing time get the best grades while those who play heavily underperform academically. These results are in line with what previous studies indicating that participants were young people from Spain, the UK and the US (Callejo, 2016; Peiró-Velert et al., 2014; Schmitt & Livingston, 2015), and also with studies comparing samples from various countries (Borgonovi, 2016). Despite this, there are other authors who find no relationship between time spent playing video games and academic performance (Jackson et al., 2011). However, these data offer very general information for a complex and nuanced issue (Ventura et al., 2012; Ventura et al., 2013). For this reason, this paper delves into video game usage time according to academic performance and type of day, as well as usage time profiles according to academic performance.

In particular, the results of this study show a pattern of video game use characterized by less weekday time and a considerable increase in usage time during the weekend. In other words, teens who play video games substantially increase their use in the weekend, regardless of their academic performance. This circumstance may be due, as pointed out by other authors (Peiró-Velert, et al., 2014), to the fact that during the weekend adolescents have more free time and that some of them invest it in both academic and leisure activities, with no negative relationship between these activities. Since teenagers do not attend schools on weekends, it seems likely that the time spent on video games will increase, as this type of leisure is prevalent among teenagers worldwide (Newzoo, 2018).

On the other hand, teenagers who spend the longest time playing video games are those who fail 1-3 subjects and more than four school subjects, while those who spend the shortest time playing video games get notable and outstanding grades. In other words, by comparing the averages of various groups or categories of grades, the results obtained by correlating the time spent playing video games with academic performance are reaffirmed, thus confirming the studies that abound in this same result (Callejo, 2016;

Peiró-Velert et al., 2014; Schmitt & Livingston, 2015). Depending on the type of day, we find that teens who fail more subjects spend more time playing video games on weekdays than on weekends, and those who get better grades spend more time on weekends. This result is key because it shows that an increased dedication to video games on weekdays, coinciding with school days could affect the academic time that ultimately results in lower performance, as indicated by other studies (Drummond & Sauer, 2020; Hartanto et al., 2018). However, as Lizandra et al. (2016) suggest, it could be the other way around, i.e., that low academic performance is what affects the greater dedication to video games precisely on school days. In this case, Jackson et al. (2011) would be right because academic success would not depend on the time dedicated to video games and, instead, video games would become an activity where they might be competent, leading adolescents with low academic performance to dedicate more time to this activity.

When the time dedicated to video games is transformed into game profiles (non-gamer, occasional, moderate, frequent and intensive), we can obtain results that help to deepen their complex connection with academic performance. In this way, an important group of occasional gamers are not prevented from obtaining good academic results because, as with those who spend more than two hours on technological leisure in other studies (Valencia-Peris et al., 2016), it seems that they do not spend much time on video games to undermine the time they spend on academic tasks, with a lower percentage obtaining poor results. On the other hand, the opposite is true for many of the intensive players who may have difficulties with the time they have available because, as Lizandra et al. (2016) point out, in those cases playing time seems to compete with study time which ultimately results in poor academic performance. The fact that non-gamers are divided between those with low and high academic performance is an indication that they are not affected by video games and therefore their academic performance is impacted by other factors.

5. Conclusions and limitations of the study

Secondary school teenagers in the Valencian Community spend an average of 47.23 minutes a day playing video games. They show a pattern in the use of video games characterized by a decrease in the time spent on weekdays and a considerable increase in the time spent on weekends. Teenagers who spend more time playing video games on weekdays, compared to the weekend, fail more subjects and those who spend more time playing on weekends get better grades in school.

There is also an inverse relationship between academic performance and time spent playing video games, i.e. the longer the time spent playing, the poorer the academic performance. In general, teenagers who spend more time playing video games are those who fail more school subjects, while those who spend less time playing video games are those who get the best grades. In addition, many of the casual gamers appear to be doing well academically because they don't seem to be spending much time on video games to detract from the time they spend on homework. In contrast, the opposite is true for many of the intensive gamers because game time seems to compete with study time which ultimately results in poor academic performance.

As limitations, we found that the measures of academic performance of the students who participated in the study were obtained from self-reports because it was not possible to access their official grades. This is a concern because of the possible lack of precision in the data collected that may be derived from the participants' recall. However, this is a global approach to the collection of academic performance data, covering the whole school curriculum and not just a few subjects or indicators taken from other studies. This is the case of the Pisa Report, which only considers reading comprehension, mathematics and science, and excludes the arts, social sciences and humanities (Silió, 2014). On the other hand, we must point out that the sample is only representative of secondary education students, which means that we must take the results with caution, since other educational levels may display a different relationship between the variables in our study, given that they cannot be generalized to all educational levels.

In future studies dealing with the subject, it would be interesting to look more closely at the time of day when video games are played during the week, since it seems that this may be a determining factor, as Drummond and Sauer (2020) point out, in order to understand the relationship between these variables.

Finally, we must point out that this is a cross-sectional, correlational study, which indicates the existence of possible interactions of extraneous variables in the study. Therefore, it is important to continue working

on this issue through more sophisticated designs, whether quantitative (longitudinal or experimental) or qualitative, carried out from a more ecological and global epistemology. It is also important to focus on the study of time according to the type of video game, since it has important socio-educational consequences for its practitioners.

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Mobile learning for homework: Emerging cultural practices in the new media ecology

El aprendizaje móvil en las tareas escolares: Prácticas culturales emergentes en la nueva ecología mediática

Dr. Klaus Rummler, Senior Lecturer, Zurich University of Teacher Education, Zurich (Switzerland) (klaus.rummler@phzh.ch) (https://orcid.org/0000-0002-8379-244X)
Caroline Grabensteiner, Scientific Assistant, Zurich University of Teacher Education, Zurich (Switzerland) (c.grabensteiner@phzh.ch) (https://orcid.org/0000-0002-9762-675X)
Dr. Colette Schneider-Stingelin Scientific Assistant, Zurich University of Teacher Education, Zurich (Switzerland) (colette.schneider@phzh.ch) (https://orcid.org/0000-0001-6106-0312)

ABSTRACT

This contribution discusses emerging cultural practices of media activities with the example of homework as an out-of-school learning context. Data was collected using diaries on the use of media during out-of-school learning activities. Central theoretical frameworks include the German theory of Medienbildung as an actor's threefold relation towards the material/factual world, the other/s and society, and her-/himself and the socio-cultural ecology of mobile learning as a triangular relationship between agency, cultural practices and structures. Following a grounded theory approach, data analysis was conducted in an inductive manner, drawing on contemporary methods of computer enhanced qualitative analysis. This article focuses on verbal expressions within the diary entries, implicating cultural practices in everyday media activities and their impact on media use in a domestic learning context, such as homework. Two central aspects are highlighted from the results, exemplifying the category and theory generation. First, "checking", as one of the reappearing in-vivo codes, will be examined more closely regarding its embedding in media practice and homework. It will be characterised as a daily recurring receptive and productive media practice. Second, apps and services, as well as media hardware used at school, are mirrored in the way students actually use media during homework, mingling with everyday media practices.

RESUMEN

Esta contribución se centra en prácticas culturales emergentes en las actividades mediáticas, tomando las tareas como ejemplo de contexto de aprendizaje extraescolar. Usando diarios, se recabaron datos sobre el uso de los medios en las tareas. Sirven como marco teórico, por un lado, la teoría de Medienbildung como triple relación del actor con el mundo material/objetivo, los demás/la sociedad y consigo mismo; y por otro, la ecología sociocultural del aprendizaje móvil, como relación triangular entre agency, las prácticas culturales y las estructuras. Siguiendo la teoría fundamentada, el análisis de datos se realizó de modo inductivo, empleando métodos de análisis cualitativo asistido por ordenador. Este artículo se centra en las expresiones verbales que implican prácticas culturales en las actividades mediáticas cotidianas, así como en su impacto en el uso de medios en un contexto como el de las tareas. Se destacan dos aspectos centrales de los resultados, que ejemplifican la generación de categorías y teorías. En primer lugar, «checking», uno de los códigos in-vivo que se repiten, se analizará a fondo respecto a su incorporación en las prácticas mediáticas y los deberes. Se caracterizará como práctica mediática receptiva repetida diariamente. En segundo, tanto las aplicaciones y los servicios como el hardware de medios empleado en la escuela se ven reflejados en el modo como los alumnos emplean los medios cuando hacen las tareas, combinándolos con prácticas mediáticas cotidianas.

KEYWORDS | PALABRAS CLAVE

Media education, secondary school, homework, software, smartphones, social media, qualitative analysis, quantitative analysis.
Educación mediática, educación secundaria, tareas escolares, software, smartphones, redes sociales, análisis cualitativo, análisis cuantitativo.

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1. Introduction

When discussing risks, threats and opportunities of digitalisation (Floridi, 2014), and processes of deep mediatization (Hepp, 2017), perspectives on opportunities are often left out (Condruz-Bacescu, 2019). Not to fall into a trap of un-reflected utopianism, drawing data from social realities and analysing them with a focus on opportunities is essential to be able to make data-driven statements in a discussion that is normatively shaped by over-protectionism on the one hand and euphoria on the other (Selwyn, 2011). This applies especially for children and young people and their media environment.

In the perspective of media studies and media education there are a couple of recurring studies on everyday media usage. In order to draw conclusions and to make recommendations as precisely as possible, it is necessary to use country specific usage data. Literature and data reviews for European, but especially for German speaking countries, in preparation for launching the presented project, revealed that until 2018 there was no detailed data or project report on the intersection between homework and media usage. Esp. literature in the field of media education either assumed or demanded that there would or should be media use involved in homework (Rummler, 2018). Other data mentioned some interrelations (Feierabend et al., 2017; Suter et al., 2018) but could not give further detail on cultural practices of homework and media use. The gap in research and scarcity in literature motivated this project. Looking into literature on homework, descriptions, and definitions as a didactic feature of planning lessons (Mischo & Haag, 2010; Haag & Streber, 2015) are pervasive. Aspects of parent involvement and its effects (Wild & Gerber, 2007), as well as explorations of homework effects on self-efficacy, have been conducted (Trautwein & Lüdtke, 2014). In the literature, little attention was paid to the ways students themselves develop practices of "doing" their homework. In respect to media and homework, profound data was missing on which (media) resources (apart from recommendations which media to prescribe on part of the teachers) pupils are actually using in their domestic learning environments, let alone, what meaning they make of their media environment.

The following contribution presents outcomes of the Swiss exploratory study "Homework and Media Education" (http://p3.snf.ch/project-175909) which investigated the media use of secondary school pupils in domestic learning contexts (Sharples et al., 2010; Rummler, 2018; Rummler et al., 2018). This exploratory study follows an inductive approach of qualitative research with its aim of mapping the field, i.e. identifying structures, patterns, and dimensions of the interrelation between homework and everyday life media use, working on a data-driven, grounded theory. The guiding questions marking the field to be mapped are:

- In the context of complex home media and learning environments (media ecology), how do pupils use media as resources for their daily learning practice?
- In which ways do pupils select and find orientation within the wide range of media and the resulting opportunities?

The two preceding questions lead to the central question:

- How do pupils perform agency within their daily media-practice appropriating and making sense of social, cultural and technical structures?

Asking for agency raises questions of enabling and restraining social practices and structures (Pachler, Bachmair, et al., 2010; Giddens, 1984). Those become visible from pupils' ways of reflecting upon these structures. Within the project, domestic learning means "doing homework" in a wider sense (Aßmann, 2013; Kohler, 2011; Hascher & Hofmann, 2008; Kress, 2010). This working definition covers oral, written and/or performed tasks directly posed by teachers, plus activities for school, like preparation and general learning to be carried out outside the lesson during in- and out-of-school-settings (Trautwein & Lüdtke, 2014). This definition also includes contemporary forms of schooling where the afternoon is not spent at home but in learning-support or day-care institutions. In the context of the researched schools, the project team found diverse forms of support and supervision, including fulltime and part time day schools with and without lunchtime, as well as stay-at-home parents and grandparents. Thus, together with learning practices, it is possible to cover a variety of structures of homeschooling along with insights into daily lives and routines of pupils.

Drawing upon an understanding of media formation (German: Medienbildung) the project team argues that media are substantial for individual constructions of world- and self-relations (Spanhel, 2010). Emergence of these relations are reflected in individual articulations, perceived as acting with, through and towards media (Marotzki & Jörissen, 2008). Media use and appropriation (Pachler et al., 2010) are substantial for understanding the concept of formation regarding media as Medienbildung (Pachler et al., 2010; Meder, 2011: 71f). The constitution of this relation of individuals towards themselves and towards the world (including media) is mutual and reflective. It shapes media use as well as agency in the sense of an ability to act upon the world (Archer, 2000). The threefold relation in respect to media and their functions is developed towards: the material/factual world in the mode of representation; the other/s and society through communication; and Her*self/him*self throughout the life-course across interaction (Meder, 2007: 65).

Besides focusing on the individual's relations and personal development, the project team takes a wider view on the development of reflexive agency through everyday media practice (Buckingham & Sefton-Green, 2003). The project team locates those practices embedded in media ecologies (Fuller, 2005) reflected in the triangular relation of social and technological structures, agency and cultural practices (Giddens, 1984; Lefebvre, 1958; Pachler et al., 2010). Thus, everyday activity is assumed as a part of this ecology of the physical and structural world (Luckin, 2008; Rummler, 2014). Consequently, it is an active process of appropriation within (media)activity and the inherent agency constituting the assumed reflexive relationship between individual and collective life-worlds (McDougall & Potter, 2015). The notion of culture and cultural practices is seen as rather routinised common activities in everyday life. In this sense, in the context of homework and interrelated patterns of media usage, which themselves shape pupils' meaning-making.

2. Sample, material and methods

For the project, the research team established access to teachers and their school classes through the associations of Swiss teachers (LCH) and of Swiss school principals (VSLCH). This approach resulted in a desired heterogeneous composite sample of schools offering varying levels of autonomy, which is typical for the Swiss school system.

After pre-studies in 2016/17, the main survey in autumn 2018 involved 250 pupils from 25 secondary 1 school classes (7^{th} to 9^{th} grade) in seven German-speaking cantons in Switzerland, using pupils' media diaries (Rummler, 2018; Rummler et al., 2018) in accordance with parental consent. As parents had to give consent to the use of data on an individual basis, only four school classes could be surveyed as a whole. Additional 21 classes took part with an average return of 8,38 of 17,53 pupils per class (overall return: 73.96%).

The resulting sample consisted of 138 (55%) female and 108 (43%) male pupils, where 4 pupils did not answer on their sex. The average age is being 13.24 years, where 7 answers about age are missing. Information about migration backgrounds was gathered by asking for languages spoken at home (return: n=239). German languages were aggregated and re-coded. Thus, three groups emerged: At the homes of 9% of the pupils only non-German languages are spoken. 26% of the pupils in the sample grow up in households where a German and at least one non-German language is spoken. In 65% of pupils' households only German languages are spoken. 29 non-German languages were named in the sample. The households' socio-economic level was not determined.

Media diaries as a survey instrument (Gleaves et al., 2007) foster the above-mentioned threefold relationship through self-reflection. Reflective elements are interpreted in terms of (Media-)Bildung (Meder, 2015) based on an understanding of formation (Bildung) as both the process as well as the result of a reflexive relation of the individual towards the world through articulation. These processes are documented in the format of diary notes in terms of the individual's educational engagement with the material and social environment (Meder, 2007; 2011). Furthermore, the diaries also serve to document self-reflective processes (Meder, 2015). For this reason, the study also deals with the question of how to interpret such processes as (media) educational processes. The "media diary" is the central instrument in a mixed methods research design that consists of four parts to be completed in writing:

1) Introductory sociodemographic questions.

2) Closed-ended questions regarding support and supervision of homework by parents and other actors in the pupils' social surroundings. In addition, questions are asked about the support the pupils receive from selected media for their homework, and which actors in everyday life are significant in their media activities. These questions were formulated as a four-level scale (never, sometimes, often and always, plus no specification) and were answered by the pupils with the help of the researchers during the introduction of the instrument in the school classroom.

3) The actual "media diary" is conducted in form of a written survey led by an open-ended question encouraging the pupils to report media activities in the context of homework for two weeks.

4) Three open questions at the end of the diary provided the opportunity to reflect on homework during the two weeks of the survey.

The quantifiable data from the closed-ended questions were entered into Microsoft Access, and the open-ended questions in the media diaries were transcribed and organised via Adobe Acrobat PDF forms, and collectively imported into MAXQDA. The media diaries were coded in MAXQDA using word-for-word coding. The coding scheme was inductively developed –relying on previous coding indicated by pre-studies (Rummler et al., 2018)– and further refined in an iterative process of open coding (Kelle, 2007), concept and category formation (Mey & Mruck, 2011). The open process was maintained as long as possible, thereby revealing a large number of individual codes (Kuckartz, 2010). Several rounds of interactive coding were undertaken to develop a common understanding and consensus of codes within the team, according to advice for teamwork in grounded theory analysis given by Corbin and Strauss (1990).

In the course of this process, the team developed four code dimensions in order to differentiate between the different aspects of media:

- The dimension "medium" comprises all types of hardware mentioned by pupils in their diaries. All physical devices for storage, transmission, playback, display, and (re-)production of signs –i.e. (media) hardware such as TV sets, smart TVs and smartphones– were coded (suggestions for a definition of media in Rummler, 2018; Herzig, 2016; Swertz, 2000).
- The dimension "representation" describes types of media content, such as radio stations' programming, YouTube channels, or specific types of messages like emails, Snaps –messages within the Snapchat app– or videos. The definition was refined with reference to Stuart Hall's notion of "representation" in the sense of "processes by which meaning is produced" (Hall, 1997: 1), and it is helpful to distinguish levels of representation as practice as well as its symbolic function: "[…] a kind of 'work,' which uses material objects and effects. The meaning depends, not on the material quality of the sign, but on its symbolic function" (Hall, 1997: 25).
- The dimension "apps/services" includes all types of software and applications, services and websites enabling the use of particular modes of representations on local hardware devices.
- The dimension "media activities" was used to capture verbs indicating direct references to practices constituting activities associated with various media (incl. apps/services, representations, or hardware). This dimension of codes literally specifies what pupils do with media.

The code groups were developed following the "'coding paradigm' of conditions, context, strategies (action/interaction), and consequences" (Corbin & Strauss, 1990: 13) in grounded theory, working towards categories by relating the codes emerging in the open coding process to code groups as their components. This process of upward differentiation was applied to the code group of "everyday activities". Separation precision against scheduled activities was achieved by differentiating e.g. training in a sports club or music lessons from other "leisure time activities", such as arranged social meetings and "school activities", including homework. By distinguishing these different contexts including their ecological resources, it was possible to relocate the documented media activities within routines and recurring situations. During the coding process, combining the code groups helped to describe temporal, spatial-local and social constellations and link media activities to them.

To isolate homework activities in the data, the code dimension "activities for school" was created and codes indicating the physical location and time of "inside school" were excluded. While this describes the

technical filter algorithm in MAXQDA for the retrieval of "homework" codes it also covers a wide range of activities in relation to school but outside the lesson/school building, and suggests an expanded, data-driven working definition of "homework" for the project in correspondence with the elaborated definition, based on literature, above.

Pupils, in most cases, reported incidents in the media diary as single entries, often in form of standalone phrases or individual sentences. These entries served as entities of analysis and were consequently treated as single lines of data. The joint occurrence of codes within these basic entities carry expressions and articulations that help to explain how media use is entangled in everyday practice. The identification of commonly occurring word combinations in single lines of data meant to apply the concept of "collocations" to explore forms of these expressions. In phraseology, located in the science of linguistics, these sets of word combinations are called "collocation". This refers to co-occurring, but non-idiomatic word combinations that mean more than the sum of their parts (Burger, 2007:38f.). Technically, in MAXQDA this means to filter codes that have a proximity of "0" and the search is limited to the occurrence of codes that meet in a single line. Thus, specific word combinations could be determined by means of systematic search (i.e. co-occurrence in a single entity resp. code line) and were evaluated according to their frequency. If patterns of associations resp. collocations occur frequently, it is assumed that they name specific routines taking place in everyday life, that could be interpreted as cultural practices (Buckingham & Sefton-Green, 2003; Pachler et al., 2010).

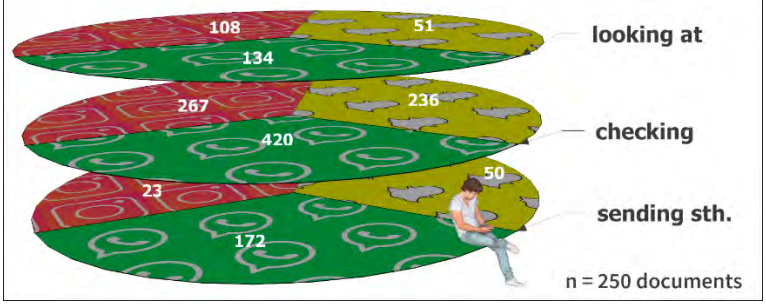
3. Results

The following presentation of results focuses on two aspects. First, the example of "checking" will be reconstructed, revealing it as an everyday media practice associated with popular media. Second, we investigate media activities in the context of homework in Mathematics and English language education to determine how pupils appropriate and make sense of their media environment for learning purposes.

3.1. Pupils' use of language as an indication of media activities

What follows is an analysis of how pupils describe their own media use. Early morning media activity, for example, is in many cases described as sets of word combinations (collocations) such as "WhatsApp" (coded as "apps/services") and the verb "checking" (coded as "media activities").

Figure 1. Collocations with WhatsApp, Snapchat, Instagram



"Checking" was one of the in-vivo codes (Kelle, 2007) most found as collocation with the three dominant Social Media Apps. It occurs 811 times in the entire dataset. "Checking" was mentioned in collocation with WhatsApp 420 times, with Instagram 267 times, and with Snapchat 236 times. The pupils note "ISW" as an abbreviation when all three apps are checked as a unit. Checking could be dimensioned on a range of activities from a quick look to an actual use of an app to see if there was new content. "Sending [something]" and "looking at [something]" are further relevant verbs with importance for the focus on "checking" as a practice. Whilst "sending" primarily occurs in collocation with Snapchat and WhatsApp, "Looking at", in contrast, is mainly used in collocation with WhatsApp and Instagram, and only to a limited degree with Snapchat. Only "checking", so the first conclusion, combines practices connected to all three of the most mentioned apps.

3.1.1. Discussion: "Checking" as cultural practice

"Checking" is to be understood as a particular media activity or cultural practice that is both receptive and productive. Nevertheless, it is distinct from "sending" and "looking at", as could be seen in the section above. How is "checking" to be interpreted as a (cultural) media practice? Close examination and comparison of different data showed that pupils are not checking in the sense of testing functionalities, but rather verifying whether new messages or posts have arrived. In addition, "checking" involves a way of receiving information and of skimming or browsing content. But the reception does not go as far as "looking at"; rather, it corresponds to registering, filtering and appropriating relevant information and content. The frequency of this practice and its integration into pupils' routines, recurring in similar settings, at similar times, in similar time-space-contexts, suggests that new posts and new messages, as well as following them frequently is an established cultural practice or media-related routine in the everyday life of pupils.

A different interpretative reading of the collocation "checking" suggests appropriation as a way of receiving information and making sense of it. "Checking" corresponds to registering, filtering and selecting relevant information and content. The authors interpret "looking at" as activities related to reading messages in the sense of a mere receptive activity, more intense than "checking". "Sending" more explicitly indicates writing and production of media representations such as messages. In this sense "checking" is a generic term, covering the quick skimming of messages, as well as distinct and deliberate reading, only sometimes including the productive writing of new media representations and content. With reference to an understanding of the formation of self- and world relations (Medienbildung), this practice leads to an interpretation of pupils' engagement and construction of their relation towards the world/media structures represented in social media apps and their possibilities and restraints for action. In the course of "checking" they are actively working out their relation towards the social other(s) making distinctions between new and familiar information, and knowledge. Within this recognition and processing of communicated information and content they act upon the world, making sense of it and prioritising which leads and offers for social meaning-making they follow and consider for their own media action. Close reading of the data suggests that "checking" is a cultural practice as a set of activities that pupils have developed in the triangular relationship between agency and structures within the socio-cultural ecology of everyday media use.

3.2. Pupils within the media ecology of homework

When studying the relationship between pupils and their media ecology in the context of homework, it is necessary to develop an operationalisation of the practice of homework. One question arising when asking for homework and media concerns hardware and apps/services used by pupils. This leads to the inquiry of connections between media/apps and school subjects. Drawing upon the elaborated method of collocation, it was possible to search the data for single line co-occurrences of codes from the dimensions "medium" plus "school subject" or "apps/services" plus "school subject". This is the combination of two collocations allowing for the meaningful qualitative correlation of three dimensions.

3.2.1. The use of apps/services and hardware for homework in Mathematics

There is a diverse use of apps/services for homework in Mathematics and Microsoft Office365 with its applications Teams, Word and Excel were the most mentioned (30 mentions in n=149 documents). Second is WhatsApp (14 mentions in n=149 documents), YouTube (8 mentions) is third and Google (5 mentions) is fourth. Online services offered by school-book publishers were named 4 times. Four other apps/services were stated 3 times or less. See Figure 2: The use of apps/services and hardware for homework in the subject Mathematics in Figshare (https://doi.org/10.6084/m9.figshare.12250166).

The school or exercise book as specific hardware was named 10 times (plus one mention of unspecified documents and papers). Second is the computer or laptop which was indicated 8 times. The smartphone was mentioned 3 times, and a tablet computer was only stated one time. One pupil pointed out on a watch.

3.2.2. The use of apps/services and hardware for homework in English

The bandwidth of apps/services used for homework in English is less than in Mathematics. The most mentioned application or service is Quizlet (53 mentions in n=149 documents). 21 pupils state websites

resp. services for translation. Others mention YouTube (7) and Google (5). Two pupils refer to the app/service "GoStudent".

See Figure 3. The use of apps/services and hardware for homework in the subject English (https://doi.org/10.6084/m9.figshare.12250154).

In terms of media hardware, the smartphone is most mentioned, with 11 times for homework in English. The schoolbook is mentioned 5 times, and computers or laptops are mentioned 4 times. Portable Bluetooth loudspeakers, unspecified documents and papers, and a data projector are only mentioned one time each.

3.2.3. Discussion: Schools' use of hard- and software has impact on homework

The use of Office365 in Mathematics in the combination with laptop computers and the use of Quizlet in English language education in combination with smartphones for homework is striking. Additional background information shows that within the sample there are some schools and classes that have established an environment of schoolwide WiFi along with one-to-one laptops (such as Google Chromebooks) making use of the Swiss-wide Office365 framework-contract. In relation to the theoretical framework, this example shows that infrastructures such as notebook computers and online learning environments directly relate to pupils' agency and ability to act upon their world in the context of domestic learning. In practice, it means that it makes sense to invest in a school wide wireless Internet access (WiFi) plus a learning management system, incorporating software-as-a-service (SaaS) such as Office365. The data shows that –within this environment– laptop computers do make more sense than just tablet computers as they provide a fully equipped operating system which is ready for everyday production use. The instant messaging system WhatsApp seems to provide an accompanying level of communication.

The language education subjects provide a different but complementary picture in that teachers provide tasks on the platform Quizlet which pupils are fulfilling on their smartphones. Additionally, pupils are using translation apps and services. Both work well browser-based on smartphones as well as on laptop computers. Homework in both subjects (Mathematics more than English) use traditional paper-based school and exercise books, as well as documents and papers.

4. Discussion and conclusion

The project "Homework & Media Education" and its team question how pupils use media as resources for their daily learning practice within their media ecology and in which ways pupils select and find orientation within the wide range of media and the resulting opportunities. The central question is how pupils perform agency within their daily media-practice considering social, cultural, and technical structures.

The ways and modes in which media are integrated in learning practices by pupils, drawing from their everyday media practice as resources, show manifold ways of not just reaching the goal "homework completed". Pupils integrate their media environment into daily learning practices by diversifying their media ensemble according to their needs and possibilities. This practice of integration demonstrates how pupils actively produce their own learning contexts. This production of contexts, i.e. actively overlapping characteristics and practices of different contexts, is one of the central performances of pupils' agency. In the survey resp. in the media diaries the pupils were asked to note media activities in the context of their homework, displaying a much wider range of activities than just the obvious completion of homework. This demonstrates the fluidity and overlap of the school's learning context and everyday life outside school.

The example of "checking" and its collocations with popular Apps such as WhatsApp, Instagram and Snapchat show how it is possible to argue that smartphone-centred media activities can be described as an emerging cultural practice. It does not only occur as a routine in the data but expands from everyday life media use towards being appropriated for not originally designed purposes (such as learning/doing homework). As could be shown, these emerging cultural practices, including the use of hardware as well as apps/services, are deeply integrated into homework as school-associated activities in out-of-school contexts (Blair et al., 2017). Besides traditional didactic and educational functions of homework, discussed in the introduction, the presented results suggest widening the view on media use from "traditional" school

media to everyday media integrated by students into homework and learning activities. Although the data provides rich insights on mornings, afternoons and evenings, activities with media inside school was rarely mentioned by pupils and was not a focus of this study. However, the data allows inference on media used for specific school tasks and subjects (such as English vocabulary training in Quizlet), mirrored in the domestic learning practices. The sample size is rather large but heterogeneous for a qualitative study, which fosters computer-aided data handling, documentation, and analysis by exploiting most recent procedures in qualitative analysis.

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WhatsApp for the development of oral and written communication skills in Peruvian adolescents

WhatsApp para el desarrollo de habilidades comunicativas orales y escritas en adolescentes peruanos

Dr. Fortunato Escobar-Mamani, Research Professor, Graduate School, National University of the Altiplano, Puno (Peru) (fescobar@unap.edu.pe) (https://orcid.org/0000-0002-3922-4621)
Dr. Indira Gómez-Arteta, Assistant Professor, Faculty of Educational Sciences, National University of the Altiplano, Puno (Peru) (indigoar1@hotmail.com) (https://orcid.org/0000-0001-6489-2261)

ABSTRACT

In Puno, a region of Peru, the development of oral and written communication skills in basic education students displays weaknesses which could be overcome with the application of technological tools. The objective of the study was to determine the effectiveness of WhatsApp as a mobile learning resource in the development of oral and written communication skills of secondary level students at the 'José Carlos Mariátegui' educational institution (Puno-Peru). The population was comprised of 343 students and a non-probabilistic, convenience sampling was applied to include two fourth-level sections of 36 and 34 students, respectively. The first was the experimental group and the second, the control group. The selection was made considering that fourth-level students are the most appropriate age to use WhatsApp in order to assess the evolution of their skills through rubrics, in a participatory way. Statistical analysis was based on the difference in means with a Z distribution, with a 95% confidence level. The results show that WhatsApp develops significant oral and written communication skills, as those skills rose by 3.5 points on average, on a twenty-point scale, after the experiment. Thus, WhatsApp is a mobile learning technology resource available to develop skills and strengthen knowledge in students.

RESUMEN

En Puno, una de las regiones del Perú, las habilidades comunicativas orales y escritas de estudiantes de educación básica muestran debilidades en su desarrollo, que podrían ser superadas con la aplicación de herramientas tecnológicas. El objetivo del estudio fue explorar la eficacia del uso del WhatsApp, como recurso de aprendizaje móvil, en el desarrollo de habilidades comunicativas orales y escritas en estudiantes del nivel secundario de la Institución Educativa 'José Carlos Mariátegui' (Puno-Perú). La población fue de 343 estudiantes y el muestreo no probabilístico, inducido por conveniencia, fue de dos secciones de cuarto grado, de 36 y 34 estudiantes, respectivamente. La selección se hizo considerando que los estudiantes de cuarto grado tienen la edad más adecuada para usar el WhatsApp y poder evaluar la evolución de sus habilidades a través de rúbricas, de manera participativa. El análisis estadístico se basó en la diferencia de medias con distribución Z, con un nivel de confianza del 95%. Los resultados muestran que el WhatsApp desarrolla habilidades comunicativas orales y escritas de modo significativo, en el caso estudiado, ya que esas habilidades se elevaron en 3,5 puntos, como promedio en una escala vigesimal, después del experimento. Por lo descrito, WhatsApp es un recurso tecnológico de aprendizaje móvil disponible para desarrollar habilidades y fortalecer saberes en los estudiantes.

KEYWORDS | PALABRAS CLAVE

WhatsApp, mobile learning, digital technology, communication skills, ICT in education, social networks, secondary education, multimedia resources.

WhatsApp, aprendizaje móvil, tecnología digital, habilidades comunicativas, TIC en educación, redes sociales, educación secundaria, recursos multimedia.

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1. Introduction and state of the art

The National Curriculum for Regular Basic Education in Peru considers, within the curricular area of Communication, three competencies: oral communication, plus reading and writing various types of texts (Ministry of Education, 2016). However, in spite of policies aimed at developing these competencies, the expected results have not been achieved, and deficiencies have been found in the development of communication skills, since students do not yet demonstrate optimal speaking, listening, reading, and writing skills. This situation prompts the quest for resources and strategies to help overcome these weaknesses. One alternative is the use of information and communication technologies (ICTs), which attract attention, motivate and make students feel part of the globalized world, trying to strengthen the positive use of technology and reducing one or more problems, such as the risk of addiction to social networking sites due to their inadequate use (Nie et al., 2019). When used rationally, ICTs enable us to access a range of resources to develop various types of learning. For this reason, it is necessary to adapt to them, considering that "the appropriation of technologies is conceived as a process that takes place in a certain socio-historical space, through which subjects develop an active and participatory position around them" (Angeriz, 2019: 98).

In this context, educational institutions have had to strive to use these resources for the benefit of their students. "The incorporation of the mobile phone into teaching-learning processes (m-learning) is becoming increasingly important, sometimes initiated by the teacher and sometimes as part of the personal or group learning processes of the students themselves" (Gómez, 2017: 62). Previous studies related to the use of ICTs by teachers, show "a scenario where students perceive themselves as self-sufficient and capable of obtaining solutions, but without attributing it to the use of ICTs in the educational institution" (León-Pérez et al., 2020: 99).

However, the use of ICTs also has some disadvantages, especially when it is separated from academic purposes. Previous studies state that social networks have a negative impact on physical and social dynamics, since adolescents spend several hours online, leaving aside their physical and social activities, which can lead to behavioral and health problems (Hernández et al., 2017). Additionally, "students who make more problematic use of mobile phones tend to have a higher degree of FoMO (Fear of Missing Out)" (Santana-Vega et al., 2019). In Latin America, problematic use of the Internet has been related to aspects such as: distraction during study hours, obstruction of daily activities, poor social skills, altered sleep quality, impulsive behavior, neuroticism, aggressiveness, anxiety, insomnia and depression (Araujo, 2016); the frequency of problematic Internet use amounts to 13.84% in medical students and 24.18% in students in other health careers (Muñoz-Dueñas et al., 2017).

1.1. WhatsApp in education

WhatsApp is an evolved form of written communication that can enrich expressions with iconic and audiovisual elements (Cremades et al., 2016). It is an eye-catching, entertaining and useful resource in the educational process, as it allows the student to feel that he or she is part of a technological saga, and to learn spontaneously through its multiple text and multimedia functionalities. In addition, "WhatsApp use has become ingrained among teenagers, with the mobile phone now being the most widely used" (Del-Barrio & Ruíz, 2017: 29). Overall, the pedagogical possibilities of WhatsApp have been explored from different areas: in formal, informal, face-to-face and distance education (Suárez, 2018). Studies such as the one conducted by Bottentuit et al. (2016) state that the greatest pedagogical use of WhatsApp takes place at the university level. This is explained by the fact that "in many secondary school classrooms students are not allowed to use their mobile phones" (Suárez, 2018: 126).

WhatsApp can be used as one of the most productive and feasible pedagogical resources for creating a rich, interactive learning environment in the classroom compared to computer and CALL labs (Singh et al., 2020). WhatsApp also establishes a more personalized relationship with the teacher, motivates students to learn by maintaining a positive attitude toward their educational use, promotes participation, even among the most withdrawn or shy students and develops written and oral communication (Suárez, 2018). Also, the time dedicated to WhatsApp has a positive influence on the psychological well-being of students (Bano et al., 2019). Likewise, it is important to consider that communication through WhatsApp "is no

longer exclusively textual, and increasingly the exchange of information, opinions or feelings becomes more expressive, rich and varied with other communicative elements through images, videos, audios, stickers" (Gómez, 2017: 62).

In addition, WhatsApp provides users with information beyond the published message, such as: viewing the status of the recipient, knowing whether the recipient is writing, or checking whether the message was read (König, 2019). Additionally, among the advantages that WhatsApp provides in student-teacher communication, it is worth noting that it allows teachers to be highly available for their students' questions and requests, allowing the entire group to learn from answers given to a student who requested clarification (Rosenberg & Asterhan, 2018). Because of these advantages, the viability of using WhatsApp as a support group for graduates in remote and marginalized spaces has been demonstrated (Pimmer et al., 2019).

However, the use of WhatsApp has also shown disadvantages and even dangers, ranging from use that only leads to information overload (Matthes et al., 2020) to cyberbullying, which generally occurs in WhatsApp groups (Chan et al., 2020) and which, in Israel, affects 56% of students (Kashy & Aizenkot, 2020). There is also evidence of a high rate of adolescent use of WhatsApp, with negative use linked to personality and anxiety problems (Tresáncoras et al., 2017).

Specifically, WhatsApp has been linked to the development of communication skills, which are defined as groups of verbal and non-verbal strategies that people perform with certain communication objectives aimed at developing communication competence (Ministry of Education, 2013). Communication skills are indispensable for people to relate to others effectively since they allow people to understand and produce relevant messages. However, these skills have been found to be poorly developed in some contexts. For example, it is known that 54.5% of higher education students at the Universidad Nacional del Altiplano (UNA) in Puno, Peru, demonstrate a fair level; 42.9% have a deficient level and only 2.6% demonstrate a good level in the use of their communication skills (García et al., 2018). That is why it is important to promote the use of ICTs in educational processes, particularly WhatsApp, which facilitates interactive discourse, with rapid exchanges of text, images, audio, video (Rosenberg & Asterhan, 2018) and can be used as a strengthening tool for pedagogy in general and for language and literature teaching specifically (Singh et al., 2020). In addition, the multiple resources provided by WhatsApp allow students to understand and produce text by using both verbal and iconic code, which is easy and fun for them to do. In this regard, WhatsApp chats have been known to allow users to use "laugh" particles to demonstrate how they understood a publication or how they want their publication to be understood (König, 2019).

Therefore, the study focused on the use of WhatsApp's textual and multimedia resources to develop communication skills in high school students, so that they can listen, speak, read, and write freely, when their curiosity demands it, developing their critical thinking to have effective communication processes. Therefore, the objective of the research, implemented by the National University of the Altiplano in 2019, was to determine the effectiveness of using WhatsApp as a mobile learning resource, in the development of oral and written communication skills in students from the "José Carlos Mariátegui" Secondary School.

2. Material and methods

The design corresponds to a quasi-experimental case study, with pre and post-test and control group, to determine the effects of WhatsApp use as a mobile learning resource in the development of oral and written communication skills.

2.1. Participants

The study was developed in 2019 in the city of Puno-Peru, which is located 3,823 meters above sea level. This city is home to a secondary school population of 147,654 students (Ministry of Education, 2017), who live in a multicultural and multilingual context. The population in the present study was comprised of students from this secondary school in Puno (Table 1). It is located on the university campus, and one of its objectives is to promote the implementation of new strategies and resources proposed by teachers and students of the Professional School of Secondary Education from the Faculty of Educational Sciences at UNA in order to achieve better learning.

Table 1. Research Population			
Level	Section		Total
	A	B	
1º	35	35	70
2º	34	35	69
3º	35	34	69
4º	36	34	70
5º	32	33	65
Total	172	171	343

Note. 2019 enrolment lists for 'José Carlos Mariátegui' Secondary School in Puno (Peru).

The sample was selected through a non-probabilistic convenience sampling approach, selecting students from the two sections of the fourth year of secondary education (A and B), whose ages fluctuate between 15 and 16 years, considering that the older the teenagers are, the more they use the cell phone to send messages through WhatsApp. Moreover, this application reaches its peak in the fourth year of Compulsory Secondary Education (Del-Barrio & Ruiz, 2017). Additionally, it was verified that all students had a cell phone with WhatsApp installed and considering that this application is free, there were no issues in its use. Of the two sections, the first was the experimental group (36 students) and the second was the control group (34 students).

2.2. Instruments

Data were collected using the convenience-based participant observation technique, with rubrics to assess oral and written communication skills: speaking, listening, reading, and writing.

The rubric was chosen considering that it is "an instrument of educational evaluation that contemplates a progressive scale of performance levels that correspond to ranges of task execution, enabling the establishment of quality judgments regarding the work of students" (Bruna et al., 2019: 19). Additionally, the main advantages of this instrument have been identified as: a) Its formative (versus summative) and training value; b) The possibility of guiding a process (versus valuing a product); c) The value of building it (versus consuming it) (Cano, 2015).

Table 2. Rubrics used in the study			
Criteria	Abilities evaluated	Qualitative scale	Numeric value
Speaking skills	Expressing an opinion and making a case for it Expressing feelings and emotions Transmitting information objectively Interpreting the meaning of symbolic language	Poor Regular Good Excellent	2 3 4 5
Listening skills	Understanding the content of speech Understanding the communicative purpose Distinguishing relevant from irrelevant information Inferring the message contained in the discourse.		
Reading skills	Identifying the main and secondary ideas Extracting the overall meaning of the text Inferring information Critically discussing the content of the text		
Writing skills	Writing with clarity and logical order Writing with correct spelling and grammar. Using language shared with the reader Writing complete narratives Demonstrating a clear communicative purpose	Poor Regular Good Excellent	1 2 3 4

Each skill was evaluated considering specific descriptors, which respond directly to the competencies and abilities for the area of communication, embodied in the National Basic Education Curriculum in Peru, so that they make it possible to catalogue the execution of the task or activity at a level of the qualitative scale and numerical value proposed (Table 2). Although the qualitative scale is the same for assessing all skills, the quantitative scale varies according to the number of skills assessed. Thus, in each of the first three criteria, four skills were evaluated, with a score ranging from 2 to 5. Moreover, in the fourth criterion, five skills were evaluated, with a score ranging from 1 to 4. It is important to consider that the rating was made on a twenty-point scale. These aspects allowed for an objective collection of data, ensuring that the instruments have content and construct validity, which was achieved through the review of their correspondence with the theory used and the evaluation of eight experts from UNA Puno, both in terms

of form and substance. Of these experts, seven have degrees in education, specializing in language and literature, and one has a degree in linguistics and literature. All of them hold a PhD degree. The results show an Aiken's V coefficient of 0.9, which implies that the instruments had content validity, verifying the item-construct relevance (Galicia et al., 2017).

The reliability of the instruments was measured through Cronbach's alpha coefficient, using SPSS 23 software. This coefficient was 0.731 for the headings measuring speaking, listening and reading skills, which is an acceptable internal consistency value. For the rubric used to measure writing ability, the Cronbach's coefficient was 0.902, which shows an excellent internal consistency.

2.3. Procedure

The research was carried out during the third quarter of 2019, previously releasing a protocol for the rational use of WhatsApp, inside and outside the institution. This protocol for the use of WhatsApp received the consent and approval of the students and parents in the experimental group. In order to guarantee healthy conditions in its application, the protocol considered the following points: time of use (no more than three hours a day, under the supervision of the teacher or parents), location of use (one hour at school and two hours at home), rules concerning respect in communications (polite use of language, respect for the opinions of others and use of chats only for academic purposes) and sanctions for offenders (individual calls for attention or expulsion from the group). To execute the experiment, the following resources available in WhatsApp were used: text messages, emojis, voice messages, calls, video calls and attached files (audios, videos or documents), both to order and to receive activities; encouraging actions of oral expression, listening, reading and writing. The experiment was carried out during 20 learning sessions in the area of communication, in the following sequence:

- To develop written communication skills, 10 literary texts (Peruvian stories) and 5 non-literary texts (informative) were shared.
- In order to develop oral communication skills, 10 motivational audios and 5 personal development videos were shared.

Each file was accompanied by pertinent indications to evidence that the students are reading, writing, listening and speaking including oral reading, open questions, analogies, comments and practical exercises. These were all oriented to verify the specific skills considered in the rubrics. These activities were carried out through individual and group chats in order to promote self-learning and inter-learning. The students' communication skills were measured before and after the experiment, both in the experimental group and in the control group, in order to be able to compare these results. It should be noted that the control group worked with the same texts, audios and videos; but the activities were carried out directly in the classroom, without promoting the use of WhatsApp or other virtual media.

2.4. Data analysis

Considering that we sought to compare the means of two independent groups with known variances, the final statistical analysis was based on the difference of means with Z distribution, with a confidence level of 95.0%.

3. Analysis and results

The results obtained (Table 3) show that WhatsApp develops oral and written communication skills in a significant way, according to the following scale: Qualitative/quantitative scale: Poor [0-10>; Fair [11-13>; Good [14-17>; Excellent [18-20].

Table 3. Communication skills in pre-test and post-test

Communicative Skills	Pre-test				Post-test			
	Experimental group		Control group		Experimental group		Control group	
	Fi	%	Fi	%	Fi	%	Fi	%
Poor	10	28	9	26	0	0	10	29
Regular	23	64	22	65	12	33	23	68
Good	3	8	3	9	22	61	1	3
Excellent	0	0	0	0	2	6	0	0
Total	36	100	34	100.0	36	100.0	34	100.0

Before the experimental treatment, more than 60% of the students in both groups had a regular level in the use of communication skills, with an average of 11.4 in the experimental group and 11.8 in the control group, showing weaknesses in the comprehension and production of texts, both oral and written. Statistical analysis based on the difference in means with a Z distribution, with a confidence level of 95.0%, shows the value of Zc=0.8960 < Zt=1.9599; therefore, there is no significant difference between the results of the pre-tests of the two groups.

After the treatment, 61% of students in the experimental group showed a good level in the use of oral and written communication skills, raising their average from 11.4 to 14.9, with an improvement of 3.5 points. This improvement includes the use of verbal strategies that allow them to achieve communication objectives to listen, speak, read and write better, using WhatsApp's text and multimedia resources in an entertaining way and encouraging autonomous learning. In the control group, 68% maintained a regular level in the use of communication skills, with an average of 12.1 points. This result is also ratified by the statistical analysis based on the difference of means with Z distribution, with a confidence level of 95.0%. The value of Zc=6.4788 > Zt=1.9599 shows that there is a significant difference between the results of the post-tests for both groups.

It is important to highlight that in the experimental group; the most developed skills were oral: listening and speaking (Table 4). With WhatsApp, students could better understand an oral text since they could listen to it more than once and do it at a convenient time within the parameters established in the protocol. Moreover, they could deliver oral messages more naturally, overcoming the insecurities and fears generated by speaking in front of their peers and teachers, expressing themselves freely with more confidence, criticism and relevance.

Table 4. Development of communicative skills of the group

	Pre-test average	Post-test average
Oral skills	11.2	15.9
Written skills	11.6	14.0

In oral expression, the skills developed included the expression of feelings and the articulation of opinions; while the less developed ones were the interpretation of figurative language and the objective transmission of information. In oral comprehension, the most developed skills were understanding the content and purpose of the discourse, developing less skills related to the discrimination of relevant and irrelevant ideas and inference of the message (Table 5).

Table 5. Communication skills results - experimental group

Criteria	Assessed Skills	Pre-test*	Average Pre-test*	Post-test*	Average Post-test*
Speaking Skills	Expressing an opinion and articulating it	11.8	11.3	16.8	16.2
	Expressing feelings and emotions	11.5		17.9	
	Transmitting information objectively	11.5		15.6	
	Interpreting the meaning of figurative language	10.5		14.6	
Listening skills	Understanding the content of discourse	11.5	11.1	16.6	15.5
	Understanding the communicative purpose	11.0		16.0	
	Discriminating relevant from irrelevant information	10.9		15.0	
	Inferring the message of the discourse.	11.1		14.3	
Reading skills	Identifying the main and secondary ideas	11.0	11.4	13.4	13.8
	Extracting the overall meaning of the text	11.6		14.5	
	Inferring information	10.9		12.8	
	Critically commenting on the content of the text	12.1		14.5	
Writing skills	Writing with clarity and logical order	12.6	11.7	14.8	14.2
	Writing with correct spelling and grammar	10.1		12.8	
	Using a language shared with the reader	11.8		13.2	
	Writing complete narratives	12.5		15.7	
	Demonstrating a clear communicative purpose	11.7		14.3	

*Qualifier on a twenty-point scale.

Written skills, reading and writing, advanced with certain particularities. Regarding reading comprehension skills, the most developed ones were critical commentary and identification of the overall meaning of the text; those that were least developed included making inferences and identifying main and secondary ideas. In relation to written production, although it improved, it did so in terms of substance rather than form as each text is understandable, but the cohesive mechanisms have almost been forgotten;

there are spelling errors in 95% of the texts and the use of the digital language created by the users of WhatsApp is present in 100% of the texts (Figure 1). The skills that were most developed were writing complete narratives (anecdotes) and demonstrating a clear communicative purpose. The use of language shared with the reader and spelling and grammar correction were less developed (Table 5).

When comparing the number of messages used by students, the prevalence of voicemail, as opposed to text messages, was noted. On average, each student recorded 98 text messages (approximately 48 words each) and 143 voicemails (approximately 73 words each) during the quarter, demonstrating that students are more comfortable sending voicemails.

Figure 1. Example of the textual production of a student from the experimental group

4. Discussion

The results substantiate the idea that the use of technology "allows, for example, teachers to create networked environments for students to store, share and develop their work in a collaborative manner, and to apply flexible student-centered teaching and learning strategies" (Casanova et al., 2019: 148).

The use of WhatsApp as a learning resource has positive effects on the development of communication skills, providing opportunities for students to feel that they are using modern technology and to strive to speak, listen, read, and write appropriately. This result reinforces the idea of Bottentuit et al. (2016) who define WhatsApp's pedagogical strategies as educational possibilities. That is, they are resources that provide great opportunities in the teaching-learning process. Furthermore, they assert that "some benefits of using social networks include sharing information and ideas and improving reading skills" (Badri et al., 2017: 1441).

Students communicate more often through WhatsApp, with enthusiasm and a feeling of freedom, especially when speaking, which has been noted in the critical comments they made on various topics, showing spontaneity in their expressions. This is due to the fact that the didactic use of the mobile phone is very motivating (Pineda et al., 2017).

Likewise, the results support the idea that "young people justify that, either for comfort, lack of time or shyness, they communicate through WhatsApp more often than face to face" (Rubio-Romero & Perlado-Lamo-de-Espinosa, 2015: 81), showing that this application, used rationally in an ethical framework, is a very useful learning resource to promote the development of oral and written communication skills, especially in those students who displayed shy traits when speaking.

The finding suggesting that oral communication skills were developed at a greater rate than written skills with the use of WhatsApp, coincides with authors who found a strong correlation "between the use of voice chat on mobile phones and the development of oral competence, suggesting some speech skills have experienced a superior improvement over others, such as fluency, pronunciation and vocabulary" (Andújar & Cruz, 2017: 48). It also supports findings by Rosenberg and Asterhan (2018), who indicate that chats on WhatApp make students feel closer to their teachers, because of the playful speech used and the informal content, which is common in this type of communication. This aspect is related to the more personalized interaction that is created between teachers and their students, providing greater confidence to express themselves, which also generates a sense of "students' connection with the teacher and consultation, which promotes group work and the use of technology to perform school tasks in teams" (Coicaud, 2019: 157). In relation to written communication skills, these were developed with the use of WhatsApp, since this application is an inexpensive and flexible resource that offers potential to assist in the process of learning to write (Susanti & Tarmuji, 2016). However, the weakness lies in the grammatical and spelling errors found in the messages (Figure 1). In this regard, Vázquez-Cano et al. (2015: 101) point out that some of the errors in this type of communication include: "the absence of capitalization and accents, duplication of letters, word linking, phonetic spelling, heterographies and errors in letter spelling". For their part, Del-Barrio and Ruiz (2014) believe that spelling and standard language use does not improve with the use of WhatsApp, as students create their own digital language. This language responds to the need to express a lot with few words, which have been changed or shortened to make writing easier, a common feature in social networks (Díaz, 2019). Likewise, results show that 100% of the students used textisms in their productions, which far from impairing understanding, helped to interpret the message. On the one hand, researchers such as Gómez-Camacho et al. (2018) showed that there is no direct negative relationship between textual use and spelling; on the other hand, Hunt-Gómez et al. (2020) considered that textual use of non-normative graphemes, excluding capital letters or accents, causes spelling mistakes and learning problems. These last results should help to think of new strategies that help to improve written communication through WhatsApp in the educational field. In this respect, Gómez and Gómez (2015: 102) state that "a new digital literacy in communication mediated by computers and smartphones is essential among the objectives of secondary and higher education" since the innovative forms of digital writing should be opportunities to teach the language and be included in the classroom as educational resources (Hunt-Gómez et al., 2020).

5. Conclusions and recommendations

In conclusion, WhatsApp, as an educational resource, develops communication skills in secondary education students, helping them understand and produce oral and written texts with greater spontaneity and responsibility, promoting self-learning in a fun way and making them feel part of the technological age of knowledge. It is a highly motivating resource that allows students to learn in a fun way and have a more personalized relationship with the teacher, which fills them with confidence to produce their texts. This mobile learning resource has enabled students to read and write short texts, developing their critical and argumentative skills, using text and iconic resources spontaneously. In addition, and with greater intensity, WhatsApp has enabled the development of oral communication skills, by allowing students to listen to audios, analyze videos and broadcast voice messages to express their critical views on the texts heard. This mobile learning resource opens the door to new forms of teaching and learning, with many possibilities yet to be discovered. These must be oriented towards rational and ethical use, in order to continue to counteract the negative effects of technology since we know that, "despite the benefits of student participation in social networks, their misuse could affect students' academic lives and, therefore, their performance" (Badri et al., 2017: 1441).

Finally, it should be noted that the results of the study have two main weaknesses: they cannot be generalized due to the small sample used as it is a case study; and that only communication skills were evaluated in a general way, without reaching an in-depth analysis (semantic, syntactic and pragmatic), which opens up several possibilities for further research on this topic. These include broadening the sample, using complementary qualitative and quantitative methods, delving deeper into the content analysis of the productions and exploring the pedagogical potential of WhatsApp to promote other learning in various settings.

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