Toward Interactive Reading: Co-designing With Adolescents to Explore Opportunities for Overcoming Reading Challenges

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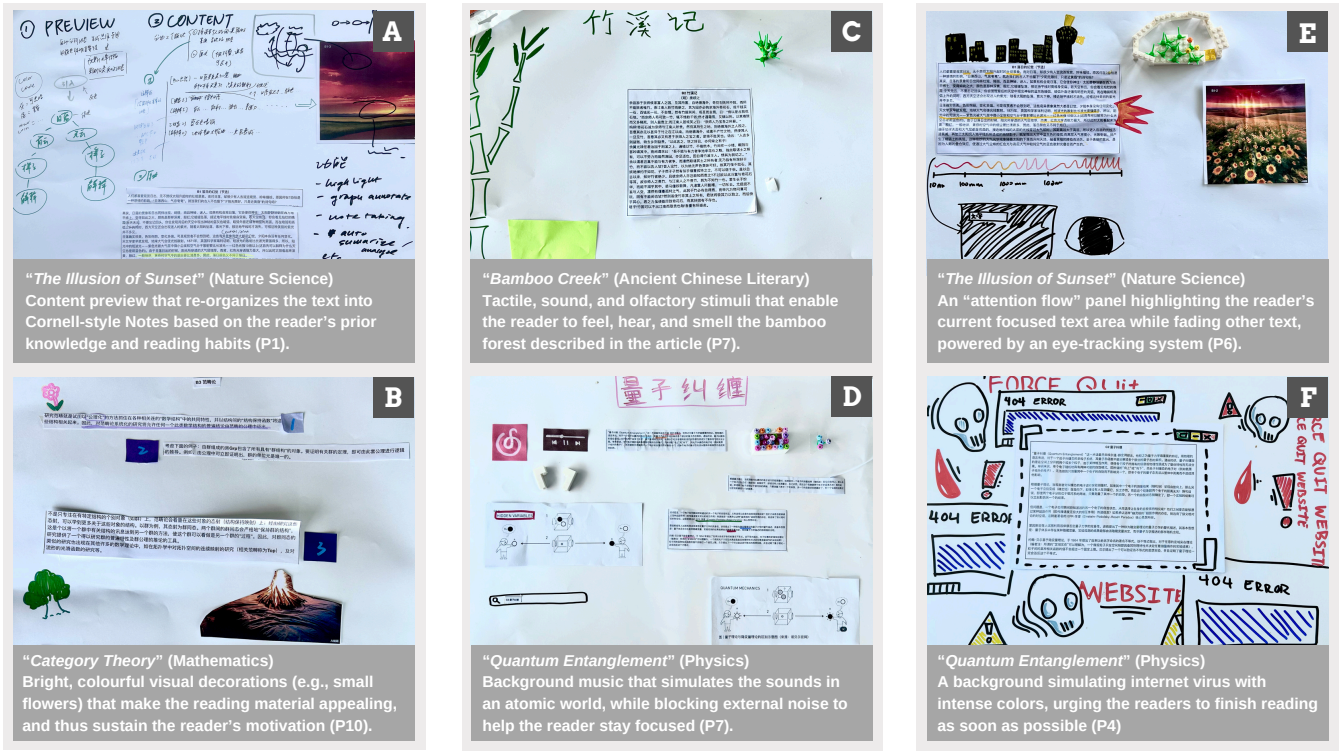

Figure 1: Design examples created by adolescent participants, which were grouped based on the main rationales: sustaining reading motivation (A and B), engaging and interactive reading experience (C and D), improving reading efficiency (E and F). In particular, C and D were both designed by P7 for different reading materials. As native Chinese speakers who are fluent in English because of their school curriculum, participants incorporated both Chinese and English notes into their design.

ABSTRACT

Adolescence is a critical stage in developing life-long reading ability, but many adolescents struggle with reading due to inadequate vocabularies, lack of interest, and limited self-regulation. Amidst existing technology for reading support, few are specifically designed

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for this group. As the first step to bridge this gap, we conducted co-design sessions with 10 participants aged from 14 to 17 (with seven exhibiting attention deficiency or hyperactivity) to explore their challenges in reading and the support they need. We found that participants' design ideas were primarily centered around structured previews or visual elements with positive sentiment to sustain their motivation to read, multi-sensory stimuli to make reading interesting and engaging, and progress monitoring combined with high-intensity visuals to improve reading efficiency. Drawing from the findings, we discuss the needs behind participants' designs and future directions for supporting the development of adolescents' reading ability.

CCS CONCEPTS

• **Social and professional topics → Children**; • **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Reading, Learning, Adolescents

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1 INTRODUCTION AND BACKGROUNDS

Reading is an essential skill throughout life, from childhood to adulthood [18]. Adolescence, in particular, is a critical stage where individuals transition from learning to read to reading to learn [15]. While the former emphasizes recognizing text and decoding words, the latter focuses on extracting meaning and knowledge through reading [15]. However, many adolescents find reading challenging, due to factors such as inadequate vocabulary, lack of interest, and limited self-regulation [15, 26]. These challenges are amplified in the digital age, where the young generations are exposed to an overwhelming amount of social media posts and short videos in fragmented or non-linear formats [6]. This constant exposure can hinder their reading ability development by reducing sustained attention and fostering a preference for skimming rather than deep reading [16]. Moreover, compared to adults, adolescents often exhibit limited self-regulation ability, which further prevents them from effectively processing and synthesizing long text [21].

Existing approaches that support adolescents in reading have focused mainly on interventions facilitated by human individuals, such as peer support and shared learning experience [12], as well as interactive, conversational reading-aloud exercises with a trained practitioner [5, 14]. On the other hand, while technology assistance are available, they are primarily designed for adults. Examples include e-books highlighting the key concepts [19], reading platforms with adaptive annotations [27], and AI-powered comprehension activities [8], which may not adequately address the unique cognitive and developmental needs of adolescents, especially individuals face attention deficit or hyperactivity.

As the first step to bridge this gap, we explore how technologies can be tailored to address adolescents' challenges in reading by conducting a series of co-design sessions with 10 adolescent participants, seven of whom displayed tendencies associated with ADHD. During the sessions, participants were asked to pick reading materials they found most difficult among several subjects, and then illustrate ideas that they believed could help them better process the information and develop an interest and joy in reading.

Our findings showed that participants' design ideas were driven by their needs of sustaining motivation to read, making reading interesting and engaging, and improving reading efficiency. They highlighted the importance of elements with positive sentiment that motivate them to read, making reading an interactive experience leveraging multi-sensory stimuli beyond visual elements (tactile, sound, olfactory, and virtual reality interfaces), and tools to monitor their attention and reading progress, which can be combined with high-intensity visual to create a sense of urgency. With the lessons learned, we discussed design implications for learning technologies to better support the development of adolescents' reading ability.

This preliminary work contributes to the IDC community with an empirical understanding of adolescents' envisioned solutions to address their reading challenges, which offers foundational insights for researchers and designers to develop effective learning technologies that help this group manage their attention and enhance their literacy in the long run.

2 METHODS

In this section, we describe our participant information, co-design procedure, and data analysis methods. The study was approved by the university's ethics review committee with a full review.

2.1 Participants

We recruited participants through personal invitation and convenience sampling at an international school in Southeast China. Participants must be (1) between 12 and 18 years old, (2) enrolled in a middle or high school program at the time of the study, and (3) experiencing reading challenges and interested in making improvement. Among 16 individuals who completed the screening survey, 10 met the inclusion criteria (see Table 1). As a preliminary study, we asked participants to complete the ADHD Self-Report Scale (ASRS) [11], as ADHD is frequently observed in adolescents experiencing reading difficulties [7, 9, 20]— understanding its potential impacts on participants' reading challenges could provide valuable insights for shaping next steps. Among the ten participants, four exhibited signs of attention deficit (P1, P7, P8, P9), two showed signs of hyperactivity (P5, P10), one displayed both conditions (P4), and three did not exhibit either conditions (P2, P3, P6). Each participant received RMB 100 at the end of the study, with their participation obtained through parental consent.

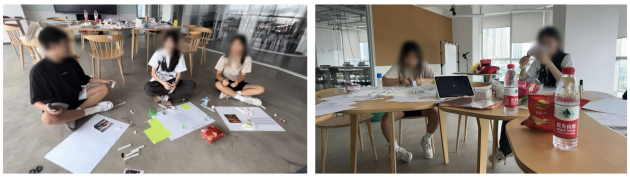

Figure 2: Participants actively engaged in co-design.

Table 1: Participants' demographics. The full mark of each part (attention deficit and hyperactivity) in the ASRS assessment is 36, and if a participant scores 24 points or above on either part (marked by *), they are highly likely to have ADHD [2]. We arranged the co-design sessions based on participants' schedule, and grouped those who had already knew each other before the study so that they would feel comfortable to share their challenges and thoughts.

Group	Participant ID	Gender	Age	Grade level	Attention Deficit	Hyperactivity
Group1	P1	Female	16	G11	27*	16
	P2	Female	16	G11	21	14
Group2	P3	Female	15	G10	13	11
	P4	Female	15	G10	27*	25*
Group3	P5	Female	16	G11	20	24*
Group4	P6	Female	16	G11	23	11
	P7	Female	16	G11	31*	13
	P8	Male	14	G9	24*	20
Group5	P9	Female	17	G11	25*	14
	P10	Female	16	G11	21	26*

2.2 Procedure

Following the co-design practices outlined in prior HCI literature [23, 28], we conducted five in-person sessions, with one to three participants per session based on their schedule (each session lasted about 1.5 hours).

2.2.1 Warming Up. Participants were firstly guided to share their reading experiences, such as reading habits, subjects of reading for schoolwork/leisure, and challenges encountered. Next, they discussed their specific reading challenges in more detail, each providing examples and describing their current coping strategies.

2.2.2 Familiarizing With Reading Samples and Design Materials. After the warm-up, we introduced the activity procedure, and asked participants to familiarize themselves with the reading samples and design materials we prepared. The reading samples were nine excerpts selected from textbooks widely used in Chinese middle and high schools (450 Chinese characters per sample), spanning different subjects (i.e., Chinese literary, mathematics, natural science, and physics). The design materials included blank and color papers, color markers, Lego blocks, perfumes, tapes, and printed pictures related to the reading samples, serving as potential mediums to be used in design ideas. These reading samples and design materials were selected to contextualize participants with a scenario of reading [17], which is a common strategy employed in co-design studies [17, 22, 25].

2.2.3 Co-design. Participants engaged in two rounds of design. For each round, they were asked to choose one reading sample that they found difficult to comprehend or engage with; additionally, we encouraged them to choose samples from different subjects in each round. During the co-design activity, participants started by reading the sample for about five minutes, and then were prompted to reflect on their reading experience, including their comprehension of the sample, whether they were distracted during the process, and the most difficult part of the text. Next, participants were asked to illustrate design ideas to support them in better understanding and engaging with the reading sample on an A3 paper. We clarified that their design could be placed on any medium—phone, iPad, e-book, or even a physical or virtual space; and encouraged them to think aloud and emphasized that there were no right or wrong ideas.

2.2.4 Demonstration and Discussion. At the conclusion of the co-design session, each participant presented their design ideas to the group, explaining how their proposed reading support technology would function and the reasoning behind their design choices. Afterwards, the group exchanged feedback, discussed their ideas with one another, and made adjustments to their designs as needed.

2.3 Data & Analysis

We kept audio recordings from all co-design sessions, along with the design artifacts created by participants. These audio recordings were transcribed into text for thematic analysis. The designs created by participants were photographed and documented at the end of each session. Two researchers developed the initial codes following a bottom-up thematic analysis through an iterative process with rounds of discussions [3]. Later, these codes were refined and merged into coherent themes with the project supervisor.

3 FINDINGS

We found that the challenges that participants faced during reading were mainly associated with lacking motivation to read, difficulty in comprehending complex text, and distractions (see Table 2). To address the abovementioned challenges, participants envisioned a range of design ideas, which we describe below.

3.1 Sustain Motivation to Read

3.1.1 Structured Text Preview. Participants emphasized the importance of a content preview that could help them navigate the material before reading. P1 and P9 designed an AI assist to summarize main points and clarify passage structure, which could reduce their stress by setting up an expectation of what is important, and how much effort to spend. P1 and P2 noted that the structured preview could remain on the side panel and be updated according to their reading progress. As shown in 1 (A), P1 suggested that each article could be re-organized into Cornell-style notes (with the main information on the right side, key concepts on the left, and a summary at the bottom), taking into account the reader's

Table 2: The Challenges that participants described about Reading.

Challenge	Description	Quotes
Lacking motivation to read	Difficulty in starting to read assignments from school, especially with those that participants initially had no interest.	"*For reading assignments, such as those that are purely theoretical or informational, I found it difficult to get started.*" (P1)
Comprehending complex text	Struggling to extract meanings from complex text, particularly in science and mathematics materials where they often stuck on specific words and could not progress.	"*Without understanding the meaning of the term, it becomes impossible to continue or to better understand the reading passage.*"(P2)
External distraction	Easily becoming distracted during reading by notifications and bright screens on digital devices, social media, and friends with whom they stayed together.	"*In relatively noisy environments, I can't concentrate. And when I'm with friends, it's impossible to focus.*" (P6)

background knowledge and reading habits. This design can assist them in extracting the key concepts from the text, thus lowering comprehension barriers and sustaining their motivation to read.

3.1.2 Visual Elements With Positive Sentiment. P7 and P10 emphasized the importance of maintaining a positive emotional status in reading, which is the key to keep them motivated. For instance, P10 placed a small flower beside the text (see Figure 1 (B)), which, although unrelated to the reading material, was thought to "*feel the beauty of life and feel more hopeful to read*" (P10). Similarly, in Figure 1 (D), P7 assembled a block of colorful Lego pieces in a cute shape, believing it would evoke positive emotions. A commonality in these two examples is that both participants selected reading materials they were not interested in and even felt resistant to reading. Meanwhile, they both scored above the threshold of the ADHD assessment. These suggest that they might be more sensitive to minor details within the text, thus more likely to be motivated by the seemingly unrelated positive visual elements.

3.2 Make Reading Interesting and Engaging

3.2.1 Sensory Stimuli to Enrich Reading Experience. In addition to using contrasting and vibrant colors for enhancing visual engagement (e.g., by highlighting key concepts or outlining background, which resonates with prior literature on the color perception of individuals with ADHD [1]), participants actively explored the use of non-visual stimuli, including *tactile*, *olfactory*, and *sound* to enrich their reading experience. In Figure 1 (C), where P7 chose an ancient Chinese prose describing a bamboo creek scene, they proposed an idea to physically feel the texture and touch of bamboo, while sensing its smell. P7 believed that these sensory stimuli could enhance their connection with the text beyond merely reading or imagining it. When reading another sample in physics, as shown in Figure 1 (D), P7 hoped to incorporate background sound that mimics the quantum world while blocking external noises. Likewise, reading the article about the "Illusion of Sunset" (a natural science article explaining the formation of the visual effects during sunset), P2 envisioned hearing the sound of ocean waves to complement the visual scene. This auditory addition was seen as a way to make scientific concepts more relatable and easier to understand.

Furthermore, participants brought up the idea of immersing themselves in a multi-sensory virtual environment. While reading the "Illusion of Sunset," P1, P2, and P5 all hoped that they could virtually interact with the water, air, and light described in the reading sample. P5 explained that this multi-sensory interaction could help spark their curiosity, and encourage them to learn more about relevant natural phenomena. P2 added that such an immersive VR reading experience could magnify details that are often overlooked in text (e.g., the principle of light refraction).

3.2.2 Post-Reading Reflection. Participants highlighted that, besides sensory stimuli to enrich their reading experience, it is also useful to have an opportunity to review and reflect on the learned information post-reading. For example, P1 proposed an interactive Q&A feature into the reading platform, where they could select specific text segments that they find unclear for a summary or clarification questions: "*Below has a function, click a button to summarize the article, such as structural, language [...], just like AI that required internet connection.*" P1 believed such reflective interaction could further help transform their reading habit from passively word-reading to critically information digesting.

3.3 Improve Reading Efficiency

3.3.1 Adaptive Progress Monitor. To address their insufficient self-regulation, participants recognized the need for an external progress monitoring tool to maintain focus. As shown in Figure 1 (E), P6 envisioned the integration of eye-tracking technology: as the reader reads through the text, the currently focused area will be highlighted, while the remaining sections gradually fade away, so that readers can stay focused on what they are looking at: "*I just want it to flow. Except for the word that the user is looking at, the other parts are dark.*" If the reader becomes distracted, the highlighted spot would remain fixed to help them re-engage. Similarly, P6 suggested adding a progress bar to their reading devices, which not only indicates the relationship between their time spent and overall reading progress but also enhances reading efficiency by making time elapse obvious.

3.3.2 High-intensity Visuals. Another strategy that participants came up with to improve reading efficiency is through highly intensive visual elements that "pressure" them to complete reading as soon as possible. As depicted in Figure 1 (F), P4 created elements such as skulls, warning signs, and chaotic pop-up windows, to simulate an interface when a computer is hacked: "*It was like a viral pop-up into my head, and we had to shut it down. I know it's a virus web page, so then I can read it, and then close it.*" Note that P4 scored highly on both the attention deficit and hyperactivity scales in the ASRS assessment. This suggests that adolescents with ADHD tendencies may have a higher sensitivity to overstimulation and a strong urge to assert control (e.g. the act of "shut down" intense

stimuli with a sense of urgency) [13], thus potentially enhancing their reading efficiency.

4 DISCUSSION AND FUTURE WORK

This work surfaces the need of adolescents for reading support, showing the promise for emerging interactive interfaces to make reading more engaging and fun for this group. As shown in prior work, there is a critical shift among adolescents' cognitive development, especially in inferential and elaborative skills, such as managing multiple processing goals, and interpreting idiomatic or metaphorical languages [10]. In our study, participants' preferences towards multi-sensory engagement highlighted the opportunities for enriching reading experiences beyond traditional materials [29]. Their ideas on sustaining motivation to read also aligned well with prior work that emphasized the importance of self-efficacy in learning from unfamiliar text [24].

On the other hand, the inclusion of seven participants with ADHD tendencies has shed light on findings that enhance the current understanding of reading engagement. For example, adolescents with ADHD often face challenge in managing their emotions [4], and the incorporation of positive and vivid visual elements not only helps capture their attention but can also play a crucial role in strengthening emotional regulation. In addition, the use of high-intensity visuals, which might initially seem counterintuitive, but can potentially serve as a beneficial strategy to help individuals with both attention deficit and hyperactivity exert control over their reading process [13].

We acknowledge that these design ideas warrant future investigation, and the findings may not be generalized to all adolescents and those with ADHD given the limited sample size, imbalanced gender distribution, and a sample biased toward international school students who typically come from families with relatively high socioeconomic status. However, we believe that the rich, nuanced design ideas derived from this work provide valuable initial perspectives on the design of reading technologies for adolescents. Going forward, we will develop research protypes based on the design ideas and involve larger, more diverse group of young people for systematic evaluations.

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