The potential for digital technology to support self-directed learning in formal education of children: a scoping review

Thomas Howard Morris[1], Matthias Rohs[2]

[1] School of Education, Bath Spa University, England

[2] Department of Education, Technische Universität Kaiserslautern, Germany

Abstract

Self-directed learning is a critical competence for living and working in our increasingly complex and unpredictable world. The concept of self-directed learning grew out of the adult learning field and scholars highlight the need to examine how self-directed learning competence can be fostered during childhood – a key competence needed in working life. However, to the knowledge of the authors of this report, there are very few empirical studies that seek to understand how self-directed learning is facilitated in the formal education of children in our digital age. In order to review empirical studies that contribute toward understanding this research question a literature search was conducted. The potential for digital technology to support learners in this process was highlighted in the studies reviewed, but commonly learners lacked the competence to use digital technologies for educational purposes. Learners often required support, especially with the planning and reviewing aspects of self-directed learning, as well as guidance regarding how digital technologies can be used effectively for educational purposes. Importantly, studies that focus on understanding the facilitation of self-directed learning in childhood education are seldom. Further studies on self-directed learning in childhood education are vital – given that this is a fundamental competence for preparing our youth to deal with work and life in our rapidly changing world.

Keywords

self-directed learning (SDL); competence; constructivism; lifelong learning; digital age

1. Introduction

Imagine a child having the privilege of access to formal education. Now consider, in the event that their education is predominantly teacher-directed, if such educational experience is conductive to fostering their self-directed learning (SDL) competence. This is a very important consideration given that early childhood experiences lay the foundation for life-long learning: where children begin to develop their behavioral, emotional, social and cognitive skills (Mustafa, Abbas, Hafeez, Khan, & Hwang, 2019).

Indeed, SDL has been recognized as a fundamental competence for living and working in our modern world, which enables persons to adapt to changing conditions (e.g. Boyer, Edmondson, Artis, & Fleming, 2014; Kranzow & Hyland, 2016; Morris, 2019a, d). In this context, SDL competence is defined as "the ability to pursue SDL with success and efficiency: to proficiently direct one's own learning means and objectives in order to meet definable personal goals" (Morris, 2019b, p. 302). The SDL process involves learners being primarily responsible for planning, undertaking, and reviewing aspects of their learning process.

The importance of fostering SDL competence through formal childhood schooling is advocated by prominent educational international organizations. For example, the European Commission (2018) highlight the fundamental need for learners to learn how to learn during their formal education: "Individuals should be able to identify and set goals, motivate themselves, and develop resilience and confidence to pursue and succeed at learning throughout their lives" (p. 10) – in sum, learners should enter adulthood with SDL competence. In this respect, formal learning involves a process

that “follows a syllabus and is intentional in the sense that learning is the goal of all the activities learners engage in” (CoE, n.d., para. 1).

Understanding how SDL can be fostered through formal schooling in childhood is very important because studies have historically and consistently identified that many people do not fully foster SDL competence during their childhood (e.g. Bonk, Zhu, Kim, Xu, Sabir, & Sari, 2018; Canty et al., 2019; Gatewood, 2019). Bonk and Lee (2017) note that this is somewhat surprising given that the importance of SDL has been noted by scholars for decades. Moreover, and consequentially, it is particularly disconcerting therefore that for these persons SDL will not be fully utilized throughout their course of their life.

Even in the nineteen-sixties, SDL was positioned as the most important competence to foster in formal childhood schooling: because, above all, SDL competence enables persons to adapt to change (e.g. Rogers, 1969). Actually, adaptability has been described as the sine qua non of professional expertise (Ward, Gore, Hutton, Conway, & Hoffman, 2018). In particular, SDL competence is especially advantageous for persons who intend to enter a career in which the working environment is rapidly changing – such as in medicine, entrepreneurship, nursing, information technology, etcetera (e.g. Abraham et al., 2018; Canty et al., 2019; Gatewood, 2019; Golightly, 2019; Ma, Yang, Wang, & Zang, 2018; Tohidi, KarimiMoonaghi, Shayan, & Ahmadinia, 2019; Wagner, 2018).

At the same time, it seems necessary to consider that advanced digital technologies, especially the Internet, are increasing in their prominence in schooling systems (Starkey, 2019). Additionally, there is a considerable interest from a multitude of educational stakeholders in how digital media can enhance the quality of education delivered to children in formal education (e.g. Chen, Chen, &

Horng, 2019; Huang, 2019; Li, Ma, Wang, Lan, Zhang, & Dai, 2019; Mou, Kao, Lin, & Yin, 2019; Rodríguez-Martínez, González-Calero, & Sáez-López, 2019).

Some scholars have pointed out that the advanced digital technologies available today present as an opportunity for, and to support, the facilitation of SDL (e.g. Bonk & Lee, 2017; Rohs & Ganz, 2015). However, to date, to what extent the recent affordances of digital technologies have influenced facilitation of SDL within formal schooling of children is unclear.

It is important to further our understanding in this regard given that formal childhood schooling provides a primary setting to develop the learner skills necessary for the SDL process – that might enable persons to be competent lifelong learners in a digital age (e.g. European Commission, 2018; Mazenod et al., 2019). But, to the knowledge of the authors, there are few recent empirical studies that examine how SDL can be facilitated in the formal schooling of children. This seems somewhat odd given the importance of affording learners with SDL competence – in regards to preparing them for living and working in our digital age. The purpose of the present paper is therefore to review recent empirical studies in order to gain an overview of the state-of-the-art research regarding what we know about, how is SDL facilitated in formal education of children in our digital age?

2. Methodology

A scoping review was conducted in order to provide an overview concerning what is known about how SDL can be facilitated in formal education of children in our digital age. The review was deliberately thorough in design: employing multiple peer-reviewed literature search channels: (1) traditional journal indexes (Web of Science, Scopus, ERIC) (2) an open access index (DOAJ) (3)

publisher directories (Sage, Taylor & Francis, Wiley, and Springer), as well as (4) considering SDL specific journals (International Journal of Self-Directed Learning; which was identified as the only applicable journal in this respect) not indexed in the above channels.

2.1. Data collection

The literature search sought to identify journal articles published since 1st January 2017 up until the date in which the literature search was conducted (between January and May 2019). Given the rapid speed in which social contextual conditions are changing in our modern world (cf. Morris, 2019a), especially digital technologies, a short-time period for the present review was employed to allow the examination of teaching-learning transactions in our modern digital age and to enable the provision of drawing timely conclusions and further research directions.

In order to identify as many records as possible relevant to the research question the investigators used the very broad search term "self-directed learning", within the title or key words (where possible with the relevant database). In total 691 records were identified through database searching. From which, 369 duplicates were removed, and a further 308 records were excluded based on screening of the title, the abstract, or/and the full-text against the inclusion criteria outlined in Figure 1. The inclusion criteria included that the record preliminarily focused on the formal schooling of children with an average participant age of less than 18 years. In total fourteen studies were included in the analysis (cf. Figure 1).

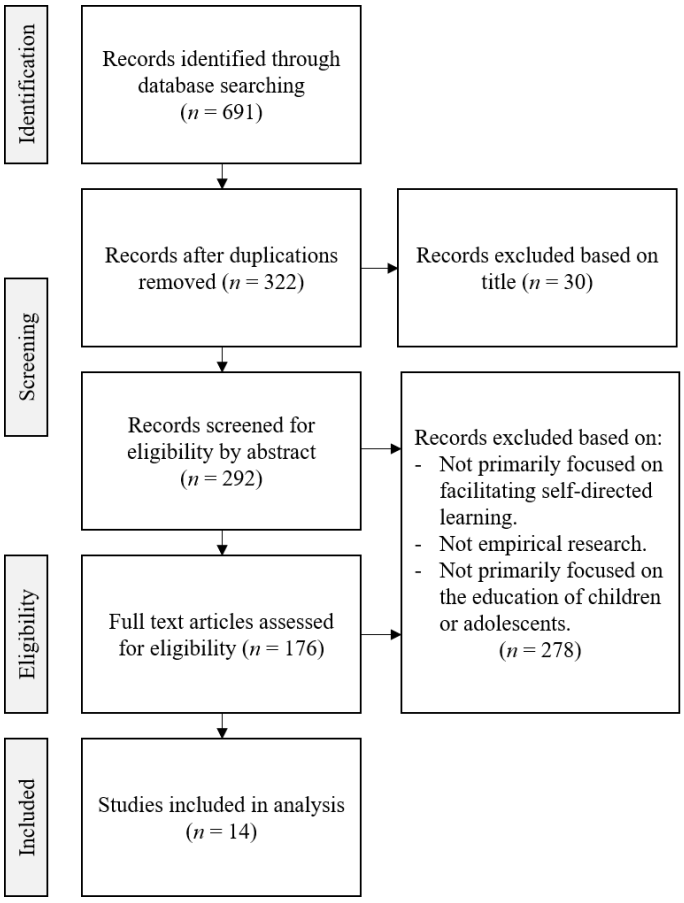

Figure 1. Flow diagram for inclusion of journal articles in the review

2.2. Data analysis

Three investigators independently conducted the data analysis process. First, investigators were given one day of formal training regarding the operation of the data analysis software MAXQDA10 (VERBI GmbH, 2011), which was used to code and organize the data. Eligible articles (cf. Figure 1) were fully read by each investigator, who sought themes in the data. The journal articles were uploaded in PDF format into the software in order to begin the process of data coding and identifying themes. The inductive analysis was based on six phases suggested by Braun and Clarke (2006) and exampled by Morris (2019c), which involved the investigators (1) familiarizing

themselves with the data (2) generating initial codes (3) searching for themes (4) reviewing themes (5) defining and naming themes, and (6) producing the report.

Each investigator made an independent analysis of the journal articles. Data familiarization was made where each investigator began to read the articles in full and noted down, independently, initial ideas regarding possible themes and codes within the data. A summary of key details of the studies concerning (a) authors, publication year (b) context of study/learning typology (c) methodology/study details and (d) study outcome/finding/details (note the two journal articles presented by Bartholomew and colleagues were judged as being part of one study) were collated by investigators to assist the data familiarization process and presented in the initial section of the results.

The analysis was inductive in that codes and themes were not predetermined, but defined and redefined during the analysis. The investigators met to finalize the coding system that was then used by all three investigators to code the data. Each investigator then independently used the data analysis software to code parts of sentences, whole sentences, and groups of sentences with one or more code(s). During the analysis new codes were defined and the initial analysis revisited and data were recoded, where applicable. Examples of codes include “learner support”, “learner responsibility”, “media use”, “teacher facilitation”, “barriers to digital media use”, “learning means”, and “epistemology”. At times, the data organization was complicated by the overlapping of data into the themes identified at this stage of the analysis and the researchers took a best-fit approach to the classification of the data. The researchers made further notes about the data extracts, which assisted the process of finalizing the themes presented in this report. The data software program was used to extract a Microsoft Excel (Microsoft Office Professional Plus, 2019) data document with data extracts. Afterwards, the investigators met in person once more, over a

period of one week, to discuss the initial themes generated and to work in collaboration in reviewing the themes and to define and name the final themes (cf. Table 1). A summary of the discussion held by the investigators regarding the key themes in the data is presented in this report.

Theme	Description
Contextualized: based upon the learners' world	The learning process was situated – which centered on solving or resolving real-world based questions, issues, cases, problems, or projects.
(Co-) responsibility	Learners had primary responsibility for directing the learning process. However, more often than not teachers and other learners supported the learner in terms of directing the objectives and means of learning.
Learners as producers/creators, not just consumers, of knowledge	During the learning process learners were active agents in their meaning-making. Learning was a proactive process in which learning outcomes were open and individual, rather than being uniform for all learners.
Epistemology: constructivism	Learning positioned with a constructivist perspective: where learning is seen as an individual, interpretive, and active process of meaning making (cf. Merriam, Caffarella, & Baumgartner, 2007).
Taxonomy: multiple classifications of learning means	Taxonomy refers to the means of learning in which SDL was supported.

Table 1. Description of themes

3. Results

The majority of studies discussed how including digital technology in the learning process could support SDL. However, an initial and important observation was that the majority of studies identified in the present literature search involved adult learning populations and only a small minority of studies focused on SDL of child learners. Moreover, an important overreaching insight

from the present research is that from all of the journal articles obtained through the review process all studies involved a formal-educational context; no study reported upon SDL of children in non-formal or in informal learning contexts. There were three overreaching themes in the data (cf. Figure 2, Figure 1 for theme details).

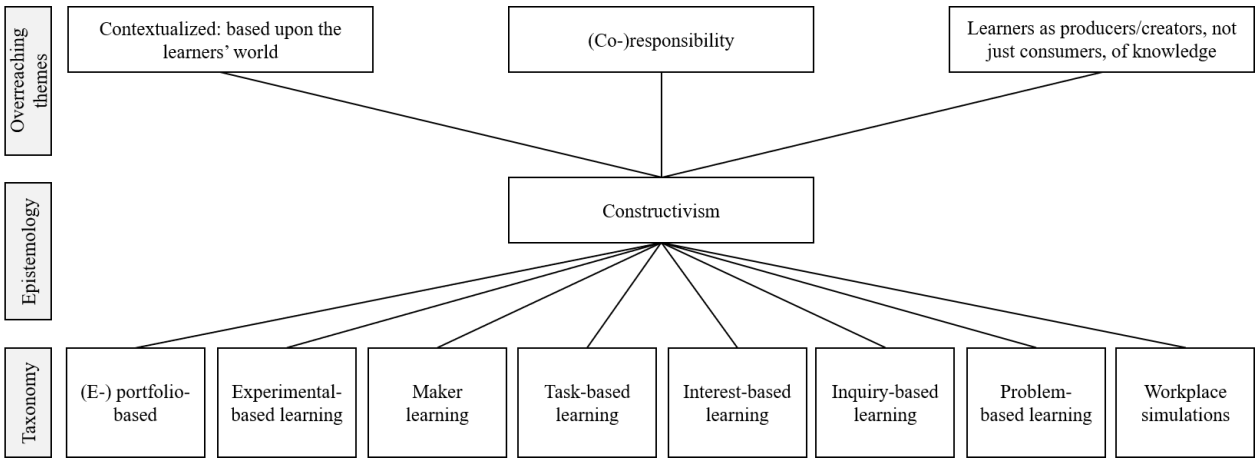

Figure 2. Thematic map

Three overreaching themes were common to studies included in this report (cf. Figure 2); but it is important to note that all studies focused on just one of the eight SDL taxonomies identified through the review. This highlights the multiple means in which SDL might be facilitated in formal educational settings. Moreover, in terms of epistemology, because in these studies learning was a personally meaningful process, in which learners were stipulated to take responsibility, often in collaboration with other learners, in a learning process in which learners were produces/creators of knowledge, the learning process concurred with a constructivist perspective: where learning is seen as an individual, interpretive, and active process of meaning-making – a salient feature of the SDL process (cf. Merriam, Caffarella, & Baumgartner, 2007).

A commonality through all of these studies was that through attempting to facilitate SDL, learning was a personally meaningful process, in which learners were stipulated to take responsibility, often in collaboration with other learners, in a learning process in which learners were produces/creators of knowledge. Examples of studies in this respect are presented in the forthcoming sections.

3.1. Contextualized: based upon the learners' world

A key theme identified in this study was that the learning process was situated – which centered on solving or resolving real-world based questions, issues, cases, problems, or projects. For example, Jossberger, Brand-Gruwel, van de Wiel, and Boshuizen (2018) presented a study with Dutch pre-vocational education students. In total 18 female and 22 male learners, who had worked with workplace simulations for at least one year, participated in semi-structured group interviews. The thematic analysis revealed that workplace simulations were highly valued by students, but many students found it difficult when given primary responsibility for learning. Teachers did however hold responsibility for safety of the students and gave clear instructions regarding the tasks. But, student self-assessment was not always taken seriously and self-assessment and reflection was a notable weakness of learner skills. Personal attention from teachers was valued and teachers played an important role when students got stuck, however students often asked peers for help before asking the teacher. Motivation to keep going was a difficulty for many students and there was some evidence of social loafing and cheating. Students seemed to highly value the teacher being there in space and time, but students found that teachers did not have enough time to give detailed feedback to all learners, especially given that students were very heterogenous. Learning environments reflected hands on real-world based activities, but a safe place that enabled students to make mistakes. A key insight of the study was that learners valued whole, complex, and authentic

learning tasks. The potential of using digital technology to support workplace simulations was not highlighted in this study.

Commonly real-world based questions, issues, cases, problems, or projects were linked to personal interests or/and future career choices. For example, Koh, Snead, and Lu (2019) presented a study with 20 North American high school (ninth to twelfth grade) media students. Classes were minimally structured, with mentorship from teachers and librarians. The mixed-method study included individual interviews, process mapping activities, and a maker process survey. It was reported that learners appreciated freedom and they commonly linked their work to personal interests and future career choices. The process involved learner reflection and collaboration, but time management, technical difficulties, and distractions were key issues. When learners got stuck they often overcame barriers through (1) asking for help from people, such as teachers, friends, and family members (2) searching for information on the internet and other reference sources (3) trying things out and practicing, and (4) adjusting, modifying, and often scaling down their learning goals.

3.2. (Co-) responsibility

Another key theme identified in this study was that learners had primary responsibility for directing the learning process. More often than not teachers and other learners supported the learner in terms of directing the objectives and means of learning. For instance, Abdullah, Mohd-Isa, and Samsudin's (2019) study concerned problem-based learning in a Malaysian Primary School and included 30 twelve-year-olds studying science education over four sessions employing virtual reality. The study was a quasi-experimental design, where students defined problems, gathered information through multiple activities, held discussions and undertook a reflection task in groups to generate solutions. Virtual reality brought excitement and learners found it to be stimulating and different. Teachers facilitated questioning and enabled students to come to their own conclusions:

demanding learner responsibility. Teachers encouraged dialogue between students, staged learning tasks, and provided questions to induce deeper thinking.

Part of responsibility involved learners being responsible for the management of learning tasks in their learning process. For instance, Hsu (2017) examined 38 Taiwan third graders (M = 9 years old) who completed a task-based English vocabulary game with augmented reality using a tablet. The author compared the effectiveness of two systems: one system allowed free selection of learning tasks and in the other system the students followed the task order and had no choice. The study found that the learners' flow state in the SDL group was higher, but had no effect on learners' mental effort or anxiety.

Although it was commonplace that students were given, it was also conventional for learners to work together in collaboration with both teacher and other learners. For example, Morris's (2018) study aimed to understand the balance of control between teacher and learners (M = 17 years old) within Further Education colleges in England. The study was an exploratory thematic qualitative analysis of inspectors' comments within inspection reports. The comparative analysis between outstanding and inadequate colleges revealed a clear difference between colleges rated by the inspectorate body as outstanding and inadequate. Inadequate provision was overwhelmingly teacher-directed, but outstanding provision reflected a collaborative relationship between teacher and learners in directing the learning process. Transactions that involved more learner control of directing the learning process often involved learners searching for information on the internet.

A teacher's role in this collaborative process was one of support, which took much time and effort on part of the educator. For instance, the study of Beckers, Dolmans, and van Merriënboer (2018) concerned 22 senior vocational learners (M = 17.7 years old) studying in the Netherlands. In this study, students of pedagogical work and media development trialed the use of an e-portfolio over

three weeks. Teachers made notes during the coaching sessions and used a questionnaire to examine the effectiveness of the portfolio. Learners needed additional support, especially in regards to selecting appropriate learning tasks and setting appropriate criteria for assessment. The authors concluded that the process of supporting and guiding students, which could be diminished overtime, was very time consuming on part of the teacher.

Feedback from teachers was an important part of support. For example, in a parallel study, which involved a sample of 32 male and 15 female (M = 17.3 years old) Dutch "retail" vocational students that was also e-portfolio based (Beckers, Dolmans, Knapen, & van Merriënboer, 2018), data was gathered from the portfolios and student interviews. The portfolios were also used to restrict students' choice of tasks and to gradually reduce supportive information over time to promote student responsibility. But, students often stated that they required more support from teachers. In particular, students found it hard to self-assess/identify problems within their own work. Rather, many students' perspective was that it should be the teachers' role to provide feedback.

Importantly, there were some challenges reported with providing students with responsibility combined with using digital technology. In this respect, Gokcearslan (2017) presented a mixed-method study conducted in Turkey with 414 high school students, which concerned SDL with tablet computers. Students found tablets useful for researching information, but for many the tablets represented a distraction. The author discussed the need for educational policy in this regard. Students identified that they often used tablets for just gaming, highlighting the potential for gamification-based learning. Also, technology problems were a barrier at times, including device battery performance. In conclusion, when students were competent to do so, which they were often not, tablets and other technology may provide an advantage of giving students access to information.

Moreover, it was noted that teachers needed much support and competencies to implement such programs. A study from Hennis (2017) was conducted in Greece, Italy, Spain, Portugal, Austria, and the Netherlands (twelve pilots in total). The purpose of the intervention was to engage at-risk youth migrant students through SDL with the use of ICT Web 2.0 in formal and in non-formal contexts using interest-based collaborative learning activities. The case study presented in the article concerned 15 Dutch students during a three-year educational program. Data were collected through teacher and student interviews and log books. The authors highlighted the need for teachers to be provided with support and competencies to implement such programs: teacher training was provided with a focus on getting use to the ICT tools and to prepare learning activities based on a set of pedagogical principles (collaboration, creativity, self-guidance, and relevance). For learners, the process of planning personal projects (to choose topics) was challenging. Many students became distracted and were disorganized. In practice some students also lost interest in the topics they proposed. Many students switched and changed learning projects, but the chosen projects commonly had personal, social, or academic relevance.

3.3. Learners as producers/creators, not just consumers, of knowledge

During the learning process learners were active agents in their meaning-making, where learning was a proactive process in which learning outcomes were open and individual. For example, the study from Hughes, Morrison, Mamolo, Laffier, and de Castell (2019) was conducted in Canada with two grade six Middle School students with behavioral, language, or learning challenges that aimed to address bullying through critical making inquiry-based learning, in which iPads were loaned to students. In this ethnographic case study, over two and a half hours per week for eight weeks, teachers played a very supportive role to change learners' willingness to progress and they encouraged learners to take ownership of their learning. In the hands-on learning process every

student became a creator/innovator. Teachers gave positive feedback to support student progression. However, students were at first overwhelmed and a lack of learner digital literacy was reported.

Moreover, López-Castilla, Terradillos-Bernal, and Alcalde (2019) conducted a study in Spain that concerned experimental archaeology, underpinned by the concept "learning by doing". The report consisted of reflections upon facilitating activities which were carried out with thousands of learners in different school grades trialed in different venues (schools, museums, etcetera). Information was presented by the educator to students, where often a practical demonstration was followed by experimentation and a reflection activity. The learning process promoted a process of scientific inquiry. The potential for using digital technology to support the learning activities in this context was not discussed in this study.

In addition, the need for support and training for teachers was highlighted in the studies. For instance, in a study based in the Netherlands, van Uum, Verhoeff, and Peeters (2017) presented multiple case studies of four classes of pupils (N = 101; aged 10 to 11 years old) in inquiry-based science education. Teachers were given training on inquiry-based learning and scaffolding. After the intervention teachers and learners were interviewed and observation notes were taken. The duration of the module was a notable disadvantage highlighted by teachers. The authors argued that further professional development of teachers was needed because some teachers answered students questions directly which did not promote SDL. The potential of using digital technology in this context was not highlighted in the study.

Moreover, in a mixed-method quasi-experimental study in North America with six teachers and 706 K–12 technology and engineering students, learners completed design portfolios and constructed prototypes (maker learning), with or without access to mobile devices, in groups of

two to three learners across five class 90-minute periods within a two-week intervention (Bartholomew, 2017; Bartholomew, Reeve, Veon, Goodridge, Lee, & Nadelson, 2017). The study revealed that some teachers facilitated learners' learning significantly better than other teachers and teachers themselves had the most impact upon learning outcome quality. Moreover, mobile device access led to an improvement in portfolios, but did not improve the quality of the final product design. Mobile devices supported some students by enabling access to a rich source of information, but they were a distraction for other learners who used the devices for playing rather than working. In this regard, students identified that rules and regulations were needed. The authors highlighted the importance of teachers assisting students to learn how technology can help with learning.

4. Discussion

In most studies, digital technology was identified as having a key potential for supporting students in the SDL process, especially as a means of sourcing information. For instance, in the study of Koh et al. (2019), when learners got stuck during the learning process one way of overcoming barriers to progression was through searching for information on the internet and other reference sources.

But, other studies identified that many students lacked the competence to use digital technology for such educational purposes. Often, learners needed teacher support or specific training in order to use digital technologies such as mobile devices effectively for educational purposes (e.g. Bartholomew et al., 2017; Hughes et al., 2019).

4.1. Contextualized: based upon the learners' world

A key theme identified in this study was that the SDL process was situated – centered on solving or resolving real-world based questions, issues, cases, problems, or projects. Thus, learning was a contextualized process: learners were encouraged to learn something that was personally meaningful to them (cf. Reber, 2018, for wider discussion).

What was particularly insightful was that a multitude of differential taxonomies (cf. Figure 2) were employed in different studies to enable a SDL process. Identification of a full taxonomy of learning activities that support a SDL process – which was not possible in this report – would be potentially highly valuable for a multitude of educational stakeholders, especially teachers, and represents an important area for further studies. Within these contextualized learning means, learners rarely worked in isolation.

4.2. (Co-) responsibility

In the studies examined in the present report, it was commonplace for learners to work in small groups, collaboratively. Also, importantly, learners were supported by teachers, especially during the planning and reviewing dimensions of the learning process. A question that may arise from these observations is whether such a collaborative learning process actually represents "self-directed learning".

Indeed, in this respect, Garrison (1997) first proposed that SDL in formal educational settings is inevitably a collaborative process. Later, Tan (2017), in writing from a Confucian perspective (refer to Sheng, 2018, for a review of the concept), highlighted that learning outcomes from the SDL process should consider both learners' and societal needs. Furthermore, Morris (2019a) noted that it should be considered that SDL does not happen in a societal vacuum. The present study concurred with this perspective: that SDL in formal educational settings often represents a collaborative process between teacher and learner, and other learners.

4.3. Learners as producers/creators, not just consumers, of knowledge

When learners were tasked to be produces/creators of knowledge, this was notably a difficult challenge for learners. In particular, learners found the process of planning relevant and meaningful learning processes rather difficult. Additionally, learners generally found the process of self-assessment especially challenging. What stood out in the reports was that during the process of SDL learners highly valued and proactively sought feedback from teachers and others.

In respect of teacher support, in some of the studies teachers were provided with specific training and ideas, advice and guidance on supporting or scaffolding students. For instance, in one study (van Uum et al., 2017) a "question machine" was used as a "hard scaffold" in order to assist students to formulate and reformulate questions. Beckers, Dolmans, Knapen, and van Merriënboer (2018) also discussed how an e-portfolio can be used to assist the planning phase of learning, but highlighted that the support process demands much time on part of the educator. They also compared teacher facilitation of SDL as to "walking a tightrope" (p. 1), highlighting that too much or too little support on part of the educator may significantly reduce a learner's progress in the SDL process. These studies highlighted the difficulty on the part of the teacher in dealing with differential learner levels of SDL competence.

Indeed, it could also be considered in this respect that previous studies have highlighted the importance of considering personality characteristics upon tendency and propensity toward SDL (e.g. Alharbi, 2018; Barry & Egan, 2018). Importantly however, a key limitation and important direction for further research concerns for how long (days, weeks, or years – which is perhaps differential in accordance with each learner's individual skills necessary for the self-directed inquiry process) gradually tapering learner support for SDL (until they are considered competent self-directed learners) is actually required for.

Moreover, importantly, to the knowledge of the present authors there are a lack of studies to date that have longitudinally examined development of SDL competence through childhood, which is an important direction for further studies. However, such studies would require a formal educational system that enables for such a study: a holistic system of SDL competence development. In this regard, one previous study by Beese and Watson (2016), in a home-schooling context (cf. Jolly & Matthews, 2018, for a homeschooling review), describes how over the course of twelve years SDL competence was fostered. In this respect, it is quite possible that, for some learners at least, fostering of SDL competence should be undertaken over many years if not decades and further studies are required to examine this possibility.

At the same time, it should also be considered that some studies reported that employing digital devices in the classroom was not problem free. For example, Gokcearslan (2017) identified that mobile devices can be distracting for some students. Moreover, Bartholomew and colleagues (Bartholomew, 2017; Bartholomew et al., 2017) concluded for instance that rules and regulations were required and also highlighted the importance of the need for teachers to assist students to learn how technology can help with learning. Improving digital competence of learners to use digital technology for educational purposes stands out as a key direction for educational outcome goals and further research.

5. Study limitations and conclusions

Digital technology was identified as having a key potential for supporting students in their SDL process, especially as a means of sourcing information. But, often it was reported that some

students lacked the competence to use digital technology for such educational purposes (although they may be considered as "digitally skilled" for using technology for other purposes; cf. Wong & Kemp, 2018). The importance of teachers assisting students to learn how technology can help with learning was highlighted. But, for some learners the opportunity to use mobile devices was potentially distracting and rules and regulations in this regard may be required. What regulations may be effective and how teachers can assist students to use digital technology to only support and not hinder their educational process represents an important direction for further research.

Moreover, what was particularly insightful in the present study was the identification of differential taxonomies in which a SDL process can be facilitated. A key limitation however of the present study is that because there were very few studies in the literature that focused on SDL in childhood – which is an important conclusion in itself – the array of learning activities identified that might support SDL of children in schooling is unlikely to be saturated (cf. Figure 2). In this respect, identification of a full taxonomy of SDL activities would be potentially highly valuable for a multitude of stakeholders, especially teachers, and represents an important direction for further studies.

It is also not clear why so few studies are conducted on SDL in childhood – especially given the importance of fostering this competence during childhood, as outlined in the introduction section of this present report. It is possible that, as suggested by Kranzow and Hyland (2016), still some formal childhood educational institutions in some contexts do not place the facilitation of SDL as a forefront goal. Indeed, one study by Morris (2018) provided some evidence, in the context of that study at least, that some educational institutions still operate around a teacher-directed learning model – and therefore do not enable their learners to practice SDL and foster their competence in SDL.

In addition, the fact that the majority of journal articles were excluded during the review process because they focused on understanding SDL in adult learning contexts is somewhat concerning. Further research is required to examine the reason for this. It is possible that because SDL is a concept that originated from the field of adult learning the theoretical perspective has not yet been fully embraced in research on SDL in childhood education – where we conclude that research on SDL in childhood is seldom. This is an alarming conclusion given the importance of fostering SDL competence in formal schooling – which presents as a primary opportunity to do so – when this is a fundamental competence for living and working in our rapidly changing world.

Furthermore, it is essential to point out that all studies in the present review concerned learning in a childhood formal educational context. However, conducting research into the SDL behaviors of youth outside of formal education, in non-formal and in informal contexts, seems very important especially given the educational opportunities afforded through our modern digital world.

Another key limitation of the present study is that there are other various labels found in the literature that describe a process of offering learner responsibility for their learning process, as identified by Knowles (1975, p. 18), such as, "'self-planned learning,' 'inquiry method,' 'independent learning,' 'self-education,' 'self-instruction,' 'self-teaching,' 'self-study,' and 'autonomous learning.'" But, as Knowles also pointed out, these processes seem to imply and involve learners learning in isolation. Whereas, as highlighted in the present study, SDL concerns and encourages collaborative working. A salient differentiation of SDL therefore is that it is a process that encourages the resourcefulness of learners, which includes learners learning to proactively seek support and guidance from relevant human resources – which is a key aspect of learners being primarily responsible for their learning process.

In addition, a further "inside-out" literature review might bring additional knowledge regarding what is known about the facilitation of SDL in childhood. More specifically, through examining studies in childhood that focus on particular classifications of learning (identified in this report to support the facilitation of SDL; cf. Figure 2), but did not specifically intend to facilitate SDL, might bring a more detailed picture of how SDL can be facilitated in formal educational settings and the problems, issues, and further benefits associated with the process.

Nonetheless, it is also important to consider that the studies examined in the present review were generally very short lived, over a few educational sessions or months at most. Therefore, what could not be concluded from the present review was how long it would take to remove or reduce learning scaffolds. Specifically, at present there is a dearth of research that has longitudinally studied development of SDL competence over a significant period of time through childhood. This remains a very important direction for further studies on SDL. Moreover, understanding the teacher competencies required to support the process, and in addition how to foster such teacher competencies was not possible to observe in the present review and also remains a key direction for further research.

In sum, the potential for digital technology to support learners in SDL in formal childhood education was highlighted in the studies examined in this present report, especially as a means of sourcing information. But, commonly learners lacked the competence to use digital technologies for educational purposes. Importantly, studies that focus on understanding the facilitation of SDL in childhood education are seldom. Further studies on SDL in childhood education are therefore vital – given that this is a fundamental competence for preparing our youth to deal with work and life in our rapidly changing world.

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