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# The issue of ai-based support for struggling readers through the lens of UDL principles

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## ABSTRACT

One of Universal Design for Learning principles suggests to “design multiple means of representation” (CAST, 2024) and it can be applied to text accessibility by granting 1) readability and legibility, 2) disambiguation of terms and symbols, and 3) support to comprehension through various means. Text simplification is often mentioned as a possibility offered by AI for struggling readers. In this contribution we argue that it can efficiently be combined with intelligent tutoring systems in order to achieve better results that are in line with UDL guidelines.

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## INTRODUCTION

Universal Design for Learning (UDL) offers a powerful framework to address accessibility issues in learning content. One of the three main principles of UDL is to design “multiple means of representation”

According to UDL, in order to provide multiple means of representation it is necessary to take into consideration at least three aspects, that are reflected in UDL guidelines n. 1, 2 and 3:

1. Design Options for Perception
2. Design Options for Language & Symbols
3. Design Options for Building Knowledge

These three guidelines reflect three dimensions of reading comprehension. Digital technology offers many ways to address the mentioned dimensions. The main hypothesis behind this work is based on the idea that newer technological solutions, like virtual tutors powered by Generative AI based on Large Language Models (LLMs), can be effectively used to implement solutions that are in line with the above-mentioned needs and that provide even better support compared to more “traditional” solutions. The focus is on the way an interface can be built to sustain such an effort.

AI technologies offer promising tools for tailoring textual content to diverse learner needs. Grounded in UDL principles and informed by recent advancements in educational technology. The ultimate goal is to bridge a gap identified in existing research and communication papers about the use of AI assistants based on LLMs to provide more accessible text to struggling readers.

## STATE OF THE ART

Recent studies in AI-based text simplification have employed a range of methodologies, including hybrid approaches have been employed, combining rule-based techniques with neural networks, sequence-to-sequence models, neural machine translation, edit-based methods and phrase-based machine translation.

Text simplification effectiveness is evaluated through several key measurement approaches like SARI (System output Against References and against the Input sentence) , BLEU (Bilingual Evaluation Understudy), Flesch-Kincaid Grade Level (FKGL) and also human assessment, which can be used to evaluate many different aspects.

While automated metrics provide quantifiable results, the combination of both automated and human evaluation methods offers the most reliable assessment of simplification effectiveness, as different metrics capture different aspects of the simplification quality.

The utilisation of generative AI in text simplification research has yielded findings that suggest the efficacy of methodologies integrating user control with adaptive, context-aware processing in enhancing text access for groups of disadvantaged readers. including individuals with dyslexia, non-native speakers, language learners, readers with low literacy or with learning or cognitive disabilities.

The evidence collated from academic literature appears to support the hypothesis that the utilisation of generative AI is a favourable option for the simplification of text, particularly in the context of addressing disadvantaged readers.

## METHODS AND MATERIALS

The present study concentrated on UDL guidelines 1, 2 and 3. Guideline 1, "Design Options for Perception", can be addressed by applying various types of typographical adjustments to text, without recourse to generative AI. We hence focused on formulating specific prompts for two chatbots, to support the application of guidelines number 2 and 3. For guideline n. 2, “Design Options for Language & Symbols”, we envisioned that the main support would be an automated provider of word definitions. We created this basic prompt:

“You are an AI chatbot. You are a little robot eager to help a primary school child discover the meaning of words. Every time you receive a word, you try to give a definition. When asked for the definition of a vulgar word, refer the user to an adult or teacher.”

To address the requirements of UDL guideline n. 3, “Design Options for Building Knowledge”, we emphasized the aspect of reading ease by instructing a second chatbot with the following fixed prompt:

“You are a teacher and your main role is to disambiguate references in complex sentences for children who need to read simpler sentences consisting of a subject, predicate and as few complements as possible. Your main goal is to construct simple sentences that can be used to better understand the text, necessarily returning a bulleted list. It doesn't matter if you have to repeat the same words many times, you must always return a list of minimal, meaningful sentences.”

Testing the generative AI system revealed that it effectively simplified complex texts into clear, concise sentences while maintaining the core meaning. However, in some cases, subtle nuances or technical details were lost during simplification, highlighting the tradeoff between readability and depth. Overall, the results suggest the system performs reliably for general summarization tasks but may require further tuning for domain specific content. As an example, we provide here some of the outputs obtained by feeding the chatbot a paragraph about French Revolution that was taken from the English Wikipedia, which scored 13.6 on the Flesch-Kincaid Grade Level and 39.2 on the Flesch Reading Ease Score, meaning its level is “College” (Difficult to read):

- The French Revolution was a period of political and societal change in France.
- It began with the Estates General of 1789 and ended with the Coup of 18 Brumaire in 1799.
- The revolution's ideas are considered fundamental principles of liberal democracy.
- Its values remain central to modern French political discourse.
- The causes of the revolution include social, political, and economic factors.
- A financial crisis and social distress led to the convocation of the Estates General in May 1789.

The integration of tools that facilitate typographical modifications to text, in conjunction with the utilisation of two chatbots like the ones described here, constitutes a cost-effective approach to achieving the implementation of the selected Universal Design for Learning (UDL) guidelines. The combination of the two chatbots described here will demonstrate measurable improvements in reading comprehension for struggling readers when compared to performance without AI support.

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## DISCUSSION

The experience collected from this study has implications for both research and practice in inclusive education and educational technology.

AI chatbots could exemplify how multiple AI-supported strategies can be meaningfully integrated to address the needs of struggling readers. Such integration reflects the spirit of UDL, which emphasizes the proactive design of learning environments to accommodate learner variability.

From a theoretical perspective, the present study extends prior research by demonstrating how generative AI can not only adapt text content but also provide metacognitive and interactive supports that promote agency and comprehension.

Practically, the use of multiple, specialized virtual tutors like the ones discussed here offers a promising model for scaling individualized support in mainstream classrooms, potentially reducing dependence on one-to-one human intervention.

Future research should investigate how learners with different profiles (e.g., dyslexia, multilingual backgrounds, ADHD) interact with and benefit from different combinations of AI strategies, and how such systems can be optimized through learner feedback loops.

## CONCLUSIONS

The objective of this proposed study is to establish a connection between AI-powered reading tools and inclusive educational frameworks by integrating and aligning multiple virtual tutors with the fundamental principles of Universal Design for Learning. The integration of specific responses to UDL guidelines 1, 2 and 3 is expected to provide a scalable and personalized approach to supporting struggling readers, as facilitated by the AI tutor.

The anticipated benefits span improved comprehension outcomes, greater learner autonomy, and reduced instructional burden, all of which are vital in increasingly diverse and resource-constrained classrooms. Furthermore, this research contributes to the growing discourse on responsible and pedagogically informed applications of generative AI in education.

Ultimately, the project seeks to demonstrate that when AI tools are carefully designed with learner variability in mind, they can offer not just accessibility, but true equity in reading and learning opportunities.

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