ICT-Supported Home-Based Learning in K-12: a Systematic Review of Research and Implementation

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Abstract

With the integration of technology in teaching and learning, online learning is not a new instructional strategy in the education landscape. However, the onset of the Covid-19 pandemic has necessitated the implementation of Home-based Learning (HBL) for educators, parents, and students on an unprecedented duration and scale. The notions and the factors associated with the implementation of HBL are yet fully investigated. As such, this study aims to shed light on the prerequisites needed for implementing HBL and suggest its future research direction. The methodology involves a systematic review of the existing studies on ICT-supported formal learning outside the classroom and to identify the prerequisites of HBL from various perspectives of the students, teachers, and parents. By doing so, this report will provide a deeper understanding of the multiple components of HBL and how it is to be taken into consideration when implementing HBL from both the theoretical and practical standpoint.

Keywords Word · Home-based learning · ICT · K-12 · Formal learning

Introduction

Home-based Learning (HBL) has received tremendous attention worldwide due to the COVID-19 pandemic in 2020. HBL is not new; it includes homeschooling where parents are primarily responsible for their child's education and distance education (Harding 2011). Originally, HBL is the practice of parents or guardians taking responsibility for the education of their school-age children outside of the conventional school system (Conradie 2016). The wide use of Information and Computer Technologies (ICT) and the influence of the pandemic give new meaning to HBL, which refers to the practice that takes place when the teacher and students are in separate locations but learning occurs with ICT tools. Students are also

expected to complete learning activities at their own pace and over a period of time. Currently, the students' age, digital skills, computer access, the flexibility of learning modes, and home support are considerations for the implementation of HBL. However, beyond these, principles behind the pedagogical design or strategies of HBL implementation are still undefined as many existing studies focus on either homeschooling or online learning, which cannot provide a different experience from such long-term and large-scale HBL.

Apart from homeschooling, previous studies have shown that learning at home is commonly defined by 'informal learning', whereas 'formal learning' refers to learning in schools. The prevalence of the usage of mobile devices for education has led to changes in the precise definitions of formal and informal learning. The blurring of lines between formal and informal learning has given rise to the type of learning morphing into a continuum, with the organization at one end and setting at the other (Sefton-Green 2004). Organization refers to a highly structured learning process, while setting refers to the location learning occurs. This change could be due to the integration of technology in learning. An increasing number of studies on mobile learning emphasizes the role of technology as "extended cognitive tools" (Barr et al. 2015) that

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can bridge the gap between formal and informal learning (Mills et al. 2014). Consequently, the differences between formal and informal learning have been reduced. Some researchers even contend that there are no distinctions between them, as they believe that components of both formal and informal learning are involved when learning occurs. (Manuti et al. 2015, p.12).

Despite the knowledge that learning within and beyond schools should complement one another (e.g. Bamberger and Tal 2006; Stocklmayer et al. 2010) and the effectiveness of ICT for education in schools has been widely investigated, there exist few studies that involve the usage of ICT for learning in homes, where more learning can occur (Furlong and Davies 2012). The recent surge in interest with regard to flipped lectures is an exception. Different from the traditional pedagogical framework, curriculums involving these flipped lectures incorporate learning activities in both home-based and school-based settings (Kong and Song 2015; Manuti et al. 2015). However, a limitation with these studies would be that these studies emphasize designing student-centered activities in the classroom but most involve relatively passive activities at home. These passive activities include watching video-recorded lectures to educational materials, which are much less preferable to active learning activities. In contrast, there are many online courses available for adults for the past few years, with an increasing awareness of Massive Open Online Courses (MOOCs). Nevertheless, it remains unknown whether the factors affecting learners of MOOCs and prerequisites of MOOCs could apply to HBL towards younger learners.

In sum, it is still unknown how the factors in existing research related to HBL in terms of pedagogical design and learning effectiveness. Thus, this study aims to uncover the prerequisites needed for implementing HBL via a systematic review of the existing studies on ICT-supported structured learning outside the classroom. This analysis will allow us to find out the characteristics of learning from home as a context for learning with ICT tools. As there are different learning needs between adult learners and young learners, it will be prudent to focus on differentiating the age of the learner. This study focuses on studies among K-12. It seeks to provide insights on implementing K-12 HBL for both educators and researchers. The present study poses the following research questions (RQ):

- RQ1. What are the main applications and measured outcomes of HBL in K-12 settings?
- RQ2. What are the instructional strategies or design principles used by HBL studies?
- RQ3. What are the implications drawn from the findings of HBL studies?

Methods

Identification of Eligible Studies

To address the research questions, we performed a systematic literature review following the guidelines created by Kitchenham and Charters (2007). This approach can help to systematize and summarize the empirical work in the field over time, and aggregate the insights from the review (Mangaroska and Giannakos 2019). In this study, the literature selection consisted of three stages. In Stage 1, two online research databases (ERIC via EBSCOhost Web and ISI Web of Science) well known with regard to education and technology were used to search for home-based learning articles published from 2000 to 2020. Majority of relevant studies could be obtained based on these two databases. To ensure the quality and scope of the articles reviewed, the document type was limited to peer-reviewed journal articles and articles written in English. The keywords employed the Boolean/Phrase search mode and are the following: (1) “Formal Learning” AND “Online” NOT “Higher Education”; (2) “Home Learning” AND “Technology” and; (3) “Home Learning” AND “Digital”. The last search was conducted on 2nd June 2020. The search produced 619 results by the search terms, including 23 duplicates, which were eventually deleted.

In Stage 2, two researchers read through the titles, abstracts, and articles of the search results. Six exclusion criteria were used to screen out those articles that were not eligible in this review. They were: (a) adult learning; (b) not in formal schools; (c) blended learning or flipped learning in which HBL occupies a small proportion; (d) without involving technology; (e) only concentrating on network or infrastructure and; (f) non-empirical studies. There were only 18 articles had met the selection criteria.

In Stage 3, we eliminated sources with identical authors describing the same project. We did so by adopting the “snowballing” technique (Biernacki and Waldorf 1981), where we scanned the references in the identified articles. During the process, one more article was added. Finally, 19 articles were included as eligible articles for the review.

Analysis

Articles that met the inclusion criteria were analyzed using thematic analysis. Following the 6 steps of thematic analysis (Braun and Clarke 2006), two authors first familiarized themselves with the data. Next, the first author defined the direction for analysis for each research question, such as context, instructional strategies, methods, and findings. Following that, the first author and the third author manually coded the studies in Excel sheet separately as part of this data-driven stage. At this stage, part of data could be coded literally, for instance,

the participants or instructional strategies, whilst semantic codes were generated to capture the data regarding main applications and implications of research findings. This coding was an inductive process to generate categories based on what had been done and suggested in the reported studies. Then as a pair, the two authors explored the dimensions of each category and combined some categories to establish common themes by focusing on existing HBL studies concerned and suggested. Lastly, the final dimensions of categories were confirmed by all the three authors together.

Results

Main Purposes of HBL Studies and Measured Outcomes

All the studies are categorized into 2 groups in terms of their research purposes: designing for and implementing HBL (7 studies, see Table 1) and understanding HBL phenomena and needs (12 studies, see Table 2). **Designing for and implementing HBL** focuses on developing or implementing a specific system or online learning approach for learners to carry their learning at home. Some examples of the learning tools include the following: educational games developed by Jong (2015), Stubbé et al. (2016) and Barajas-Saavedra et al. (2015); a cyber home learning system through video conferencing by Lee, Yoon, and Lee et al. (2013); LMS by Laho (2019); an online learning platform by Borup et al. (2019) and a language learning software by Nshimbi et al. (2020). In addition, there is only one study in this category focusing on the pedagogical design and its implementation at home (Laxman 2011).

The other category, **understanding phenomena and needs**, consists of studies investigating students', teachers', and parents' behavior and interaction with technology at home and their effects on learning at home. This category mainly includes the generic investigation of the use of ICT tools in HBL across different age groups (e.g., Huber et al. 2018; Palaiologou 2016; Friedrich et al., 2017) and the factors affect the learning effect, such as gender or adults' supports (e.g., Lei & Zhou 2012; Lim and Meier 2011).

Based on our research, there is only a small number of studies paying attention to design for HBL. In addition, the impact of HBL is often evaluated through self-reported measures concerning an individual's perceptions via questionnaires or interviews. Although there are a few studies regarding online game-based learning at home (e.g, Jong and Shang 2015; Stubbé et al. 2016) as well as pedagogical strategies of HBL (e.g., Laxman 2011) that provide evidence of the cognitive benefits of HBL, it remains that the majority of studies are concerned with affective benefits.

Instructional Strategies Used/Investigated in the Studies

Few HBL studies emphasize investigating instructional or pedagogical strategies, of which **parental involvement** (e.g. Huber et al. 2018; Laho 2019; Palaiologou 2016; Plowman et al. 2008; Borup et al. 2019; Eutsler et al. 2018), **peer learning** (e.g. Jong 2015 & Furlong and Davies 2012), or **clear communication between teachers and parents** (e.g. Lee et al. 2013; Laho 2019; Borup & et.al., 2019) were mentioned and adopted.

Additionally, Lee et al.'s (2013) study indicated that **synchronous video conferencing** could allow more room for the human touch in an online learning system and also encourage

Table 1 HBL studies about designing for and implementing HBL

Author (year)	Method	Subject (Level of Participant)	Main data source	Cognitive outcome	Affective outcome
Laho 2019	Survey study	Generic (K-12)	Questionnaire	–	Acceptance
Hermes & King 2013	Case study	Foreign language learning (primary)	Interview; Videotaped learning process	–	Motivation
Lee et al. 2013	Survey study	Generic (primary)	Questionnaire	–	Acceptance and effectiveness
Nshimbi et al. 2020	Experimental study	Literacy (primary)	Pre-and post-tests	Academic performance	–
Stubbé et al. 2016	Experimental study	Mathematics (primary)	Pre-and post-tests	Academic performance	–
Jong and Shang 2015	Case study	Geography (secondary)	Questionnaire; Interview; pre-and post-test; observation of learning	Academic performance; Higher-order thinking skills	Motivation; Enjoyment; Engagement
Laxman 2011	Experimental study	High school	Learning log	Academic performance	–

Table 2 HBL studies about understanding phenomena and needs

Author (year)	Research purpose	Method	Targeted group (Country)	Main data source
Huber et al. 2018	Examining the use of ICT tools	Survey study	Parents with a child aged between birth and 8 (Australia)	Questionnaires
Palaiologou 2016	Examining the use of ICT tools	Mixed methods	Parents with a child aged 5 (European countries)	Questionnaires and interviews
Plowman et al. 2008	Examining the use of ICT tools	Mixed methods	Parents (U.K.)	Questionnaires and interviews
Yılmaz Genç & Fidan 2017	Examining the use of ICT tools	case study	Parent-child preschool-aged (Turkey)	Observations related to preschoolers' tablet use and interview
Friedrich et al., 2017	Examining the use of ICT tools	Ethnographic case studies	Parents of pre-school aged children (Canada)	Interviews and field notes
Eutsler et al., 2019	Examining the use of ICT tools	Mixed methods	Parents (U.S.)	Questionnaires and interviews
Neumann 2018	Examining adults' supports	Mixed methods	Parent-child dyads (Australia)	Questionnaires
Lei & Zhou 2012	Examining the relationship between home Internet access/parental support and student outcomes.	Survey study	Students (China)	Questionnaires
Furlong & Davis, 2012	Investigating students' learning engagement	Mixed methods	Young people aged 8–21 (U.K.)	Interviews and questionnaires
Lim and Meier 2011	Investigating the difference in media use caused by genders	Mixed methods	Students (South Korea)	Interviews and questionnaires
Borup et al. 2019	Examining adults' supports	Mixed methods	Online teachers and on-site facilitators	Interviews and questionnaires
Kimmons 2014	Understanding supports for teachers	Survey study	K-12 teachers (U.S)	Questionnaires

timid students to voice their questions. Furthermore, it also stated that dual channel interaction should be provided with various modes of interaction, such as voice-only or text-only communication, to foster active participation and interaction due to its ability to engage students. Laxman's (2011) study investigated how well- and ill-structured problems influence the way students searched for information online. The research suggested that teachers may need to consider the structure of the assignments based on the student's ability.

Most studies investigate participants' perceptions of utilizing technologies as part of their HBL experiences through survey instruments, before exploring the link between participant characteristics and their perceptions. Gender has been linked to differences in perceptions of technology acceptance and technology use, and it is also highlighted in HBL studies. According to the findings of Eutsler et al.'s (2018) study examining 120 parents' reports of children's technology usage at home in the United States, boys used the digital device more than girls for both learning and entertainment purposes. They further suggested that boys may prefer more interactive apps. Lim and Meier's study (2011) towards identifying gender differences in the use of computers and the Internet in South Korea based on the survey data from 673 high school students also reveals that males preferred multi-users games playing while females preferred social networking. These studies

presented a difference in male and female behavior and attitude towards digital devices (e.g., Eutsler et al. 2018; Huber et al. 2018; Lim and Meier 2011). In addition, students' characteristics are taken into consideration in Jong and Shang's study (2015). In their study, four types of students— non-gamer student, gamer student, examination-oriented student, and angry student—are identified in terms of their views towards a HBL game. The findings suggest that students' performances and results are largely influenced by their approval of the game as a tool for formal learning. It is also stated by Furlong and Davies (2012) that young learners' engagement with new technologies is closely tied to their identity. In sum, these studies *shed light on the significance of individual characteristics when designing for HBL*. The individual difference may be caused by gender, cognitive styles, or even family economics and culture.

Implications Drawn from the HBL Studies

Table 3 shows a summary of the 4 main categories of implications and suggestions drawn from the existing HBL studies at different educational levels. The most striking trend is that *parental involvement* as an important factor affecting the effectiveness of HBL has received increasing attention in research across the ages. Younger students are dependent on their parents when it comes to technology access (Yılmaz

Genç & Fidan 2017). Parents can provide positive feedback and emotional encouragement such as “great job” or “well done” to encourage young learners to stay motivated and to complete challenging activities (Neumann 2018). Borup et al.’s (2019) study on parental engagement in HBL suggested that even for high school students, parents still have responsibilities to their children’s effective HBL, and parents can advise students on “course enrolments, nurtured relationships and communication with and between students, monitored student progress, motivated students to engage in learning activities, organized and managed students’ learning time at home” (p.79).

With regard to parental engagement, studies suggest that parents often have misconceptions about their children’s learning with digital devices (Plowman et al. 2008). Specifically, parents do not comprehend the role of technologies in supporting early childhood education and providing structure for the learning environments (Palaiologou 2016). Therefore, research findings suggest that teachers need to collaborate with parents to ensure that they understand the importance of digital devices in learning and are committed to helping their children to learn at home when implementing HBL (Borup et al. 2019). Prior to the implementation of HBL, schools should provide parents with materials and resources to clarify their misconceptions and garner their support to effectively engage their children in the HBL sessions (Borup et al. 2019; Laho 2019). Parents need to play their roles such as encouragers, facilitators, and friends during HBL (Borup et al. 2019). Also, parents and teachers should establish two-way communication between them via emails and mobile devices. This allows parents to keep track of their children’s learning progress and performance in partnership with the school teachers, enabling children to be well-supported both at home and in schools (Borup et al. 2019;

Laho 2019). Parents would also need to be informed about the proper use of digital devices instead of using them to keep their children occupied without supervision (Yılmaz Genç & Fidan 2017).

In addition to parental engagement, the necessity of *training in enhancing teachers’ e-pedagogy* is also highlighted in some of the studies. For instance, Lee et al.’s study (2013) indicated that training regarding instigating and maintaining positive student and teacher interactions in the online environment should be provided to teachers. It is also pointed out in Jong and Shang’s study (2016) that more attention should be paid to the strategies that encourage teachers to incorporate online gaming in HBL. As shown in Kimmons’s study, teachers may also have misconceptions (e.g., copyright, fair use) or a false sense of confidence in integrating ICT with pedagogical design. Hence, it is important to establish a culture of collaboration between teachers to better communicate and learn from one another (Kimmons 2014). Although supporting K-12 teacher open educational literacy development is discussed in Kimmons’s study (2014), it is observed from Table 3 that there is insufficient attention paid to developing preschool teachers’ ability to design and implement HBL.

Table 3 also demonstrates that some studies emphasize the need for high-quality and well-designed apps for HBL (e.g., Yılmaz Genç & Fidan 2017), but more studies focus on understanding users’ characteristics and needs and put effort on building innovative learning environments. It is evident that aside from learning resource design, researchers have some awareness of learning ecosystem design. Furlong and Davies (2012) stated that students are responsible for their learning strategies, increasing their motivation to learn can potentially make learning a richer and more fulfilling experience for them.

Table 3 Summary of implications of HBL studies at different educational levels

Implication	Educational Level (number of studies)				No.
	Preschool (5)	Primary (6)	Secondary/ High School (5)	K-12 (3)	
1. The importance of parental involvement	• Huber et al. 2018 • Neumann 2018 • Yılmaz Genç & Fidan 2017	• Hermes & King 2013 • Nshimbi et al. 2020	• Borup et al. 2019	• Laho 2019	7
2. Teachers’ training	• -	• Lee et al. 2013 • Jong and Shang 2015	• -	• Kimmons 2014	3
3. High-quality resources and technology access	• Yılmaz Genç & Fidan 2017	• Stubbé et al. 2016	• Laxman 2011 • Lei & Zhou 2012	• -	4
4. Understanding users’ characteristics, and needs, and building learning environments	• Friedrich et al. 2017 • Palaiologou 2016 • Plowman et al. 2008	• Eutsler et al., 2019 • Lee et al. 2013	• Lim and Meier 2011	Furlong and Davies, 2012	7

Discussion

In addition to blurring the distinction between learning at home and in school that is present in most conventional teaching pedagogy, HBL also represents an alternative teaching and learning approach due to the ubiquitous access to learning materials and interaction. The results of this study show that most studies focus on understanding the workings of HBL and its requirements rather than the designing and implementation of HBL. Therefore, there is little known about instructional or pedagogical strategies that are specific for long-term and large-scale HBL.

Nevertheless, some researchers have paid attention to designing HBL from an ecological perspective and improving students' learning agency. Jackson (2013) identifies the relationship between an individual's social environment and learning contexts as an ecosystem in which one's learning ecologies can be created. The ecological perspectives suggest that the learning environment must provide learners with opportunities to learn through various strategies that can meet their personal needs, sustain their interests, and aligns with their situation (Richardson, 2002). Correspondingly, HBL research should pay more attention to developing learning contexts and creating opportunities for interactions as well. From a technological perspective, adaptive systems can optimize game parameters at a cognitive, affective, socio-cultural, or motivational level (Plass 2016), allowing their role in HBL to be increasingly be valued. From a pedagogical perspective, HBL and school-based learning should be further integrated to provide a more meaningful learning experience in schools.

The readiness of educational practitioners is essential to the success of HBL design. Today's classrooms transforming into technology-rich and data-rich environments, where teachers are expected to make effective use of technology, and they may generate a series of "wonderings" or "burning questions" from practice. For today's teachers to keep up with the rapid development of ICT tools to be incorporated in teaching and learning, there is an increasing need for teachers to change the traditional classroom teaching model into one with a more solid, extensive and dynamic design (Persico and Pozzi 2015). However, the findings of this study reveal that there is insufficient attention paid to improving teachers' e-pedagogy, more specifically, their design capacity of HBL. Furthermore, there is a lack of research and professional training for preschool teachers.

In addition to design HBL, the importance of a fixed place and time to learn with an engaged facilitator has been underscored (Borup et al. 2019). Typically, a timetable should be planned by the teachers for the students to adhere to, with work assigned that can be monitored via selected technological tools. This enables teachers to provide follow-up and feedback on students' completed work when they return to schools

from their HBL week. However, some challenges faced by teachers when assessing students' work submitted during the HBL include the lack of appropriate digital tools and their limited digital skills and knowledge. This has sparked off the debate of how HBL should be designed when integrating it into the schooling experience of students. When the students return to schools after their HBL, the teachers would need to spend more time conducting curriculum recovery for their classes. Hence, they would need to reteach some topics in the physical classes, which is time-consuming. This would limit the teachers' time and effort to design quality instructional time and resources to help students to move on in their learning. Aside from improving the teachers' design of their pedagogical, there should be sufficient training designed to support teachers in effectively implementing such a change. Currently, HBL is not regarded as a temporary instructional strategy during the Covid-19 as it is expected to be a permanent feature of schooling. As we are forced to embrace HBL, this allows educators a rare opportunity to make sense of HBL and further understand the role of technology in education. The innovation part is the fast K-12 whole-school adoption of online learning with synchronous and asynchronous digital tools for lesson designs and uninterrupted lesson delivery for HBL. Future research may include understanding ways to provide professional training to engage teachers in sustained sensemaking activity. Such training may resolve issues such as perceived incoherence of HBL design and implementation, consequently improving the quality of HBL implemented. Existing studies have widely acknowledged the benefit of data-informed teaching reflection for student learning (McKenney and Mor 2015; Wen and Song 2021). Future research on HBL is thus also expect to investigate how teachers can improve their capacity of using data to inform pedagogical decision-making.

The latitude of HBL classroom practices reveals gaps faced not only by the teachers but also by the parents. For young learners, how parents support and facilitate learning at home is always an essential component to understand children's early development (Doucet & Tudge 2007; Tayler 2015). There is no doubt that parental involvement receives great attention in HBL studies. This systematical review study indicates that not only do parents' engagement affects the effectiveness of HBL for children, but also adolescents. Based on the existing studies, this paper also identifies some strategies to better involve parents in their children's HBL, such as informing parents about the affordance of the technologies to place them in a better position to help their children in learning with technologies and providing a channel that facilitates two-way communication between the parents and educators. Hermes and King's (2013) study on technology-based language learning also indicated that although families participating in their study were all enthusiastic and passionate about HBL, transforming this passion into a routine was still a challenge

for them. They expressed the importance of discipline and consistency for HBL to be more successful by sticking with the routine even when progress is slow.

In summary, HBL is not only about bringing the classroom into homes but also an alternative teaching and learning approach with the ubiquitous access to learning materials and interaction. Furthermore, HBL and school-based learning will be further integrated to provide a meaningful formal learning experience. In addition to the readiness of students, the tripartite relationship among teachers, parents, and technologies should be taken into consideration. Future research on HBL is thus expected to investigate (1) how to design learning contexts and create opportunities for synchronous and asynchronous interactions and personalised learning such as adaptive gamification systems to engage learners with diverse backgrounds learning at home; (2) what kind of professional development should be provided to teachers for developing their capacity of pedagogical innovation and use of learning data; and (3) what strategies of supporting mutual communication between teachers and parents in HBL.

Conclusion

This study presents a systematic review of existing studies on ICT-supported HBL for K-12 learners. The findings show that compared to the studies on adults' online learning and integrating ICT in classroom learning or seamless learning, few studies focus on ICT-supported home-based formal learning for K-12 learners specifically. HBL will likely be a permanent feature of schooling, and an increasing number of future research may focus on it due to the increasing attention on the context of HBL regarding teacher inquiry, learning design, and learning analytics. The findings suggest placing more importance on developing adaptive gamification systems to engage various learners with diverse needs, providing support and professional development for school teachers, particularly preschool teachers, and communicating with and eliminating the misunderstandings of parents of children across different ages.

The study also has limitations. Firstly, the studies reviewed are non-exhaustive as only papers published in refereed journal papers during 2010–2020 were reviewed. Thus, there might be publications related to this topic in other sources that are worthy of study but not included. Secondly, the review only focuses on how HBL has been conducted in a formal learning context. Although informal learning is also an important part of HBL, as the scope of HBL in informal learning contexts is overly broad and vague, therefore it is not included in this study.

Compliance with Ethical Standards

Disclosure of Potential Conflicts of Interest The authors declare that they have no conflict of interest.

Research Involving Human Participants and/or Animals This is a systematic review paper, so no human participants and/or animals are involved.

Informed Consent As no human participants and/or animals are involved, no informed consent.

References

- Bamberger, Y., & Tal, T. (2006). Learning in a personal context: Levels of choice in a free choice learning environment in science and natural history museums. *Science Education*, 91, 75–95. <https://doi.org/10.1002/sce.20174>.
- Barajas-Saavedra, A., Álvarez-Rodríguez, F., Mendoza-González, R., & Oviedo-De-Luna, A. (2015). Short serious games creation under the paradigm of software process and competencies as software requirements. Case study: Elementary math competencies. *Turkish Online Journal of Educational Technology*, 59(4), 155–166.
- Barr, N., Pennycook, G., Stolz, J. A., & Fugelsang, J. A. (2015). The brain in your pocket: Evidence that smartphones are used to supplant thinking. *Computers in Human Behavior*, 48, 473–480.
- Biernacki, P., & Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological Methods & Research*, 10(2), 141–163.
- Borup, J., Chambers, C., & Srimson, R. (2019). Online teacher and on-site facilitator perceptions of parental engagement at a supplemental virtual high school. *The International Review of Research in Open and Distance Learning*, 20(2), 79–95.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77–101.
- Conradie, S. M. (2016). Home-based learning support groups in Western Australia: an interpretivist study (Doctoral dissertation, the University of Western Australia, Perth, Australia). Retrieved from <https://research-repository.uwa.edu.au/en/publications/home-based-learning-support-groups-in-western-australia-an-interpret>.
- Doucet, F., & Tudge, J. (2007). Co-constructing the transition to school: Reframing the “nov-ice” versus “expert” roles of children, parents, and teachers from a cultural perspective. In R. C. Pianta, M. J. Cox, & K. L. Snow (Eds.), *School readiness and the transition to kindergarten in the era of accountability* (pp. 307–328). Baltimore, MD: Brookes.
- Eutslar, L., Antonenko, P., & Dawson, K. (2018). How parent perceptions relate to elementary Children's portable technology use by gender and grade level. *Computers in the Schools*, 6(2), 323–323.
- Furlong, J., & Davies, C. (2012). Young people, new technologies and learning at home: Taking context seriously. *Oxford Review of Education*, 38, 45–62.
- Harding, T. J. A. (2011). A study of parents' conceptions of their roles as home educators of their children (Doctoral dissertation, Queensland University of Technology, Queensland, Australia). Retrieved from <https://eprints.qut.edu.au/40931/>.
- Hermes, M., & King, K. A. (2013). Ojibwe language revitalization, multimedia technology, and family language learning. *Language Learning and Technology*, 17(1), 125–144.
- Huber, B., Highfield, K., & Kaufman, J. (2018). Detailing the digital experience: Parent reports of Children's media use in the home learning environment. *British Journal of Educational Technology*, 49(5), 821–833.
- Jackson, N. (2013). The concept of learning ecologies. In N. Jackson, & B. Cooper (Eds), *Lifewide learning, education & personal development* (chapter A5). Retrieved from <http://www.lifewidebook.co.uk/conceptual.html>

- Jong, M.-y. (2015). Does online game-based learning work in formal education at school? A case study of VISOLE. *Curriculum Journal*, 26(2), 249–267.
- Jong, M.-y., & Shang, J. (2015). Impeding phenomena emerging from Students' constructivist online game-based learning process: Implications for the importance of teacher facilitation. *Educational Technology & Society*, 18(2), 262–283.
- Kimmons, R. (2014). Developing open education literacies with practicing K-12 teachers. *International Review of Research in Open and Distance Learning*, 15(6), 71–92.
- Kitchenham, B., & Charters, S. (2007). *Guidelines for performing systematic literature reviews in software engineering*. (EBSE technical report EBSE-2007-01). Durham, UK: Keele University and University of Durham.
- Kong, S. C., & Song, Y. (2015). An experience of personalized learning hub initiative embedding BYOD for reflective engagement in higher education. *Computers and Education*. <https://doi.org/10.1016/j.compedu.2015.06.003>.
- Laho, N. (2019). Enhancing school-home communication through learning management system adoption: Parent and teacher perceptions and practices. *School Community Journal*, 24(1), 117–142.
- Laxman, K. (2011). Dynamic and spatial representation of web movements and navigational patterns through the use of navigational paths as data. *Instructional Science: An International Journal of the Learning Sciences*, 39(4), 881–900.
- Lee, J., Yoon, S., & Lee, C. (2013). Exploring online learning at primary schools: Students' perspectives on cyber home learning system through video conferencing (CHLS-VC). *Turkish Online Journal of Educational Technology - TOJET*, 12(1), 68–76.
- Lei, J., & Zhou, J. (2012). Digital Divide: How do Home Internet Access and Parental Support affect student outcomes? *Education (Basel)*, 2, 45–53.
- Lim, K., & Meier, E. (2011). Different but similar: Computer use patterns between young Korean males and females. *Educational Technology Research and Development*, 59(4), 575–592.
- Mangaroska, K., & Giannakos, M. N. (2019). Learning analytics for learning design: A systematic literature review of analytics-driven design to enhance learning. *IEEE Transactions on Learning Technologies*, 12(4), 516–534.
- Manuti, A., Pastore, S., Scardigno, A. F., Giancaspro, M. L., & Morciano, D. (2015). Formal and informal learning in the workplace: A research review. *International Journal of Training and Development*, 19(1), 1–17.
- McKenney, S., & Mor, Y. (2015). Supporting teachers in data-informed educational design. *British Journal of Educational Technology*, 46(2), 265–279.
- Mills, L. A., Knezek, G., & Khaddage, F. (2014). Information seeking, information sharing, and going mobile: Three bridges to informal learning. *Computers in Human Behavior*, 32, 324–334.
- Neumann, M. M. (2018). Parent scaffolding of young children's use of touch screen tablets. *Early Child Development and Care*, 188(12), 1652–1662. <https://doi.org/10.1080/03004430.2016.1278215>.
- Nshimbi, J. C., Serpell, R., & Westerholm, J. (2020). Using a phonebased learning tool as an instructional resource for initial literacy learning in rural African families. *South African Journal of Childhood Education*, 10. <https://doi.org/10.4102/sajce.v10i1.620>.
- Palaiologou, L. (2016). Children under five and digital technologies: Implications for early years pedagogy. *European Early Childhood Education Research Journal*, 24(1), 5–24.
- Persico, D., & Pozzi, F. (2015). Informing learning design with learning analytics to improve teacher inquiry. *British Journal of Educational Technology*, 46(2), 230–248.
- Plass, J. L. (2016). A taxonomy of adaptivity in learning. Panel on personalized and adaptive learning systems, CRESSTCON' 16. September 20, in Los Angeles, CA.
- Plowman, L., McPake, J., & Stephen, C. (2008). Just picking it up? Young children learning with Technology at Home. *Cambridge Journal of Education*, 38(3), 303–319.
- Sefton-Green, J. (2004). *Literature Review in Informal Learning: With Technology Outside School* (Futurelab series), NESTA Bristol, UK, 2004, pp. 1–39.
- Stockmayer, S. M., Rennie, J. R., & Gilbert, J. K. (2010). The roles of the formal and informal sectors in the provision of effective science education. *Studies in Science Education*, 46(1), 1–44. <https://doi.org/10.1080/03057260903562284>.
- Stubbé, H., Badri, A., Telford, R., van der Hulst, A., & van Joolingen, W. (2016). E-learning Sudan, formal learning for out-of-school children. *Electronic Journal of e-Learning*, 14(2), 136–149.
- Tayler, C. (2015). Learning in early childhood: Experiences, relationships, and “learning to be.” *European Journal of Education*, 50(2), 160–174.
- Wen, Y., & Song, Y. (2021). Learning Analytics for Collaborative Language Learning in Classrooms: From the Holistic Perspective of Learning Analytics, Learning Design and Teacher Inquiry. *Educational Technology & Society*, 24(1), 1–15.
- Yilmaz Genc, M. M., & Fidan, A. (2017). Children, parents and tablets: Preschool children's tablet use. *Pegem Journal of Education and Instruction*, 7(3), 367–398.

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