Developing and Creating Inclusive and Interactive Digital Reading Environments with and for Students with ADHD

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Abstract:

Digital solutions are often claimed to have the potential to meet individual needs and make learning more accessible, thereby allowing schools to achieve more sustainable and inclusive learning for a diverse range of learners. However, digital tools bring both affordances and hindrances, which are intertwined with the students' prerequisites to learn and how the educational space and learning environment are set up. Following this, dilemmas occur as digital materials are assumed to level or reduce obstacles when they, in fact, also generate new obstacles and opportunities. To design and develop these tools with the potential of supporting qualitative learning opportunities for all students, knowledge of inclusivity and digital materials both need to be taken into account, two research fields that are seldom put together. This article contributes by reviewing hindrances to and opportunities for accessible learning in reading through digital materials and through the case of students with ADHD. The article introduces earlier research on the intersection of learning to read, digital materials, and students with ADHD. We thereafter suggest innovative design principles to uphold sustainable use of and learning through digital materials and elaborate on how these principles fit with ideas of inclusion and sustainable education. Consequently, the paper provides different stakeholders with the possibility to identify commonalities in working processes and to reach a joint language to discuss how digital educational tools should be designed and developed.

Keywords:

digital solutions; individual needs; sustainable and inclusive learning; collaboration; innovative design principles; reading abilities; ADHD

https://doi.org/10.11576/dilema-7518

1 The Promises and Pitfalls of Digital Learning

Digital solutions are often claimed to hold the potential to make learning in school more accessible, to achieve sustainable and inclusive teaching and learning, especially for students with disabilities (e.g., Alsalem, 2016; Ben-Yehudah et al., 2018). This potential relates well to international directives, such as the UN's Sustainability Goals (USG), which point towards inclusion as a strategy for their fulfilment (UNPD, 2015). Yet while there are incentives to work with inclusive teaching strategies and digital tools, both of these have repeatedly been shown to, besides creating access, at times hinder learning and contribute to new forms of inequalities and exclusion (Alsalem, 2016; Ben-Yehudah et al., 2018; Segers, 2017; Singer & Alexander, 2017; Wylie et al., 2018). In the case of Sweden, there is currently a societal debate and policy work ongoing, connecting the use of digital tools in school to the decrease in reading skills among students, which ultimately leads to a decrease in opportunities to participate in society (cf. SOU 2021:70; Prop. 2023/24:21). Contrary to this, research shows that the use of digital tools may lead to improved language learning and reading skills in certain student groups (e.g., Svensson et al., 2021), which in turn increases their opportunities to participate in society. Consequently, it can be concluded that, firstly, digital educational tools can create both hindrances and affordances for students who are learning to read. Secondly, this is an urgent topic that needs to be addressed by policymakers, developers of digital tools, researchers, and practitioners alike. Obstacles in the learning process can be caused by very different factors, such as lack of knowledge or cognitive, physical, psychological, or sociocultural prerequisites regarding the students or their environment. Therefore, sharing knowledge and responsibility between disciplines is important in the design and development of these digital learning tools.

Governments have invested in computers and other digital devices for their schools in various geographical and cultural national contexts, South Korea and Norway being two examples (Hatlevik et al., 2015; Lee et al., 2015). There are also non-profit initiatives such as One Laptop Per Child (OLPC), which provides sturdy equipment to children in distant and rural areas with socioeconomic disadvantages and poor internet access. These are global examples of policies and interventions aiming to provide inclusive, accessible, and high-quality teaching via digital tools. However, new disadvantages and forms of exclusion seem to occur when teaching is digitalized without proper preparation. Hence, the need to have insight into the specifics of the individual and organizational prerequisites becomes apparent: obstacles and opportunities differ between varying teaching contexts, disabilities, areas of learning, and the teaching tools at hand. In the case of students with ADHD and their reading, which will be our focus in this article, there are specificities regarding focus, concentration, and attention to take into account, especially when using digital media (Ben-Yehudah et al., 2018; Singer & Alexander, 2017). In sum, there are dilemmas in the fact that digital tools may both enhance inclusion and create new forms of exclusion, depending on how the design of these tools allows students to develop core reading skills. The inequities in how digital tools are developed and implemented in education reveal that not all students are afforded equal opportunities for accessible, inclusive, and equitable learning. Yet, these tools hold great promise and potential to support such outcomes if thoughtfully designed and applied. This situation calls for a response grounded in expertise, sensitivity to diverse needs, and collaboration across disciplines and stakeholder groups.

The purpose of this article is to contribute knowledge on how core design principles can be advocated in the development and adaptation of digital tools for learning how to read. More specifically, this is done with a focus on students with ADHD, a complex case in which stakeholders, knowledge, and collaboration

need to be interdisciplinary to promote and sustain learning. Three research questions have guided the study:

1) What is known in earlier research about the intersection of learning to read, digitality, inclusiveness, and sustainable learning in the case of students with ADHD?
2) What obstacles and opportunities are represented in the intersection of this earlier research?
3) How can design principles guide collaboration so that these obstacles and opportunities can be leveraged for the sustainable development and adaptation of digital learning tools meant for students with ADHD?

Consequently, both the overarching problem and the case of students with ADHD are explored from the perspective of what is necessary regarding the design and adaptation of digital tools. For this purpose, we will initially summarize earlier research on inclusive education for students with ADHD, digital tools, and learning how to read. To provide this foundation, we have discussed studies concerning the themes of *"digitalization and sustainable development," "digitalization and inclusion," "variations in ADHD and variations of school support,"* and *"reading in digital formats for students with ADHD."* The intersection of these themes is largely lacking, but highly needed to identify possible dilemmas in offering students with ADHD good opportunities to learn reading with digital tools. We thereafter provide *implications and design principles for sustainable collaboration* through a theoretical exploration of what design principles could respond to the intersections of challenges and opportunities identified in earlier research. We then also exemplify how these design principles might support the collaboration and shared responsibility that is key for sustainable digital learning practices, specifically for students with ADHD. Consequently, we discuss how a joint development process might include sustainable development for learning, inclusive education, and innovative working methods. This way, we aim to provide common ground for stakeholders in the design process, emphasizing core aspects of digital tools for reading acquisition, for students with ADHD and specific learning needs.

2 Digitalization and Sustainable Development

Sustainable development has been defined as the development of society that fulfils the needs of today without jeopardizing future generations' possibilities to fulfil their needs (Boström et al., 2020; The World Commission on Environment and Development, 1987). From a social sciences perspective, sustainable development entails three major areas: responsibility for equity, responsibility for the future, and collaboration and integration of institutions and knowledge (Boström et al., 2020). Creating equity in an educational setting is to provide all students with the same opportunity to learn. This means that for students to be able to learn, adjustments, resources, and teaching methods need to be provided based on these students' individual needs. Providing all of them with the same digital tools in the classroom could be called *equality*, but not necessarily *equity*. Providing all students with digital tools does not necessarily mean that they all have the same opportunity to learn (e.g., Jacquet, 2016). Personal digital devices in school seem to affect improvement in motivation and cognition differently and affect student groups differently: Motivational improvements are fast and seem connected to access to a personal digital device, whereas cognitive improvements have a slower ascent (Hylén, 2013). High-achieving students and students with special needs show faster cognitive gains than other student groups (Hylén, 2013). In line with and in addition to this research, Jang and colleagues (2016) conclude that digital textbooks are good means to increase learning motivation, but that changes to educational policies and teaching and learning practices are necessary to achieve cognitive and academic gains. Some students may need additional support,

either from the tool itself or from the teacher, to be able to use the tools (e.g., Jang et al., 2016). Consequently, in order to provide digital inclusive teaching, which is good for all students, several stakeholders need to collaborate and together consider how these tools can become flexible and supporting platforms to provide learning opportunities for all students. For example, students and teachers need to be involved in the process of developing and adapting tools, and developers need to collaborate with researchers and policymakers.

To promote equity, inclusion, and sustainability in education in the future, there is also a need to balance short-term benefits with long-term benefits (Boström et al., 2020). Providing all students with digital tools in education could be one way to achieve this, if done with care and consideration. Digital tools are claimed to be a part of modern education, they provide necessary learning opportunities and help students prepare for future educational and employment possibilities (Centeno Mediavilla et al., 2019). However, using these tools also creates unsustainable short-term obstacles that need to be solved. As mentioned, some students need additional guidance and instructions to use the tools if there is not enough support integrated into the tools themselves. Otherwise, they may miss opportunities to learn or even be disrupted in their learning. Not removing this short-term obstacle would mean that long-term benefits and further learning opportunities for the individual would be diminished (Jacquet, 2016), and thereby sustainable learning as well as sustainable development for learning would be impossible.

It has been pointed out that teachers need further education in handling digital tools and supporting their students to use digital tools for learning (e.g., Hatlevik et al., 2015; Lee et al., 2015) as well as more support from school leaders (Hylén, 2013; Hylén, 2017; Jacquet, 2016; Willermark, 2018). With early teacher support, students can gradually use the tools more independently. Although teacher and student training seem to solve the long-term need, this does not solve the unsustainable short-term situation. Instead, students and teachers are now seen as both the problem and the solution. It might seem a bit unfair to ask teachers and students to work harder to solve a problem that has to some extent been put onto them and to thereby take sole responsibility for producing public value (Peeters, 2013). This may risk increasing stress in students' and teachers' everyday lives and possibly increase long-term health risks instead of improving their long-term learning. It is important to realize that digital tools themselves have a great potential to support their users, both students and teachers, in how to use them. Developers should therefore include functions and manuals as user support in digital educational tools which can help prevent everyday stress for both teachers and students. This is a way to share responsibility for making learning sustainable and further sustainable development for learning.

From the examples above it becomes clear that there are many stakeholders involved in the use of digital tools in education, such as students, teachers, school leaders, developers, and researchers. Their unique perspectives, as well as the shared experiences between them, constitute a wealth of knowledge. We claim that the responsibility for digital tools in education must be shared by all stakeholders to address the third area of sustainability: interdisciplinary and transdisciplinary collaboration. This also includes bringing the students onboard in the process of designing, developing, and adapting digital tools, as they are core stakeholders. This approach connects responsibility with equity and the ethical aspects of education. We draw on Boström and colleagues (2020), who point out that there is a recurring interest in solving these complex issues both by interdisciplinary collaboration within science, and transdisciplinary collaboration between science, practice, and other sources of knowledge. Taking shared responsibility for education concerning digital tools, interdisciplinary collaboration would imply that researchers in pedagogy and engineering need to

engage in joint developing of programs. In addition, transdisciplinary collaboration would imply that the knowledge of prospective users, such as students, teachers, and school leaders, should be involved as partners when developing such tools.

3 Digitalization and Inclusion

Digital literacy has become crucial to finding a job and taking part in society (Centeno Mediavilla et al., 2019). According to the European Commission DIGCOMP project (2019), to be digitally literate means to be able to "articulate information needs, to locate and retrieve digital data, information, and content. To judge the relevance of the source and its content. To store, manage, and organize digital data, information, and content". Other key components of digital competence identified in the report are communication and collaboration, digital content creation, safety, and problem-solving. To broaden educational practices to engage and support all students, digital literacy can be a cornerstone in planning for inclusive education, allowing for a wider range of educational practices. Inclusive education, however, has been described in various ways and varies when put into practice. In its perhaps most simple definition, it means creating learning environments in which it becomes possible to *involve all* students (Nilholm, 2020). This includes both academic and social participation, as well as (spatial) access for every student (e.g., Göransson & Nilholm, 2014). For students, inclusion can be translated into experiencing trust, a community, and a sense of belonging, all of which may improve their motivation and self-confidence (Allan & Persson, 2020).

Digital literacy can enhance students' learning and participation in school. Working with digital textbooks may create (more) equal educational chances by allowing users to change settings—e.g., by changing the size of the text, translating words, and additional or optional illustrations—in order to better suit students' individual preferences and needs. Alsalem (2016) argues that, compared to traditional printed media, digital technology has had a far greater impact on literacy, enabling a larger population to see digital literacy as a truly communicative and social endeavor rather than communicative for the few and passive information gathering for the many. In a survey, teachers' responses to digital literacy focused on digital tools helping to overcome difficulties in students' learning, specifically for students with disabilities. Digital educational tools were described by the teachers as a way to create engagement and motivation, to be flexible, to be able to multiply representation, and even as a medium for enhancing students' skills and achievements (Alsalem, 2016). Students may express their understanding in different digital forms, be it by writing a report, developing a podcast, or building an interactive presentation. In other words, digital technology allows for a wider variety of educational practices and provides more platforms that may motivate, engage, and overall improve all students' learning experience (Alsalem, 2016; Kraft, 2023; Nilsson, 2021).

When re-thinking the intersection of digital tools and inclusive education, it is important to revisit the policy, practice, and intentions of inclusive education. Key recommendations for inclusive education made by the European Agency for Development in Special Needs Education (2009) include the following: Widening participation for all learners, education and training in inclusive education for *all* teachers, organizational culture that promotes inclusion, support structures organized to promote inclusion, and flexible resourcing systems that promote inclusion. To help foster cultures of inclusivity and promote teachers' work to give voice to students' perspectives and the need for digital tools, Gillett-Swan and Sargeant (2018) drew up principles for a Voice Inclusive Practice (VIP). In their article, they depart from participation principles from the United Nations' Convention on the Rights of the Child and Shiers's pathway to participation. VIP aims to give students a voice in their education that is not only authentic, but also achievable in practice. Gillett-Swan and Sargeant (2018) have built further

on VIP, creating VIP Digital. The authors mean by VIP Digital that digital educational tools need to be accessible to all, and that educators and students should share decisions on which tools to use. The final point of VIP Digital is that there should be reciprocal knowledge and skill transmission between students and teachers regarding the use of digital tools.

Reciprocal knowledge and skill transmission are important for school leaders to facilitate and give a tangible starting point for teachers when planning and conducting inclusive education with digital educational tools. To make progress, collaboration is needed as there are both challenges and opportunities for students and teachers alike. As mentioned above, there is a lack of digital education and supplementary training for teachers. Indeed, 18% of lower secondary school teachers in the OECD (2020) international survey report a strong need for more training in digital tools. However, not all teachers are reluctant to use digital educational tools. 43% felt well prepared using information and communication technologies (ICT) when starting their profession, 56% have already participated in training on using ICT in the classroom, and 53% actively use ICT in the classroom. Overall, the use of ICT in teaching has increased by around 15% in only five years (between the dataset of 2013 and 2018; OECD, 2020).

Considering these data together, there is a positive trend to be seen regarding the need for ICT and using or training to use ICT. In addition, teachers are educated in several methods of educational practice and can help see and voice students' needs, some of which the students themselves may not even be fully aware of yet. Furthermore, while students are often described as tech-savvy and unafraid (e.g., Gillett-Swan & Sargeant, 2018), not all of them find digital tools easy to operate. While some overestimate their own digital literacy (Ben-Yehudah et al., 2018; Singer & Alexander, 2017), others, often from low-income families, don't see the need to use digital tools (Jacquet, 2016). Therefore, the point of reciprocal knowledge and skill transmission between students and teachers is important as a good example of why integrating the knowledge of stakeholders from different status groups, as discussed above, may contribute to the creation of a shared responsibility for inclusive education. Unfortunately, the VIP Digital principles leave out how to include developers of educational digital tools, although a close collaboration would certainly make for user-friendly products, especially when stakeholders have different views on the teacher, assessment, and learning in schools (Ideland, 2020). As a matter of fact, the collaboration between several professions in digitalizing school development projects has already proven fruitful for students' learning (Karlsson, 2023).

The question is how to conduct such a collaboration. The four design principles of innovation (British Design Council, 2019) may be helpful as a guide, especially when used alongside the VIP Digital principles. The four design principles include—among other principles—understanding the users' needs and promoting communication and collaborative efforts (British Design Council, 2019). These principles will be described in depth in the discussion part of this article as they fit with the idea of inclusion through special education. Inclusive education stresses the importance of including *all* students and *all* teachers to meet everyone's needs (e.g., European Agency for Development in Special Needs Education, 2009; Nilholm, 2020). Reciprocal knowledge transmission and collaboration are needed for developing the needs-driven digital tools (Gillett-Swan & Sargeant, 2018) necessary to create these teaching and learning environments.

4 Variations in ADHD and Variations in School Support

As a part of facilitating reciprocal knowledge and skill transmission, and understanding users' needs, this article aims to provide stakeholders with a common ground regarding reading with digital tools

for students with specific needs. The case of ADHD helps to understand the complexity of student groups and the educational context they are in. This complexity calls for a level of flexibility in digital tools that can be developed by involving actual users in evaluating these tools. Common ground may facilitate joint development processes that can include sustainable development for learning, inclusive education, and innovative working methods.

Schoolchildren with Attention Deficit/Hyperactivity Disorder (ADHD) can have problems with maintaining attention and effort, as well as with organizing and finishing tasks. This may result in poor academic achievements and, among other issues, difficulties with reading development (DuPaul & Stoner, 2003; Tannock, 2007). Teachers, however, often perceive a diagnosis as too vague as a tool or information to gain knowledge on what adaptations the individual needs (Ågebrant, 2016). The heterogeneity of this student population is a likely reason for this observation. An ADHD diagnosis includes attention difficulties and overactivity, both of which may be present to different degrees and vary with environment, age, and gender (Socialstyrelsen, 2016). Furthermore, reading comprehension depends on several factors such as the individual reader's knowledge and use of strategies, text genre, task design (Snow & RAND 2002), and even the design of a digital environment (Segers, 2017; Wylie et al., 2018). Hence, many factors weigh in on how well students with ADHD receive digital reading education and support for their learning. Below, we briefly review a few factors that highlight the complexity of the diagnosis and its relation to academic reading achievements.

Students with ADHD can have problems with maintaining attention and effort, as well as organizing and finishing tasks, i.e., *self-regulation* (e.g. Reid et al., 2005). Self-regulation is a part of higher-order cognitive functions and is dependent on executive functions (Blair & Ursache, 2011; Rueda, Posner, & Rothbart, 2005; Schilhab, 2017). Executive functions, such as sustaining attention, help students focus on relevant information. Because of this, executive functions are closely linked to academic achievements (Chan et al., 2008; Diamond, 2013). However, attention difficulties take different forms in students with ADHD. In a study conducted by Tsal et al. (2005), eight-year-olds with ADHD predominantly showed difficulties with sustained attention, which could be clustered into three categories: difficulties with (1) *selective attention*, (2) *executive attention*, and (3) *orienting of attention*.

Furthermore, in a review of 72 studies investigating academic achievements in persons with ADHD, 69 showed that persons with ADHD displayed lower performance in reading, writing, and math, but in three studies persons with ADHD showed higher performance than the controls (Frazier et al., 2007). No significant gender differences were found for academic achievements (Frazier et al., 2007). Although there may not be any noticeable gender differences in academic achievements, research in special education has shown that not all students with ADHD receive the support they are entitled to. This support rather depends on educators' views on the diagnosis (Hjörne & Evaldsson, 2015). For example, boys are often diagnosed earlier than girls because of acting-out behaviors (Kopp et al., 2010), whereas teenage girls with ADHD report having more depression-related problems than their male peers (Rucklidge & Tannock, 2001). This may suggest that the source for problems with academic achievements is partially different for girls and boys if educators and schools do not recognize what type of support they need, and when.

4.1 Reading in Digital Formats for Students with ADHD

To understand a text, both on a surface level and in depth, implies that the reader engages in various reading strategies while reading, such as monitoring their own comprehension of the text. Comprehension monitoring is a crucial strategy as it allows the reader to decide on and self-regulate other reading strategies

(Duke & Pearson, 2002), e.g., looking up the meaning of a word or skipping back in the text to search for an important reference. When using digital reading tools, the academic outcome is related to students' use of self-regulating strategies (Winters et al., 2008). For example, when asking students about their self-regulating strategies and digital literacy in questionnaires, self-regulation proved to be mediating the effect of digital literacy on the students' grades (Lee et al., 2015).

Sustainable development in learning for students with ADHD can be achieved by working inclusively and making reading accessible. Research shows that reading can be made accessible for these students by using a digital medium that helps maintain their attention for the task, but there are certain prerequisites needed (Ben-Yehudah et al., 2018). These prerequisites involve supporting focus and working to counteract inattention, hyperactivity, and impulsivity, for example via literacy programs that adopt augmented reality AG (Tosto et al., 2021). These findings are in line with research on digital reading in adults with ADHD, as metacognitive scaffolding supports concentration and focus, leading to opportunities to reach the same level of competence and comprehension as the group of students without ADHD (Brann & Sidi, 2025). In general, Ben Yehudah et al. (2018) show that reading in a digital environment may enhance engagement and time spent on tasks for young students with ADHD. Their study also shows that multimedia content may support comprehension by enhancing engagement. However, if the material proved too long, these potential benefits of multimedia learning were also lost for students with ADHD. Other studies show that when reading is AI-assisted and auditory, and used to support learning content rather than learning to read, it can be beneficial for students with ADHD. The increased motivation to learn the content helps engage students in the reading process (Jafarian & Kramer, 2025).

To further understand the case of students with ADHD and each student's needs in learning how to read, it must be considered that reading comprehension varies with age and digital environment. Linear texts in a digital medium, such as an e-reader, may prove helpful to elementary school students with ADHD: more correct answers are given and students spend more time on task compared to analog text. For high school students with ADHD, however, linear digital texts only help if the students can double the line spacing (Ben-Yehudah et al., 2018). In addition, high school students may seem confident regarding their digital reading skills, and their digital reading speed may also be faster compared to printed text, but they still appear to be at a slight disadvantage in comparison to students without ADHD (Ben-Yehudah & Brann, 2019). However, similar patterns or results are shown in studies that focus exclusively on typically developing high school students. They, too, are confident that they do better with digital texts and prefer these, but their performance tends to be better when they work with printed text (Singer & Alexander, 2017).

Together, earlier research indicates that academic gains cannot be expected to show just by using a changeable reading format. Motivation and reading speed seem to be enhanced by a digital format, as well as the students' confidence in their reading skills. Yet, while enhanced reading speed, reading fluency, and confidence are all important for reading development and understanding digital texts, they do not guarantee long-term learning. Reading fluency may predict immediate recall of web-based text, but vocabulary knowledge and reading comprehension in printed text may also predict comprehension and long-term learning in web-based text (Boechler et al., 2006). Hence, it is the processes that enhance concept knowledge in digital reading and help students understand the connection between previous knowledge and new knowledge that can support in-depth comprehension and long-term learning.

Similar to Jang et al. (2016), Ben-Yehudah et al. (2018) conclude that teaching practices, such as the role of teachers as effective mediators of digital training,

should be examined to ensure that students benefit from digital reading tools. Consistent with these reviews, Schilhab (2017) argues that it is not possible to overcome challenges by just using and getting used to digital tools, but that there is also a great need to practice, and therefore teach, self-regulation when using such tools. For example, the hold that digital tools take on readers' attention has two sides. On the one hand, reading on a digital device can generally keep readers' attention in a way that helps them stay on task and complete the reading that is required in a teaching/learning situation (Schilhab, 2017). On the other hand, the mere knowledge that the same device also offers other activities, such as checking emails or social media, may divert attention from reading comprehension processes (Przybyliski & Weinstein, 2013). So, to stay on task and finish reading, readers need to actively monitor their understanding of the text and make use of reading strategies. Since students with ADHD benefit from self-regulation interventions (Edwards et al., 1995; Johnson et al., 2011; Reid et al., 2005), digital reading tools can be designed to help them learn to apply various reading strategies to understand the text (Askell-Williams et al., 2012; Devolder et al., 2012; McClanahan et al., 2012).

To summarize, great complexity is revealed by students with ADHD and their reading practices in digital environments. The individuals in the student group, and therefore also their needs, vary. Consequently, schools find it difficult to provide appropriate individual support. Students' reading gains also vary by age and digital learning environment. For example, students who read faster when reading in digital mediums do not necessarily improve their reading comprehension (Ben-Yehudah & Brann, 2019; Singer & Alexander 2017). Hence, they still need more thorough help checking what they understood from the text, not only how far they came reading it. Here, digital tools that support the learning-to-read process and using reading strategies could be of help, as shown by research. Importantly, the support structures that work for these students—namely audio-support or simplistic texts in terms of content—are not necessarily the ones traditionally included for supporting reading development in digital tools. What is also needed in the case of ADHD, is mental scaffolding and metacognitive support that can be provided by adding a flexible and digital guide to the reading process. Teachers, schools, and software developers need to collaborate to prioritize ADHD students' needs and facilitate opportunities for deep reading comprehension in digital texts.

5 Implications and Design Principles for Sustainable Collaboration

We started by stating that while digital solutions have the potential to meet individual needs and make learning more accessible and sustainable, they might also generate new forms of exclusion. Herein lies a dilemma. Consequently, to better understand the potential of digital tools in education, we have reviewed research on reading comprehension in digital formats for students with ADHD. In summary, results show that reading in a digital environment seems to enhance some aspects of reading for these students, namely focusing and supporting attention, higher motivation and faster reading speed (e.g., Jang et al., 2016; Hylén, 2013). Although these aspects are important for learning from text, they do not seem to lead fully to deep comprehension, long-term learning, and higher academic achievements. Similarly, students with ADHD are more engaged by digital reading tools and show higher reading speed than when reading printed texts (Ben Yehudah et al., 2018). As they progress towards high school age, they also grow more confident regarding their use of digital tools, but there do not seem to be any benefits to deep comprehension on a general scale. This is, in addition, highly contextual and depends on what features digital tools offer. Audio support only is not enough, whilst artificial intelligence (AI) and AG seem to be fruitful, but research is not yet conclusive. Also, even though digital literacy

can enable participation for all students (Alsalem, 2019), this does not mean that all students are capable of successfully self-regulating their own learning processes. Students therefore need the guidance of the teacher's pedagogical insights, and although they often are digital natives, reciprocal knowledge transmission and collaboration are needed when working with digital tools (Gillett-Swan & Sargeant, 2018). Consequently, there are pitfalls and obstacles as well as opportunities to support reading skill acquisition with digital tools in the case of students with ADHD. We conclude that digital tools do not automatically enhance the sustainable development of learning and inclusive education simply because they are digital and allow for more flexibility. Students still need guidance to regulate their use of reading strategies while reading in a digital environment.

Throughout this text, we have pointed out that shared responsibility for the development and use of digital tools in schools is necessary for sustainable development and inclusion in education. Because digital tools create new opportunities as well as obstacles, researchers have called for more student and teacher training. This, however, comes with the risk of seeing teachers and students as both a problem and a solution to the question of sustainable digital education. In the literature on sustainable education (Boström et al., 2020) and inclusive education (Gillett-Swan & Sargeant, 2018) both collaboration and knowledge transmission between several professions and stakeholders are discussed as possible ways of sharing this responsibility. To share responsibility for sustainable and inclusive digital learning environments, a collaboration between students, teachers, schools, scientists, and developers is necessary. However, both research (Ideland, 2020) and media (Bergling & Hedman, 2021) report that, for example, school practitioners and developers of educational technology have different ideas of what works. Such differences might stem from poor communication and knowledge exchange.

For improved communication and knowledge exchange between stakeholders, and ultimately sustainable development of schools and inclusive education, we will display a model of collaboration principles and work process in the following. The *four design principles of innovation* are then put in relation to prerequisites for *sustainable and inclusive education*, as identified in earlier research. The four design principles of innovation are used by innovators in various fields (British Design Council, 2019). The first design principle states that when designing, one ought to be putting people first. This means that an understanding of the needs, strengths, and aspirations of those who will be using digital tools should guide the design process so that the outcome meets actual needs. The second design principle is to communicate inclusively and use multimodal ways to help people gain a shared understanding of problems and ideas. This implies that effort needs to be made so that communication between stakeholders (students, teachers, developers, researchers, and policymakers) works. This could, for example, be achieved through joint webinars or workshops during which multimodality is advocated to reinforce inclusive communication to increase possibilities for shared understanding. The third design principle advises a collaborative spirit and for stakeholders to get inspired by one another. To co-create, it is necessary to take on board each other's ideas. The fourth and final design principle points towards the need for collaborative processes to entail many small iterations and to do this in four phases. This allows the collaborating stakeholders to uncover potential errors and risks early and to build trust with regard to common goals being kept in sight.

The three first principles mirror values that are also held within the field of inclusive education, which stresses the importance of including all students and all teachers to meet everyone's needs (e.g., European Agency for Development in Special Needs Education, 2009; Nilholm, 2020). The last design principle of innovation provides an idea of how to make this collaborative process sustainable through an iterative

process that has four phases: *Discover needs, Define solutions, Develop, Deliver*. In this case, designing and developing the use of digital tools for learning how to read means to create concepts (and prototypes) that need to be tried out and modified iteratively because of the many reading strategies involved. The first phase in achieving this is implementing the principles to ensure that the collaborators can discover and identify a variety of needs together. If, as in the case of this article, the aim is to create a digital tool to support students with ADHD in learning how to read, there is a need to identify this student group's diverse needs. In the second phase, collaborators need to define and choose a few solutions and designs to work with. In the third phase, these need to be developed and after iterations of testing and revision, in a fourth and final phase, the designers and developers can deliver digital solutions that, in an ideal world, now work inclusively and provide sustainable learning paths for all students.

After delivering a functional tool, however, the process needs to begin anew as the service needs to be evaluated by discovering new needs and solutions, again defining, developing, and delivering them. By allowing small iterations and introducing interim goals to the process, all stakeholders can test together what kind of flexibility a digital tool needs to have and what kind of support structures it needs to offer such a diverse population as students in schools. Although teachers' resources and instructional time are rarely sufficient for development work or for addressing all parts of the curriculum equally, iterative and participatory curriculum design has shown positive outcomes for both students and teachers (John et al., 2018). The iterative processes described in the *innovative design principles* can therefore be seen as both inclusive and sustainable ways to work in education and support the reciprocal transmission of knowledge and skills that is called for in both sustainable development and inclusive education (Boström et al., 2020; Gillett-Swan & Sargeant, 2018). We hope that the contribution of this paper is giving several stakeholders the possibility to reach a joint language and strategies in developing digital tools, to discuss how digital educational tools should be designed and developed. When realizing that one stakeholder cannot work without the other, synergy can be created and inclusion in the learning process, sustainable learning, and simultaneous sustainable development of digital tools can be realized.

DILeMa (2025), Issue 1/1, 35–51 https://doi.org/10.11576/dilema-7518

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Essay Information

Citation note:

Karlsson, J., & Bagger, A. (2025). Developing and Creating Inclusive and Interactive Digital Reading Environments with and for Students with ADHD. *DILeMa, 1*(1), 35–51. https://doi.org/10.11576/dilema-7518

Available online: 28.08.2025