WHITE PAPER

Enhancing K-5 Education Through Effective Edtech Design

GoGuardian

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Introduction

When considering digital interaction and academic success, the importance of crafting well-designed educational tools cannot be overstated. Notably, for K–5 students who stand at a critical juncture in cognitive and attentional development, the design of these tools can make or break their educational experience.

> *Education tools, underpinned by sound design principles, play a pivotal role in determining how students engage, comprehend, and retain information in a digitally saturated environment.*

This white paper draws on the pioneering research in Dr. Gloria Mark and Dr. Philip Janowicz's paper, "HCI Design Principles for K–5 Digital Education," and specifically highlights their set of nine Human-Computer Interaction (HCI) design principles. These principles have been meticulously curated from the fields of Human-Computer Interaction, Instructional Design, and Children's Technology to provide research-backed guidelines when designing digital environments.

These principles are unique because they focus on the K–5 population and are grounded in research on developmental differences in attention, self-control, and self-regulation. As such, these principles provide a framework for developing digital learning experiences that take into consideration the whole child, especially their developmental level.

Understanding Digital Distraction in Students

Digital devices put a world of knowledge at our fingertips, but they also present a host of distractions.

Understanding digital distraction in students

For students, while technology offers powerful tools for learning, it also presents numerous distractions that can hinder their educational journey. Let's take a closer look at digital distraction and its potential impact on learning outcomes.

WHY DOES DIGITAL DISTRACTION MATTER?

Our brains have a limit to how much information they can process at once (Bandura, 1986; Sweller, 1994). Overloading individuals with too many sources of information can impact performance (Broadbent, 1958; Treisman, 1964). Because of this, it is important for us to help students by designing digital education experiences that minimize distractions and allow them to focus on learning. By turning to the research on digital distraction and how it is impacting student performance, we can begin to build a framework for how learning tools can be designed to best support learning outcomes.

DIGITAL DISTRACTION'S EFFECT ON ATTENTION SPAN

Broadly speaking, **attention span on computer screens is limited**. Mark et al. (2016) found adult information workers had an average attention duration of 47.0 seconds. Yeykelis et al. (2018) reported a slightly longer average of 70 seconds.

> *This range, between 47 and 70 seconds, implies a limited window for learning at any age.*

For college students, their attention span averaged around 48 seconds before task switching, with the highest multitaskers switching 2.1 times per minute and the lowest multitaskers at 0.8 times per minute (Mark et al., 2014). This range, **between 47 and 70 seconds**, implies a limited window for learning at any age.

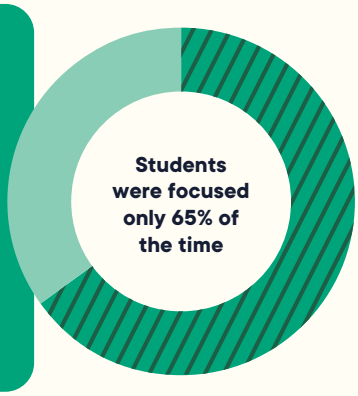
Notably, researchers saw a relationship between rapid attention shifts (or more window switches) and heightened reported stress (Mark et al., 2014). Consequently, for digital educational platforms, minimizing digital distractions and window-switching capabilities could enhance focus and alleviate stress.

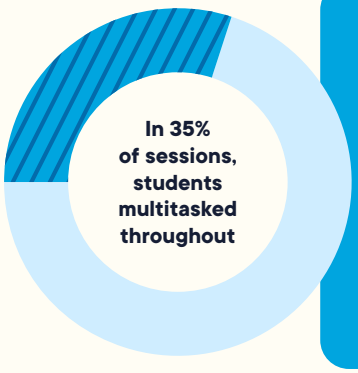
How students are distracted

The previous research highlights how the human brain can be distracted by digital devices; however, how does this distraction appear across different age groups of students? While younger students (K–5) are under-represented in current studies, we can begin to draw clear conclusions when considering studies with older students.

STUDY ENVIRONMENTS:

In a study by Rosen et al. (2013), students in middle school, high school, and college were observed while studying at home. Findings indicated **students were focused only 65% of the time**, with an average on-task duration of 5.61 minutes. Interestingly, when compared to the other groups, high schoolers were found to text more, middle schoolers played more video games, and college students applied more study strategies.



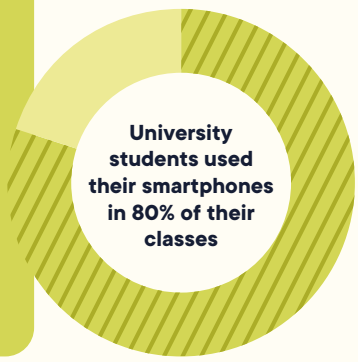


MULTITASKING:

Judd (2013) studied how often students multitask in digital learning. He found that over 70% of sessions had multitasking at some point, and in 35% of sessions, students multitasked throughout. Judd noted that **only 30% of sessions had students focus on one task for a straight 10 minutes**. This indicates that students multitask a lot, even when learning on their own.

SMARTPHONES IN CLASSROOMS:

The rise of smartphones has added another layer to digital distraction. Kim et al. (2019) found **university students used their smartphones in 80% of their classes**, getting distracted every three to four minutes. The primary culprits? Social media and messaging.



Digital distraction and student outcomes

Next, we will explore the complex relationship between digital distraction and student outcomes. Drawing from a variety of studies, we can isolate insights to inform how we can best support student focus.

ENGAGEMENT AND PERFORMANCE

One of the most consistent findings across studies is the relationship between the time students spend focused on their tasks and their performance. Bowman et al. (2010), Kuznekoff & Titsworth (2013), and Waite et al. (2018) have all found that a decrease in time-on-task corresponds with diminished student outcomes. This underscores the importance of keeping students engaged and ensuring digital platforms don't inadvertently encourage off-task behaviors.

INTERNET LITERACY

Leung and Lee's 2012 study suggested that a solid understanding of the internet and its tools correlates positively with academic performance. But there's a twist: while internet literacy is beneficial, internet addiction — often associated with leisure activities like social media — negatively impacts academic performance. The challenge is to promote internet literacy while avoiding internet addiction.

PRODUCTIVE INTERNET USE

Junco and Cotton's 2012 research throws light on the behaviors associated with productive internet use. It's revealed that students typically spend around two hours per day sourcing information online as part of their study routine. Interestingly, not all digital activities are created equal. While frequent Facebook use and texting correlate negatively with academic outcomes (GPA), other activities like email and simple browsing did not correlate with GPA.

DESIGNING TO ADDRESS DIGITAL DISTRACTION

In today's digital age, it's essential to understand how distractions impact our students' ability to learn effectively.

> *By focusing on the research and applying these insights, we can design educational tools that cater to students' needs, keeping them engaged and improving their academic outcomes.*

Contextual differences in attention and self-regulation

Understanding attention and self-regulation offers valuable insights when considering educational tools and platforms for young students. These aspects shed light on how students might engage with, comprehend, and absorb new information.

Delving into the intricate fabric of attention and self-regulation reveals some key findings:

- **DEVELOPMENTAL DIFFERENCES IN ATTENTION AND SELF-REGULATION:**
  As students age, attention span, executive function, and self-regulation capabilities exhibit significant variations (Best et al., 2013; Best & Miller, 2010; Welsh et al., 1991). These developmental differences underscore the need for a nuanced approach when interacting with different age groups. Research indicates that younger children are more prone to distraction, as they are more likely to misdirect their attention (Enns & Brodeur, 1989).

- **INFLUENCE OF INATTENTION AND IMPULSIVITY:**
  Younger students tend to make more errors due to inattention and impulsivity, though this diminishes as they mature, as demonstrated by Greenberg & Waldmant (1993). Recognizing these evolving attributes underscores the developmental journey that each student undergoes.

- **SITUATIONAL FACTORS:**
  Aspects like stress and sleep can modulate an individual's attention span, highlighting the situational dependencies of their engagement (Mark et al., 2016).

- **IMPACT OF PERSONALITY:**
  Variances in attention can emerge from different personality traits. For instance, certain personality types may exhibit shorter attention spans on digital platforms in comparison to other personality traits (Mark et al., 2016). Recognizing these variations emphasizes the diversity of student experiences in attention.

- **EARLY INDICATORS OF LATER OUTCOMES:**
  Early self-regulation behaviors in children can hint at outcomes in subsequent years, such as academic achievements (Watts et al., 2018; Mischel et al., 1989). Observing these can offer early insights into potential developmental trajectories.

In the digital education sphere, attention and self-regulation are not abstract concepts but essential elements for learning. As we explore further, it's evident these insights form the crux of meaningful interaction with young learners, offering a lens through which we can better understand their needs and experiences.

Designing for K-5 Students to Support Student Outcomes

Designing for K–5 students to support student outcomes

With the challenges of digital distraction and attention, there's a pressing need to tailor educational tools to these young students' developmental needs. Effective Human-Computer Interaction (HCI) design principles are vital to ensure digital learning platforms align with students' cognitive needs and keep them engaged.

Notable researchers, like Nielsen (1994a, 1994b), have long emphasized key heuristics for usability in design. However, balance is key: while increasing interactivity on a page can provide more insights into the object of someone's attention, as highlighted by Guney (2019), it must be carefully calibrated to prevent information overload, especially for younger learners (Chiasson & Gutwin, 2005).

Creating effective K–5 educational technology involves merging the best practices from HCI, Instructional Design, and Children's Design. The ultimate goal is to minimize distractions and foster an environment where focus and self-regulation thrive, paving the way for optimal learning outcomes.

The analysis of this research led to the proposal of nine HCI design principles that should guide the development of digital educational tools in K–5 environments. These design principles incorporate the points from existing design principles and heuristics from HCI, Instructional Design, and Children's Technology Design.

> *Balance is key: while increasing interactivity on a page can provide more insights into the object of someone's attention ... it must be carefully calibrated to prevent information overload, especially for younger learners.*

Nine Design Principles for K-5 Educational Tools

1	Make objects onscreen interactable where possible, and highlight interactability with audio and visual cues when appropriate.
2	Keep the design highly visual, and remove unnecessary elements wherever possible.
3	Take psychometric measurements as unobtrusively as possible.
4	Give feedback to students as quickly as possible with clear text, audio, and visual language.
5	Request confirmation from students before submitting responses, and let students easily modify responses.
6	Make mouse and touch-screen interactions simple with a minimal number of clicks.
7	Avoid open-text responses in favor of selecting commands.
8	Avoid using keyboard shortcuts where possible.
9	Reduce the use of extensive menus and submenus.

1 | Make objects on screen interactable where possible, and highlight interactability with audio and visual cues when appropriate.

A study by Kirsh (2020) discovered that when students paid more attention to specific words on a digital page, it might hint at issues in understanding the material. By making web pages more interactive, educators can gain a better sense of where students might be struggling (Guney, 2019). However, it's crucial to keep the design simple and not overwhelm young learners with too many visuals. Kids need more time than adults to shift their attention, so a clutter-free digital environment is essential (Enns & Brodeur, 1989). While interactive content is valuable for understanding student behavior, designers must ensure these features don't become distractions and always prioritize user privacy and ease of use (Chiasson & Gutwin, 2005; Fuchs & Obrist, 2010).

2 | Keep the design highly visual, and remove unnecessary elements wherever possible.

Children can easily get sidetracked by unnecessary information on digital screens. To help them focus, it's essential to simplify designs and eliminate any non-essential elements (Chiasson & Gutwin, 2005; Nielsen, 1994; Rosen et al., 2013). This is especially crucial for younger students in grades K–3, who are still developing their attention skills (Enns & Brodeur, 1989; Welsh et al., 1991). By emphasizing visuals and minimizing text, digital interfaces can become more user-friendly, reducing stress and cognitive load (Druin et al., 2001).

3 | Take psychometric measurements as unobtrusively as possible.

Several trusted tools can measure a K–5 student's focus, impulsivity, and self-regulation (Dougherty et al., 2002; Greenberg & Waldmant, 1993; Luszczynska et al., 2004; Scarpina & Tahini, 2017; Welsh et al., 1991). Using subtle measurement methods is beneficial because they can continuously follow student focus without disrupting them (Webb et al., 1999). These objective methods also avoid biases that can come from self-reporting. Moreover, these measures can be taken in real-life settings, offering genuine insights (Webb et al., 1999). So, when designing digital education programs, it's a good idea to integrate any wanted measurements subtly in the tools directly, ensuring they don't become additional distractions from student learning.

4 | Give feedback to students as quickly as possible with clear text, audio, and visual language.

Kids anticipate quick feedback after they take action on digital platforms. If they don't get a response from an action, they might repeatedly attempt the same action (Chiasson & Gutwin, 2005; Said, 2014). So, it's vital for digital tools to provide clear visual or sound cues after an input, making it easier for students to understand and use the system (Chiasson & Gutwin, 2005; Druin, 2001; Nielsen, 1994).

5 | Request confirmation from students before submitting responses, and let students easily modify responses.

Young children, who are still honing their motor skills, can often make mistakes on digital platforms. Confirmations before submitting entries can help students rectify errors. Confirmation in digital interfaces also allows for easy "undo" options to ensure a positive user experience. . While such precautions might be reduced for older students, the ability to quickly undo actions remains vital for tools designed for K–5 students (Chiasson & Gutwin, 2005; Druin, 2001; Nielsen, 1994).

6 | Make mouse and touch-screen interactions simple with a minimal number of clicks.

Requiring numerous clicks and drags can mentally overburden young students. To ensure a smoother learning experience, it's essential to minimize the number of clicks and streamline commands, reducing potential distractions (Chiasson & Gutwin, 2005; Druin, 2001).

7 Avoid open-text responses in favor of selecting commands.

For a smoother learning experience, students' focus should be on learning rather than digital navigation. It's essential to make digital interfaces simple and intuitive. One way to reduce complexity is to offer clear choices, like using a check mark or the word "YES" rather than requiring students to type out "Y-E-S" for confirmations (Nielsen, 1994).

8 Avoid using keyboard shortcuts where possible.

Young children are still honing their motor skills, so expecting them to manage complex mouse clicks or keyboard combinations isn't realistic. Designers need to keep it simple, avoiding tricky maneuvers like double-clicks or holding down multiple keys. As they grow, any shortcuts or advanced features should be clearly explained within the digital tool (Chiasson & Gutwin, 2005; Nielsen, 1994). While shortcuts are essential for accessibility, they need to be straightforward, especially for the K–5 age group.

9 Reduce the use of extensive menus and submenus.

Using too many menus and submenus can overwhelm and distract students. A cleaner design approach is to show commands on a sidebar when hovered over or clicked. This helps keep the webpage tidy and lessens distraction (Chiasson & Gutwin, 2005; Druin, 2001; Nielsen, 1994).

Additional considerations

These design principles offer a guide to creating effective digital environments for the K–5 population to focus on learning.

It is important to note that these principles may not be applicable in every situation, such as a math problem that requires a student to type a numerical response instead of clicking on the response. In that case, it might be the best instructional choice to have a student type the answer. In situations such as that, following the other design principles will help make sure that the student spends their mental energy on solving the problem, rather than on navigating a complicated interface.

Even in today's digital age, the physical environment remains an important piece of the puzzle. Designing digital spaces for maximum attention and focus make a huge difference, but are still impacted by a student's physical space such as clutter or a nearby television (Junco & Cotton, 2012).

Providing a reminder to students to clear the physical workspace can nurture a behavior related to highly engaged students: taking ownership of one's own learning experience (Aguilar, Sheldon, Ahrens & Janowicz, 2020).

As technology continues to evolve, digital interfaces will need to keep up. The theories guiding these principles are key to reducing digital distraction, promoting attention, and encouraging self-regulation. Designers can harness these nine HCI design principles to create learning spaces that enable K–5 students to thrive.

GoGuardian's commitment to student learning

The digital world offers a realm of opportunities and distractions for K–5 students. For designers and educators aiming to craft effective digital educational environments for young learners, the nine HCI design principles can set the foundation for building effective tools to support student learning.

At GoGuardian, the heart of our mission is the success and growth of every student, every day. We understand that in the age of digital learning, optimizing the interface and experience is paramount. We are not just software developers; we consider ourselves partners in your students' educational journey.

Our primary goal is to minimize distractions and provide a safe, interactive environment where students can focus on learning. Each new update and feature is a testament to our commitment to enhancing student engagement and aiding educators in delivering the highest-quality digital education experience. By choosing GoGuardian, you're creating a future where technology complements education rather than complicates it.

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