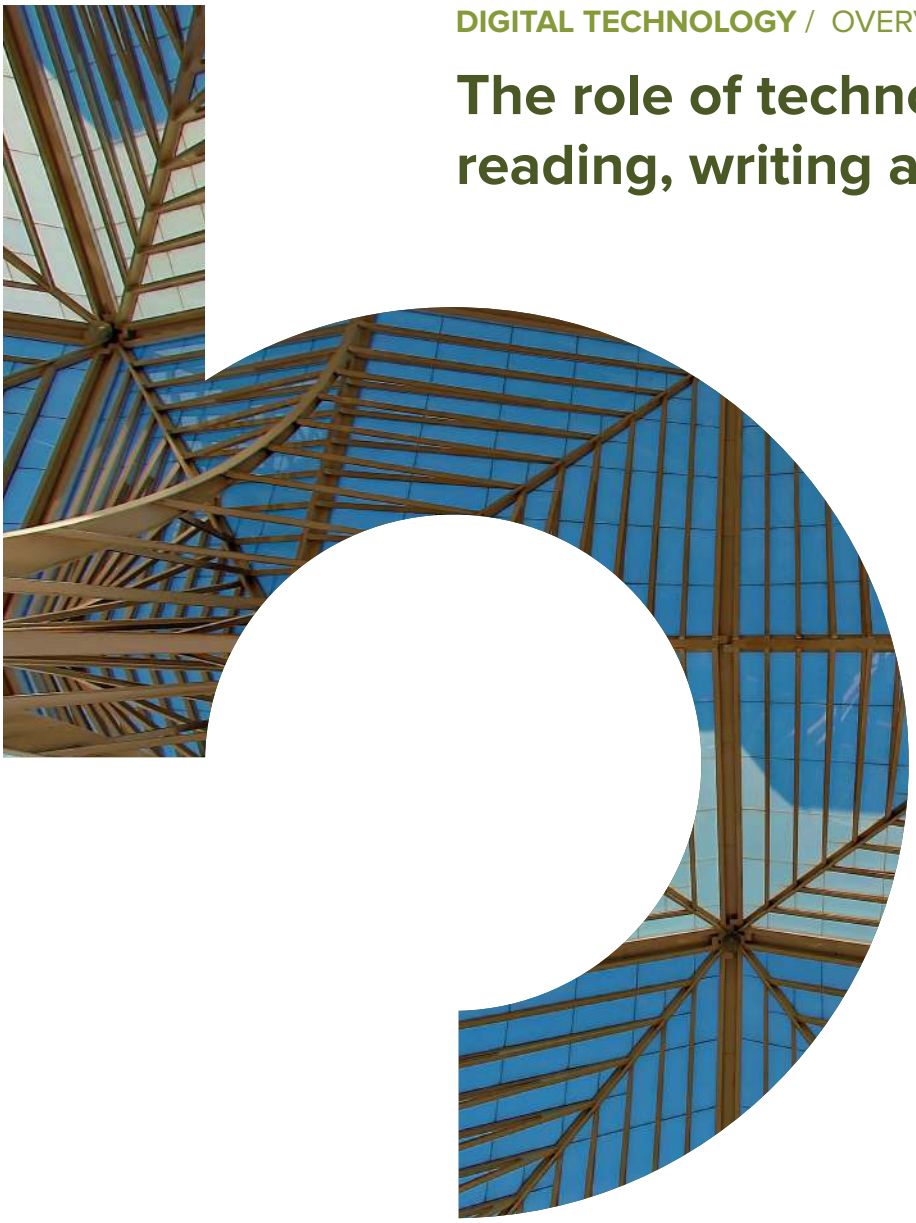

DIGITAL TECHNOLOGY / OVERVIEW

The role of technology in teaching reading, writing and maths

the education hub

Summary

The use of digital devices in schools is increasing and students are using tablets and laptops in primary school in their reading, writing and maths. Many people assume that this generation of students are digital natives and as such are familiar with and comfortable using technology effectively. Furthermore, digital devices are frequently positioned as the solution to making students more interested in the material they are learning in school. However, a growing body of research suggests that, while young people are comfortable with technology, and many find technology engaging, the use of digital devices does not always produce the learning outcomes hoped for. While there is evidence to show that using technology in maths instruction may lead to certain improvements in learning outcomes, there is evidence to suggest that digital and non-digital reading and writing methods are not analogous and that non-digital reading and writing methods have benefits that digital methods do not.

Reading

The evidence base on digital versus non-digital reading includes several key findings.

Research indicates that readers may not comprehend material as well when they view it digitally as when they read it on paper

Different cognitive processes are involved in print reading compared with digital reading. Reading digital media (particularly online sources) is more challenging than print reading because of the navigation required to access the material, including clicking on hyperlinks and scrolling through text. Research indicates that, while strong readers perform well both in non-digital and digital reading, there is significant variation in digital reading performance at all non-digital reading performance levels. Further research indicates that reading digital texts may take more mental effort, making it more difficult to remember what has been read. This is because, when reading material online, you are trying to comprehend what you are reading while simultaneously making decisions about what to read and where to navigate next. There is also evidence that people tend to read digital texts more quickly, which similarly impacts on comprehension and recall.

Increasing children's exposure to technology by having them read on digital devices may encourage a shallower kind of cognitive processing, which in turn leads to a decrease in deep comprehension of digital texts and poorer attention quality, so it is important that teachers check with students to ensure that they comprehend the digital texts they are reading. Furthermore, it is important to note that research has been inconsistent in assessing the effect of digital reading on comprehension. This inconsistency is partly explained by the difficulty of comparing paper texts to digital texts that include features such as hyperlinks and animations, as the impact on learning outcomes may in fact be attributable to these media rather than the language of the text.

People prefer non-digital text because it is more familiar

Research has found that people tend to prefer non-digital text because they are familiar with it. How the human brain interprets written language offers an explanation for people's preference to read in print rather than on the screen. People find it easier to remember written information when they can imagine where in the text it appeared. Reading a printed text allows the reader to orient themselves by focusing on what they read in relation to where it is on the page or its position in the book. This makes non-digital text easy to navigate and easier to remember, which is why we often remember where on the page we read particular information, even if sometimes we cannot remember exactly what we read. In contrast, readers of digital texts must scroll down a page or follow navigational links within the text, which interferes with the linear navigation of the text and consequently impacts on how well the reader remembers what they have read.

Non-digital text is preferable when reading comprehension is desired

It is important for teachers to align the desired learning outcomes with the reading mode. If the goal is for students to survey key points and learn the main idea, then digital text is as good as non-digital text. However, if the teacher wants students to comprehend and synthesise their reading, then non-digital text is more suitable. While most research in this area focuses on the dichotomy of digital versus non-digital, there is an opportunity for educators to provide students with an understanding of their options in accessing learning materials in digital and non-digital forms, and to teach students how to take advantage of the affordances of digital texts while also explaining their limitations. Scholars believe that, if students are provided with instruction on digital device use, they will achieve better reading comprehension when reading digital texts on those devices.

Writing

As technology continues to be introduced in the early years of schooling, children are learning to write on tablet or smartphone screens before they can write by hand. Parents and educators must exercise caution here, as the writing skills that are developed before children enter formal schooling can predict their academic achievement years later. The following are some of the key findings from the research into using technology to teach writing.

Physical movements of writing by hand aid the thinking process

Research in this area has focused on the use of keyboards and screens compared with writing on paper using pen or pencil. The evidence demonstrates that the physical movements of writing by hand are part of the thinking process involved in writing, making writing by hand an effective medium for learning. One study found that university students who recorded lists of words by hand were able to recall them more effectively than the students who used digital devices to record the words.[1] This is because writing is a physical and a cognitive experience, and the processes involved in handwriting help to develop cognition and memory, whereas typing may become automatised.

Writing by hand facilitates reading abilities in young children, and is essential to writing well-structured text later on

Research has found that learning to write by hand can aid pre-literate children in learning letters and words, and activate regions of the brain that are known to underlie successful reading. Researchers and educators alike have noted a decline in writing by hand in recent years. The ubiquity of computers, tablets, and smartphones has reduced the priority of teaching handwriting, but a growing body of research suggests that handwriting is essential to creating well-structured written text, and that handwriting training may even be superior to typing training.

Digital writing tools offer efficiency and convenience

It is tempting to look to technology as a faster, more efficient means to write. Digital resources enable language and grammar accuracy because many devices are equipped with spelling and grammar tools that automatically correct for errors. Moreover, the ability to save multiple drafts of a piece of writing and edit the writing digitally can be helpful, as it allows the writer to go back to an earlier draft and copy and paste text from different drafts together. Research has demonstrated that the practice of reworking a piece of writing based on feedback from a teacher or peer is a powerful learning strategy. Therefore, it is important to take into account the cognitive benefits of writing with pen or pencil on paper as well as the efficiency of writing with technology, and consider the affordances and limitations of both forms of writing when designing learning tasks.

Maths

Overall, there is some evidence to suggest that the deliberate use of technology can support the learning of mathematics (skills and procedures) as well as developing advanced proficiencies like problem solving, reasoning, and justifying. Several meta-analyses have determined that the use of technology in maths instruction has small but positive effects in promoting mathematics achievement, with larger effects for primary school students and learners with special educational needs.

However, the positive effect of using technology in mathematics instruction was greater when combined with a constructivist approach to teaching, which suggests that it is the pedagogical approach, rather than the technology itself, that matters most for learning. Furthermore, while small positive effects have been observed, it is important to note several important caveats. Firstly, further research suggests that gains are not maintained in the long term. Secondly, as with reading and writing, technology is known to increase motivation and engagement, but motivation and engagement do not always equate to desired learning outcomes. Thirdly, it is the type of technology used and, even more importantly, the ways in which it is used (the pedagogy governing its use), that determine the learning that occurs. The following are some of the common uses of technology in mathematics teaching and the findings of the research into their use.

Apps need to meet certain criteria in order to promote learning

The research on using apps in teaching maths finds that their impact on content learning is mixed, because not all apps are designed specifically with learning in mind, are sometimes lacking in quality, and do not have a clear alignment with the learning outcomes that are set by teachers or the curriculum. Apps that are designed to promote active, engaged, meaningful, and socially interactive learning may be considered educational if they are aligned with particular learning goals. When selecting apps to use for teaching, it is important to look for apps that draw on evidence on effective pedagogy more generally, that is, apps that utilise what we know about how people learn best and the pedagogies that best support this learning. It is also crucial to ensure that apps involve appropriate challenge and that they align with the learning outcomes and curriculum. Researchers have identified four key criteria to determine which apps may be used to promote learning in maths instruction. Look for apps that:

1. *Enable students to actively test their knowledge.* Research demonstrates that students who actively test their knowledge and skills remember more than those who just read over notes. Apps that expose students to new material and engage them in quizzes to test their knowledge will encourage learning by giving students the opportunity to retrieve information and practise their skills.
2. *Set reminders to practise over an extended period of time.* Studies show that students who practise new content and skills in multiple sessions over multiple days perform better than students who have marathon study sessions. Teachers can remind their students to practise using app-based programmes like Khan Academy as part of their lessons or for homework each day. This means that students are continually revisiting content and practising new skills, something that is particularly important in mathematics where learning builds upon previously learned knowledge and skills.
3. E*ngage multiple senses in the learning process.* Apps are most effective when they allow learners to engage with the material in tactile, audio, and visual ways. Research suggests that apps designed to present material in multiple ways—or which allow educators to experiment presenting information in different ways—could improve memory while also accommodating different learning needs.
4. *Increase feedback.* Students benefit from feedback that guides their next steps. While many educational apps provide immediate feedback on student progress, teachers must still work to provide feedback that specifically guides students on next steps.

Interactive visualisations and explorations can enhance traditional approaches

The human brain wants to think visually when learning and understanding mathematics. Multimedia technologies can make learning more interactive and engaging by bringing the concepts to life. For example, geometry software can enable students to transform a geometric object by 'dragging' its components to investigate its properties. Through this interactive and experimental approach, students can test their hypotheses about the properties of geometric objects and generate new mathematical knowledge. Used in this way, technology becomes an enhancement to teaching because it allows students new ways of developing their understanding and problem-solving capabilities. However, it is important to note that similar pedagogical approaches that do not utilise digital technologies may also yield the same learning processes.

Digital tools enable a personalised learning approach

Digital tools for personalised learning, such as Khan Academy, have been used to supplement curriculum to customise the learning experience for students based on where they are in their understanding. Personalised learning refers to the various educational programmes, instructional methods, and academic support strategies to address the distinct learning needs of each individual student. Personalised learning is designed to enable students to learn at their own pace, and to revisit content and skills that they have not yet fully mastered.

Resources such as Khan Academy, which houses practice exercises and instructional videos for students, especially in STEM subjects, exemplify personalised learning platforms online. However, these platforms, which offer variation in pacing for students, receive criticism because pacing itself is not enough of a personalised approach to learning, in which students have ownership and autonomy over their own learning. Furthermore, the evidence base behind personalised learning is uncertain. While there are small-scale studies that have determined modest positive effects of personalised learning on students' learning, others have found that personalised learning has negligible or negative effects on student learning and can lead to decreased engagement and enjoyment. Therefore, it is important to use online personalised learning platforms judiciously, and to link their use to desired learning outcomes.

Conclusion

Given the variability of how people define technology, the wide range of uses of technology, and the need for more evidence to understand what types of technology are best for particular learning outcomes, teachers must think carefully about what they want to achieve and the underpinning pedagogy when employing technology in teaching reading, writing and maths. It is important to think carefully about what forms of technology will be most suitable to the learning goals and to check the evidence on particular types of technology use in relation to particular learning areas: while the research base finds that technology use can enhance maths teaching in certain circumstances, it also warns that digital and non-digital reading and writing are not analogous and should not be seen as interchangeable. It is also important to be conscious not to use technology solely because it is engaging, convenient or available, as some scholars worry that, the more technology is used for 'shallow' purposes, the less people will be able to use technology for challenging tasks. In most cases, what matters is not the technology, but how and why you use it.

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Endnotes

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