Language Learning & Technology
ISSN 1094-3501 CC BY-NC-ND

June 2024, Volume 28, Issue 2
pp. 163–182

ARTICLE

Teacher engagement with automated text simplification for differentiated instruction

Fengkai Liu, City University of Hong Kong

Yishi Jiang, Shanghai Jiao Tong University

Chun Lai, The University of Hong Kong

Tan Jin, South China Normal University

Abstract

Differentiated instruction is much demanded yet quite challenging in face of the growing student diversity in today's K-12 classrooms. One major challenge is the provision of differentiated materials to students. Automated text simplification (ATS) tools fueled by natural language processing may serve as a useful assistant for teachers. However, little is known about teachers' contextualized use of ATS over time. This case study traced two teachers' use of ATS systems over a semester. Drawing upon three semi-structured interviews and teacher-generated materials with ATS, we identified an evolving pattern of teachers' engagement with ATS systems, a progression from a blind reliance on the tool to a more critical and coordinated use of the tool over time. We further revealed that teachers' evolving understanding of DI, positioning of the role of ATS systems and human instructors, and interpretation of DI need in specific teaching situations interplayed to shape their particular ways of engagement. Overall, this study contributes to the understanding of teachers' contextualized use of ATS technology for DI. By revealing the influencing factors, the findings hold significant pedagogical implications to inform the design of ATS tools and the creation of favorable conditions to maximize the potential of ATS tools for DI and language teaching and learning in general.

Keywords: *Automated Text Simplification (ATS), Differentiated Instruction (DI), Reading materials, Teacher contextualized engagement*

Language(s) Learned in This Study: *English*

APA Citation: Liu, F., Jiang, Y., Lai, C., & Jin, T. (2024). Teacher engagement with automated text simplification for differentiated instruction. *Language Learning & Technology*, *28*(2), 163–182. https://hdl.handle.net/10125/73576

Introduction

The primary objective of differentiated instruction (DI; Tomlinson, 2017) is to offer students various choices in learning content, processes, and product development, countering the "deficit mindset" that attributes learning difficulties solely to students (Bateson et al., 2018). By providing differentiated learning experiences, teachers can help alleviate these difficulties. However, creating tiered versions of learning content is time-demanding and challenging. A burgeoning number of ATS algorithms and systems, including generative AI, such as *ChatGPT*, developed by researchers in the field of natural language processing (NLP), present potential solutions through assessing and reducing the linguistic complexity of text materials while retaining the original information (Alva-Manchego et al., 2020). Previous research has shown that teachers perceive these systems positively (Chen & Meurers, 2019; Pérez-Paredes, Ordoñana Guillamón, & Aguado Jiménez, 2018), and play a vital role in implementing these systems in differentiated classroom teaching (Bateson et al., 2018; Keuning & van Geel, 2021). However, how teachers interact with and make use of ATS systems in their teaching contexts over time has been an open question.

To shed light on the research issue, this study utilizes an explanatory sequential design to investigate how a group of Chinese K-12 classroom English teachers perceive and use ATS systems. By revealing the influencing factors of teachers' engagement with ATS technology for DI, the findings of this study inform the design and implementation of ATS tools in language teaching and learning.

Literature Review

Research on Differentiated Instruction

Differentiated instruction (DI) is the design of learning experiences that cater to student differences in readiness level, interests and learning preferences, ultimately maximizing the potentials of each student through providing multiple options for learning, information processing, and learning demonstration (Connell et al., 1997; Tomlinson, 2017). Research has attested to the effects of DI. For instance, Baumgartner and colleagues (2003) found that incorporating differentiated instructional strategies, like flexible grouping, self-selected reading, and varied reading material, helped improve the decoding, phonemic, and comprehension skills of both elementary and middle school students. Richards and Omdal (2007) further revealed that tiered activities benefited low proficiency level learners in particular.

Teaching can be differentiated in content (i.e., what students learn), process (i.e., how students go about making sense of ideas and information), and product (i.e., how students demonstrate what they have learned) (Griful-Freixenet et al., 2020; Tomlinson, 1999). The differentiation of learning contents is perceived as essential and is a DI strategy that teachers commonly utilize (e.g., Beasley & Beck, 2017; Boelens et al., 2018; Tomlinson & McTighe, 2006). Teachers are found to cater to different levels of readiness via adapting materials to match student proficiency levels (Badri & Salehi, 2017; Baleghizadeh, 2010), and summarizing or highlighting the main body of the text (Tomlinson, 2005), and allowing students to choose learning materials that align with personal interests (Baeten et al., 2010; Dong et al., 2019). These content differentiation strategies have been found to benefit student learning. For instance, Shaunessy-Dedrick et al. (2015) found that a differentiated reading program with reading materials of varied complexity level significantly improved 4th graders' reading comprehension.

Despite positive attitudes and strong enthusiasm for learning material adaptation, teachers also express difficulty in this endeavor, including the lack of appropriate materials and resources along with the lack of knowledge in how to adapt materials based on student ability levels, such as the appropriate complexity level for a given proficiency level (e.g., Gaitas & Alves Martins, 2017; Jin & Lu, 2018). Thus, researchers started to explore how technology can be used to provide the support teachers need in adapting learning materials (Jin & Lu, 2018; Jin et al., 2023).

Computer-Assisted Text Simplification and Automated Simplification Systems

Text simplification is the process of reducing the linguistic complexity of a text to improve its understandability and readability while still maintaining its original information and meaning (Al-Thanyyan & Azmi, 2022). Simplification of learning materials in English involves reducing the complexity level of the original texts to increase linguistic accessibility and make them a better match to learners' English proficiency levels (e.g., Rets & Rogaten, 2021; Rets et al., 2022). Earlier attempts at text simplification relied on manual manipulation of the text through deleting redundant and specific word items, reconstructing syntactic structures, and shortening text length to make it more comprehensible (Green & Hawkey, 2012; Saggion, 2017).

To ease the process, researchers in the field of natural language processing (NLP) and computational linguistics (CL) have developed algorithms and systems to assist teachers extract text features, evaluate text complexity, and identify difficult text spans (Crossley et al., 2007; Jin et al., 2020). These systems were found to reduce the load in lesson preparation (Wenk, 2010), enable teachers to create texts of appropriate difficulty level for their students (Bliss et al., 2013; Farrow et al., 2015; Wiley et al., 2012), and promote teachers' engagement in differentiated instruction (Chen & Meurers, 2019; Collins-Thompson, 2014;

Meurers et al., 2010). Intelligent automated text simplification (ATS) systems are a recent development that aims to directly generate simplified versions of a given text (Maddela et al., 2021). Some of these automated text simplification systems focus on surface language features, and are characterized by lexical simplification, such as identifying and replacing complex words in the given text span (Paetzold & Specia, 2017), and syntactic simplification, such as restricting the complex syntactic structures in the texts with rule-based or data-driven approaches (Scarton et al., 2017; Siddharthan, 2006; Woodsend & Lapata, 2011). Other automated text simplification systems are capable of higher-level simplification, such as adding elaborations, and producing texts with controllable complexity levels (Maddela, Alva-Manchego & Xu, 2021; Martin et al., 2020). These ATSs assist teachers in efficiently replacing difficult words, reconstructing syntactic structures, and generating texts with different complexity levels (Eskenazi et al., 2013).

However, little is known about the teachers' perception of ATSs and how they might utilize them for differentiated instruction in classroom teaching. This study aims to fill this research gap by answering the following question:

1) How do teachers engage with ATS systems for DI over time?

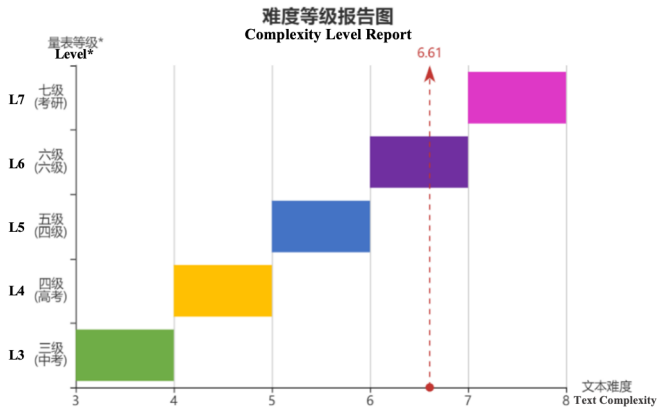
Method

ATS Tools: *Eng-Editor* and *Hero*

In this study, two ATS tools were introduced to teachers, namely, *Eng-Editor* and *Hero*. *Eng-Editor* (Jin et al., 2021) is a knowledge-intensive (Cao et al., 2021) open-access web-based ATS system that incorporates explicit lexical and syntactic rules. It can automatically assess text complexity, identify complex words and syntactic structures, and provide substituted words. Texts uploaded to *Eng-Editor* are automatically evaluated for their language complexity in reference to different proficiency levels of Chinese EFL learners, generating the lexical and syntactic complexity indices (Jin & Lu, 2018; Jin et al., 2023). In lexical profiles, words that are more complicated than the predicted lexical complexity level are highlighted in red, with their dictionary definitions provided with a click. Also, several substituted synonyms and antonyms were provided based on the Princeton WordNet for the highlighted words (McCrae et al., 2019). Complex syntactic structures and long sentences are highlighted in syntactic profiles (Jin et al., 2020). The results of lexical, syntactic, and overall text complexity are presented on the "report" page and can be downloaded for reference. Teachers can utilize *Eng-Editor* to assess text complexity and identify problematic words in reference to concrete benchmarks. (see Figure 1). Text complexity assessment is a crucial step both before and after simplification (Garbacea et al., 2021). *Eng-Editor* was chosen because its readability assessment system corresponds to the curriculum standards in the participants' teaching contexts.

Figure 1

A Snapshot of Eng-Editor

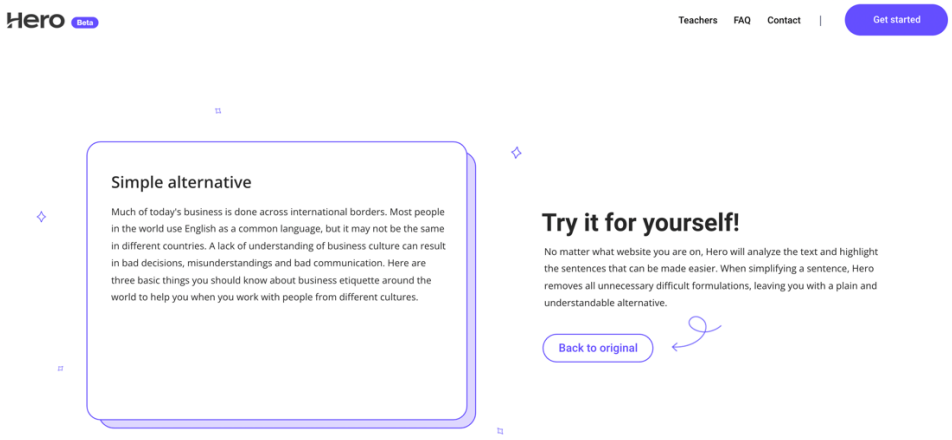


Note. The complexity level report example above is in the purple area with the difficulty value 6.61. The integer place of the value 6 indicates that the text difficulty is at the "Level 6". The decimal digit 0.61 represents that the difficulty ranking percentile of this text in the same level is about 61%.

Hero[1] is a data-intensive (Cao et al., 2021) open-source and easily accessible browser extension supported by deep learning models induced from large-scale raw texts (Bingel, Paetzold, & Søgaard, 2018). It provides teachers with simplified versions of complicated sentences (see Figure 2). *Hero* was chosen because of its user-friendly interface and easy-to-use features. Also, it is an adaptive ATS system that adjusts the simplification algorithm by tracking user behavior. It can highlight the difficult sentences and generate simplified versions. The complex sentences in the texts uploaded to *Hero* are automatically identified and highlighted in purple. Users can select and click on the sentences that need to be simplified, and the simplified versions will be generated and presented in green. Simplified version of the texts can be downloaded.

Figure 2

A Snapshot of Hero



Participants

The participants were two experienced secondary school teachers teaching Grade 10 students in China. They were recruited from the attendees of a professional development workshop that focused on introducing to English language teachers the concept of differentiated instruction and familiarize them with a project using the two ATS tools for text simplification. The two teacher participants were recruited because they both perceived ATS systems as useful for DI and showed a strong interest in and intention of using ATS systems in teaching, but taught in varied teaching contexts. Lucy taught at a top-level school in the provincial capital, which was attended by students of higher language proficiency levels, equivalent to CEFR B1 level, and placed a strong emphasis on English test scores. She had a smaller class size with 46 students in her class. In contrast, Helen taught at a school in a county town. Her class size was larger, with 73 students in her class, and her students' English proficiency was lower, roughly at CEFR A2 level. Both schools used the same textbook, Senior English for China student books by People's Education Press (PEP). Table 1 shows the background information of the two cases (names are pseudonyms).

Their responses in a post-workshop survey revealed that these two teachers had different understandings of and intended engagement in DI during reading instruction (see Table 2). Helen held a more student-centered understanding of DI, believing that DI is to understand students' interests, needs, learning difficulties and

strength, and adjust reading materials to cater to these differences so as to realize students' full potential. She also expressed a stronger intention of planning to employ DI strategies in reading instruction. In contrast, Lucy displayed a limited understanding of student-centered differentiated instruction and expressed less intention of planning to implement DI strategies in reading instruction.

Table 1

Detailed Items on Participant Questionnaires

Category	Item	Helen	Lucy
Background	Age	40	43
	Teaching experience	18 years	21 years
	Number of students in class	73	46
	Students' English proficiency level (according to CEFR)	A2	B1

Table 2

Knowledge of and Intention for DI on Participant Questionnaires

Category	Item	Helen	Lucy
Knowledge of DI	student-centered	3.83	3.00
	assessment and differentiation	3.75	4.00
	material provision	3.50	3.25
	diversified tasks	3.80	3.80
	grouping	3.75	3.50
Plan of DI	student-centered	4.00	2.33
	assessment and differentiation	3.75	3.50
	material provision	3.50	3.25
	diversified tasks	3.40	3.00
	grouping	3.75	2.75

We recruited two teachers with different understandings and intention of DI and varied teaching contexts. This enabled us to adopt a comparative lens to explore how teachers' engagement with ATSs may vary across contexts.

Research Instrument and Data Collection

To gauge teachers' engagement with ATS for DI, we followed the two participants' pedagogical practices in reading classes for one semester. The two participants were requested to use the two ATS tools to differentiate either textbook curriculum materials or topic-related teaching materials selected by themselves for three lessons throughout the semester. Researchers compiled an instruction manual of *Eng-Editor* and *Hero* to familiarize the two teachers with the technical aspects of ATSs. The following data were collected:

Text artefacts. Both the source texts and the adapted versions for the three lessons were collected. Participants were requested to track-change the modifications they made to the source texts. Furthermore, the ATS feedback on source texts was collected by the researchers to shed light on how the two participants utilized the ATS feedback for text simplification.

Teaching plans. Participants were invited to submit their teaching plans for each differentiated text. The teaching plans allowed us to explore the participants' thought processes and strategies in using simplified texts for differentiated instruction.

Semi-structured interviews. Subsequent interviews with both participants were conducted each lesson, with three interviews for each participant and in total six interviews conducted throughout the semester. Interviews focused on teachers' perceptions of and engagement with ATS for DI. During the interviews, the participants were asked questions like "what was the focus of text simplification when you were preparing the teaching materials for this lesson," "to what extent do you agree with the ATS version" and "how useful are ATS systems in assisting text simplification." Each participant was invited again to an interview at the end of the semester to reflect on their general understanding and perceptions of using ATS systems in DI classes. The interviews lasted 30 to 60 minutes each. Altogether, a total of 310 minutes of interviews were collected.

Data Analysis

Interview responses were analyzed inductively to understand the participants' engagement with ATSs over the semester. The analysis of interview data went through three phrases, namely, open coding, axial coding, and selective coding (Strauss & Corbin, 1998). In the first phase, interview data were read line-by-line and were assigned to different categories of engagement, i.e., behavioral engagement, cognitive engagement, affective engagement, and social engagement (Hiver et al., 2021) (see Table 3). These types of engagement were then analyzed and compared across the participants. For instance, "I felt very troublesome" was assigned an initial code of "negative feelings." Then, this code was developed into "emotional responses" in the axial coding. In the final selective coding, the code was grouped into one type of affective engagement. The text artefacts were coded on simplification strategies in reference to Rets et al.'s (2022) framework (see Table 4). These artefacts were analyzed in terms of simplification marks (different types and numbers of simplification strategies). Relevant teaching plans were analyzed in terms of how each DI class was carried out and how the simplified text was used in each class.

Table 3

Coding Scheme of Teacher Engagement with ATS in DI (Adapted from Hiver et al., 2021)

Teacher engagement	Manifestations
Behavioral engagement	Interaction with ATS tools in text simplification
Cognitive engagement	Simplification strategy use
	Metacognitive operations in employing strategies with ATS tools
Affective engagement	Interest and willingness to participate in text simplification activity
	Emotional responses toward ATS assisted simplification
Social engagement	Communication with colleagues and students regarding the process and effect of ATS-assisted simplifications

Table 4

Sub-Strategies of Teacher Simplification Strategy Use (Rets et al., 2022)

Strategies	Sub-strategies
Form modifications	Change word frequency, Convert into SVO order, Split sentence, Convert passive into active, Compress meaning, Add emotional emphasiser, Convert noun into verb, Break the noun phrase, Split paragraph, Combine sentences
Content modifications	Cut information, Add clarification
Cohesion modifications	Add logical connectives, Change order of ideas, Resolve pronoun

Results

Engagement with ATS Systems in DI

Analysis of the two teachers' engagement with ATS systems over the semester revealed that the participants' engagement with ATS systems in DI underwent three stages: the text-oriented stage, the pedagogy-oriented stage, and the effectiveness-oriented stage. At each stage, the teachers exhibited different profiles of behavioral, cognitive, affective, and social engagement. Table 5 summarized the participants' engagement with ATS systems in DI at each stage.

Table 5

Participants' Engagement with ATS Systems for DI

	Text-oriented stage	Pedagogy-oriented stage	Effectiveness-oriented stage
Behavioral engagement	Heavy reliance on the indices and recommendations in ATSs for iterative simplification of texts	Manual operations in addition to ATS simplifications	Coordinated use of the affordances of human teachers and technology and collaborative division of labor in text simplification
Cognitive engagement	Primary attention to the complexity level of the simplified text	Greater attention to other textual features (e.g., text genre; affective characteristics) that are critical to pedagogical goals	Emphasis on students' learning from the adapted text
Affective engagement	Satisfaction of and confidence in ATS systems	Skepticism towards ATS-generated indices and feedbacks	Renewed acceptance of ATSs after repositioning ATSs in DI
Social engagement	Asking colleagues for advice on simplification; Recommending ATS tools to colleagues	Asking students for assistance	Communicating with colleagues to curate different ways of using ATS tools for different pedagogical purposes

The Text-Oriented Stage: "This tool is so powerful!"

In the first lesson, the two teachers were most concerned about the suitability of selected teaching materials and the linguistic complexity level of the simplified text. They both reported that "the text shouldn't be too difficult linguistically or too long for reading. Also, whether the content is suitable for students to read is important." They relied heavily on the indices and advice provided by ATS tools and engaged in iterative adjustment of the text complexity to match students' proficiency levels, as reflected in Helen's remark: "I had to check the complexity indices on *Eng-Editor* after simplification, and followed its recommendations to make further adjustments. Sometimes when I wasn't pleased with the results, I had to re-simplify the text and check its complexity value again."

Both teachers were found to cross-reference the two ATS systems to reach the most appropriate complexity level. They both reported being amazed by the functionality of the ATS systems and expressed a high level of satisfaction with the usefulness and convenience of these systems. In Lucy's words, "this tool is so powerful." Similarly, Helen relied heavily on *Hero* for sentence simplification. During the interview, Helen recalled: "When there are long and difficult sentences and you think there is no way to simplify them, *Hero* can always change them into simpler expressions for you by default." With a strong confidence in the capacity of *Hero* for sentence simplification, she voluntarily recommended the tools to the colleagues at her school.

At this stage, both teachers' engagement with the ATS systems was characterized by an unwavering embrace of the affordance of the ATS tools and a primary attention to the quality of the simplified text. However, their simplification strategies and affective engagement were somewhat different.

Table 6

Participants' Strategy Use in the First Simplification Task

Participant	Source text	Simplified text
Helen	Among the numerous highlights, he scored 20 second-half points against Australia.	Among the so many highlights, he scored 20 second-half points against Australia.
Lucy	Walking is another great aerobic activity to help you increase your blood circulation.	Walking is another great aerobic activity to help you increase your blood circulation, the movement of blood through your body. It can exercise and strengthen your heart and lungs.

To simplify difficult words, Helen preferred substituting the difficult words tagged by *Eng-Editor* with easier ones, while Lucy tended to add clarifications, as shown in Table 6. Lucy reported: "I kept the original words but added some object clauses and appositions on some occasions so that the word difficulty is decreased and the students should be able to understand them...with these explanations." The different practices were partly due to the language proficiency levels of the students: Helen relied on ATS tools to directly replace difficult words with simpler ones: "I am willing to try new methods to increase our students' reading ability since they are not the best students and novel teaching methods are welcome." In contrast, Lucy chose to rephrase rather than replace difficult words because "they are not so difficult for our students. Also, students were required to read these texts thoroughly, so it's not appropriate to modify too much content in our textbooks." The readability scores predicted by the *Eng-Editor* are presented in Table 7.

Table 7

Readability Analysis of Different Stages

Name	Stage	Source	Simplified	Trend
Helen	text-oriented	5.98	5.54	-0.44
	pedagogy-oriented	6.24	4.46	-1.78
	effectiveness-oriented	5.50	5.48	-0.02
Lucy	text-oriented	5.10	5.38	+0.28
	pedagogy-oriented	6.13	5.32	-0.81
	effectiveness-oriented	6.93	5.02	-1.91

The Pedagogy-Oriented Stage: "They are just some general simplifications"

In the second lesson, the participants shifted their attention away from a primary focus on the quality of the simplified text towards a greater consideration of its situated use in the lesson. Specifically, they paid more attention to how students might process the simplified text and whether the simplified text might divert students' attention from the pedagogical objective. They were thus no longer satisfied with the simplification at the lexical and syntactic level, but were concerned more about matching the simplified texts and the pedagogical goals. Consequently, a new pattern of engagement emerged, where they paid more attention to text genre and the key information conveyed in the text when using the ATS tools to adapt source materials into simpler versions. The participants adjusted their strategy use away from "simplifying for simplification purposes" (also see Figure 3 and Figure 4), going beyond the lexical level and focusing more on serving their pedagogical objectives.

At this phase, Helen and Lucy became critical of ATS tools' capacity on maintaining genre characteristics of the texts. Enhancing students' ability of utilizing genre awareness to retrieve information from text was a key teaching objective for both teachers. As Lucy reported, she wanted the students to "learn different text structures, language styles, and narrative perspectives of two genres" by comparing texts of two different genres. However, they found that these features are not considered by the ATS systems, as reported by Helen, "the simplified text *Hero* generated [didn't] contain the teaching points required for this unit." Thus, she engaged in additional manual operations:

> *Eng-Editor* annotated so many words, which can be used for word substitution, but they are not so suitable. And the simplifications made by *Hero* … They are just some general simplifications. The machine doesn't consider the affective aspect of the text. So I had to adapt the text manually according to the text features.

As evidenced above, with teachers' increasing familiarity with ATS systems, they started to give more consideration to the fulfilment of pedagogical purposes, which led to greater attention to students' perceptions and the textual information that was critical to the pedagogical purposes. Accordingly, both teachers started to involve their students in the simplification process. For instance, Lucy talked about interacting more with students around the simplified text and eliciting their opinions: "The primary purpose of simplification is to serve students. Sometimes I would select some students in my class with lower proficiency and ask them about the overall complexity of the simplified text… Students are a good reference (for text simplification)." Helen recounted focusing more on preserving topic-related text features, such as text genre, key expressions, and topic-related knowledge. When simplifying the narrative recount text, Helen manually substituted the word *scared* into *frightened*, which was neither suggested by the ATS systems nor lexically simpler. Helen noted that she "deliberately adapted such words manually," because

the recommendations from the ATS tool did not take into account the specific features of the text. She believed that the words she chose would better align with the contextual information and facilitate the development of genre awareness. The greater focus on pedagogical goals was associated with increased awareness of the limitations of the ATS systems and a corresponding wariness about ATS-generated indices and feedback.

Thus, this stage was characterized by a greater attention to the pedagogical objective when appraising and adjusting ATS-generated simplified text, a more skeptical view of the ATSs, and a higher level of social engagement with students. Both teachers seemed to be more concerned about the ecological validity of the simplified text in specific teaching situations at this stage.

The Effectiveness-Oriented Stage: "Eventually you must figure out how to simplify by yourself"

As the teachers proceeded to the third lesson, their engagement with the ATSs exhibited a greater sense of coordinated use of the affordances of human and machine. A novel engagement pattern with the ATS systems arose. Both teachers showed a critical stance toward the role of ATS systems on text simplification, and developed a collaborative division of labor in text simplification. In this new division of labor, ATS systems served as a general reference in the simplification process, and teachers served as the final decision maker based on the specific DI needs.

At this stage, we witnessed a flexible and diversified ATS use between the two teachers in response to their teaching contexts. Figure 3 and Figure 4 present the number of Helen's and Lucy's strategy use per 500 words throughout the three tasks, respectively. As revealed in the figures, Helen demonstrated a sharp reduction of strategies in text simplification for this lesson, whereas Lucy, on the other hand, increased her strategy use dramatically.

Figure 3

Number of Helen's Simplification Strategy Use per 500 Words over Time

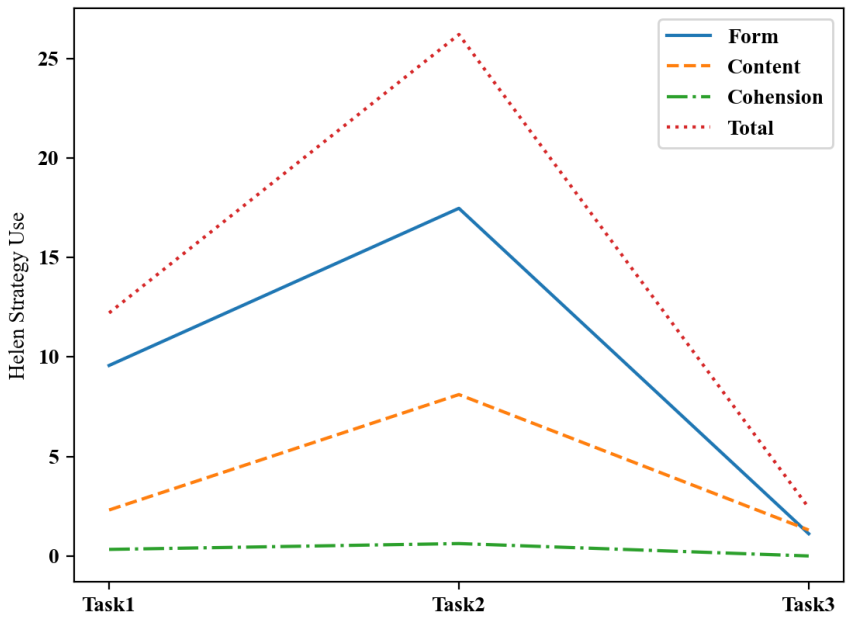
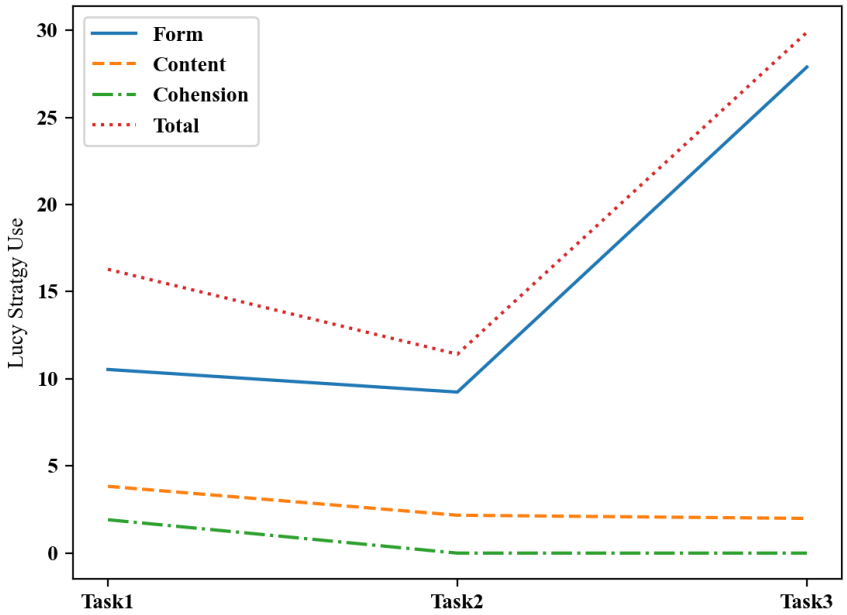


Figure 4

Number of Lucy's Participant's Simplification Strategy Use per 500 Words over Time



The simplification decision seemed to be guided more by the teachers' perception of and their contextual appraisals of the DI needs. For instance, Helen's lesson was a "reading to write" lesson, in which students needed to write a short essay using the information they extracted in the text. Helen conjectured that the DI need for this lesson was to provide rich reading input so that both high-level and low-level students could find useful information and language to enrich their writing. Due to this DI consideration, she significantly decreased her usage of the ATS systems, preserving the overall text complexity and retaining much of the original text. She reported that "students with higher proficiency can acquire more from the text, but students with lower proficiency can also obtain some knowledge from the abundant content materials given to them."

In contrast, Lucy interpreted the need of DI for her reading class as one moderated by students' prior knowledge. She explained that the comprehensibility of a text is not solely dependent on the complexity level of the text, but also on factors such as background information of the text and students' prior knowledge. Accordingly, when simplifying the reading text, she chose not to blindly follow the recommended complexity value in the system, but lowered the complexity of the text slightly from 6.68 to 6.00, which was still much higher than high-school students' reading proficiency. She justified her simplification decision based on her appraisal of the reading situation: "students had sufficient background knowledge to understand the concepts." She hence perceived computer-generated indices as evidence-based reference to be supplemented with additional manual processing, which reflected a clear division of labor between human and machine in text simplification:

> Some words suggested by ATS systems are not appropriate, and cannot be inserted in the text. So you have to think about how to change it. In fact, eventually you must figure out how to simplify by yourself. This process cannot be completely replaced by machine.

With this newfound understanding of the collaborative utilization of ATS systems alongside human judgement, the two teachers restored confidence in using such tools. Helen perceived "great progress in

reading" among her students due to this coordinated ATS-supported simplification.

Accordingly, the two teachers started to curate different ways of using ATS tools for different pedagogical purposes from their colleagues. For instance, Lucy mentioned that she learned from her colleagues on preparing questions for exams using ATS systems, "Our grade leader, who used *Eng-Editor* for question preparation, shared with us her experience step by step, which was very inspiring."

Thus, the third stage of ATS use was characterized by flexible and coordinated use of ATSs and their own expertise to meet situated DI needs, and a renewed acceptance of ATSs after the repositioning of its role in DI.

Engagement with ATSs in Contexts

Despite the common patterns in the two teachers' evolving engagement with ATSs over time, the two teachers also exhibited different trajectories due to their varied and evolving understanding of DI. Helen believed in using DI to help every student reach their full potential. Thus, although she primarily used ATS tools to simplify and create texts of different complexity levels in the first lesson, as she got over the frenzy over the tools, she stopped using ATS tools to create texts of different complexity levels to cater to students' proficiency levels in the third lesson. As she remarked at her third interview, "students with different reading proficiencies can each acquire the information they need. I think even students with a lower proficiency level can also obtain and understand some information in the text." Instead, she placed a greater emphasis on maintaining topic-related features when using ATS tools for simplification so that the simplified texts would still appeal to students. Lucy went through a rather different trajectory. She held the initial belief that the essence of DI is to adapt linguistic complexity so as to enable her to fulfill her teaching role more effectively, and hence focused primarily on syntactic and lexical complexity while simplifying with ATS systems in the first simplification task. However, her perception of DI underwent a change, where she began to prioritize the use of DI to support student learning. She observed that students were more inclined to learn original exemplar texts rather than simplified texts recommended by ATSs. This change stemmed from the students' assumptions that they should thoroughly grasp exemplar texts. Consequently, Lucy underwent a transformation from a teacher-centered approach to a student-centered one, aiming to enhance student interest in learning. Additionally, in the third stage, she incorporated learner profiles as one of the dimensions of DI. This decision was prompted by her discovery that although the ATS systems rated the texts as highly challenging, the students possessed sufficient background knowledge to comprehend the concepts.

Moreover, the participants' engagement with ATSs is also subject to the influence of school culture. Lucy reflected that she was not very willing to use the ATS systems in the first lesson, although she was aware of the power of these tools. But when the grade leader at her school recommended the ATS tool, she engaged with ATS tools more frequently (see Figure 4): "A while ago we conducted a question-setting workshop, where we were required to set questions for texts and share with each other. Our grade leader used *Eng-Editor* to help her set questions. She shared with us how she interacted with the tool step by step, which was very inspiring." Helen's situation, however, was markedly different. Although she held a very open attitude towards ATS systems at first, she was disappointed to find that her colleagues were not interested in the tools when she shared the tools and teaching plan with her colleagues: "They just said it's good. This made me feel like using ATS tools is like my personal hobby." She hence decreased the usage of ATS systems in the third lesson (see Figure 3). Therefore, the influence of contextual factors had a profound impact on the participants' dynamic engagement with ATSs.

Discussion

This study examined two teachers' engagement with ATS systems over time. It revealed that despite positively perceiving the affordance of ATSs for assessing text difficulty and spotting difficult words, these teachers were skeptical about the affordance of ATSs for simplifying text materials. The study revealed two major limitations of ATSs: 1) the lack of knowledge about the teaching contexts; and 2) the possibility of

sacrificing the text features in the process of lexical and syntactic simplification. The former reminds us that teachers' engagement with ATSs is by nature a contextualized one. The complexity of text simplification for DI can never be fulfilled by ATSs solely. Teachers need to have the capacity to engage in coordinated use of ATS artefacts for contextualized use. Professional development initiatives may need to enhance teachers' capacity for doing so. The latter suggests that, to maximize the effectiveness of text simplification, ATS systems need to base the simplification not merely on the complexity consideration but also on the consideration of other dimensions, such as retaining and elaborating context features, since preserving authentic texts features with simplified text language and content may better facilitate L2 students' text comprehension (O'Donnel, 2009; Srikanth & Li, 2021).

The perceived limitations of ATSs led to teachers' strategic modification of the simplified text generated by ATSs. This study revealed that teachers' strategic modification underwent a shift from a rigid ATS-informed practice characterized by a mere focus on the complexity level of the text towards a more flexible, coordinated and diversified ATS-assisted use in response to appraisals of the DI needs in specific teaching situations. This shift is encouraging since researchers have highlighted the importance of flexible and strategic implementations of ATS tools in accordance with the text features of source materials and students' proficiency (Murphy Odo, 2022). This trend towards a more sophisticated (flexible and diversified) use of ATS systems for DI was driven by teachers' repositioning of the role of ATS systems and human instructors and their flexible interpretation of the DI needs in specific teaching situations. Since teachers' instructional technology use is strongly grounded on teachers' value beliefs (Backfisch et al., 2020; Farjon et al., 2019; Ottenbreit-Leftwich et al., 2010), the finding suggests that working on teachers' positioning of technology in relation to instructional role is an essential aspect of professional development initiatives (Alamer & Al Khateeb, 2023; Lai & Jin, 2021; Tondeur et al., 2019). Consistent with Canals and Al-Rawashdeh's (2019) findings, this study found that the two teachers' ability to make use of ATS technology to meet the DI needs in their teaching contexts shaped the nature of their flexible engagement. Thus, to maximize the potential of ATS systems for differentiation, professional development should not rest short at the operation level of ATS systems, but also enhance teachers' understanding of the nexus of the teaching content, DI needs, and affordances of ATS systems.

Moreover, this study revealed that teachers' use of ATSs in classroom teaching was influenced by various contextual factors. It was found that teachers' engagement with ATSs was shaped by their evolving understanding of DI and their contextualized interpretations of the DI needs in specific teaching situations, and the school culture. The finding on the determining role of teachers' situated interpretation of DI needs were consistent with Ma et al.'s (2022) finding that teachers' modification of simplified texts provided by ATSs was influenced by their understanding of students' learning proficiency levels and needs. Thus, enhancing teachers' understanding of varied dimensions of DI and the capacity to match instructional needs with DI approaches is critical to boosting teachers' flexible and context appropriate engagement with ATSs.

The findings have some implications for the design and use of ATS tools. First, it is important to raise teachers' awareness of the affordances and, more importantly, limitations of ATS tools, and foster the mindset that the full realization of the advantages of ATS tools occurs when they work in conjunction with teachers' professional judgements. Although ATS systems can serve as a helpful assistance in the simplifying process, it is teachers who play the decisive role. It is critical to reduce the blind, noncritical use of ATS tools in simplification. Second, it is equally important to expand teachers' understanding of DI and boost their capacity to use ATS tools flexibly in response to the situated interpretation of DI needs in specific teaching contexts. Third, developers of ATS systems in the field of NLP may consider developing personalized algorithms for potential users, such as allowing teachers to add certain words in their simplification process based on models currently trained on large-scale corpora, with which teachers would relate their text materials to the curriculum standard more easily. Alternatively, future research could explore how teachers utilize generative AI tools in DI, considering the distinctions between the latest generative AI tools and ATS systems. ATS systems are trained explicitly for text simplification tasks, whereas generative AI tools primarily generate content based on user input prompts. Investigating teachers' contextualized use of generative AI tools would provide insights into how these tools can be effectively

integrated into DI practices.

Conclusion

This study examined teachers' engagement with ATS systems over a semester. The study documented a progression of teachers' engagement with ATS systems over time, where contextualized interpretation of the DI needs in the teaching situation played an increasing role in shaping the nature of the engagement. It was further revealed that teachers' familiarity with ATS technology, previous teaching experience, and achievements primarily affect their contextualized engagement with ATS systems and their role in DI. The findings of this study suggest the importance of supplementing training on the operational competency of ATSs with training that focuses on facilitating teachers' coordinated positioning of ATSs with the roles of the human instructor and enhancing their capacities of flexible interpretation of DI needs in specific teaching situations.

While the findings of this study contribute to our understanding of teacher engagement with ATS systems for DI, cautions need to be taken when making generalizations to other contexts due to the nature of case study and the specificity of the ATS tools. This study was based on the perceptions and behaviors of two teachers who held distinct perceptions of DI and operated within their unique teaching contexts. Since teachers' utilization of the systems may be subject to their previous instruction experiences and teaching context, the specific nature and progression of the evolving engagements with ATS systems might be different for teachers who hold different conceptions of DI and teach in different contexts. It should also be acknowledged that the two ATS systems implemented in this study provide distinct functions, one assessing text difficulty while the other only generating simplified sentences. ATS systems incorporating other linguistic features and generating document-level simplified versions may have different impacts on teachers' engagement. The findings are suggestive at most. Nonetheless, the findings underscore a dynamic and contextualized approach to understanding teachers' interaction with ATS systems, and highlight the importance of teachers' understanding of DI and situated interpretation of the DI needs in specific teaching contexts. Future research may tap deeper into how different conceptions of DI might relate to different ways of engagement with ATS, as well as the dynamic two-way interaction between teachers' conceptions of DI and ATS engagement over time.

Acknowledgements

This research was supported by a grant from the National Social Science Fund of China (18BYY110) awarded to the corresponding author of this article (Tan Jin). We would like to express our gratitude to the editors and the anonymous reviewers for their constructive comments and suggestions. Particular thanks also go to the two teachers who participated in this study.

Notes

1. *Hero* is updated and renamed as *ClearText* (https://www.cleartext.io/) by its developers.

References

Al-Thanyyan, S. S., & Azmi, A. M. (2022). Automated text simplification: A survey. *ACM Computing Surveys (CSUR)*, *54*(2), 1–36. https://doi.org/10.1145/3442695

Alamer, A., & Al Khateeb, A. (2023). Effects of using the WhatsApp application on language learners motivation: a controlled investigation using structural equation modelling. *Computer Assisted Language Learning*, *36*(1-2), 149–175. https://doi.org/10.1080/09588221.2021.1903042

Alva-Manchego, F., Scarton, C., & Specia, L. (2020). Data-driven sentence simplification: Survey and benchmark. *Computational Linguistics*, *46*(1), 135–187. https://doi.org/10.1162/coli_a_00370

Backfisch, I., Lachner, A., Hische, C., Loose, F., & Scheiter, K. (2020). Professional knowledge or motivation? Investigating the role of teachers' expertise on the quality of technology-enhanced lesson plans. *Learning and Instruction*, *66*, Article 101300. https://doi.org/10.1016/j.learninstruc.2019.101300

Badri, L., & Salehi M. (2017). The effect of oral authentic materials on Iranian EFL learners' motivation and listening comprehension ability. *Technology of Education Journal*, *11*(4), 313–322. https://doi.org/10.22061/jte.2017.730

Baeten, M., Kyndt, E., Struyven, K., & Dochy, F. (2010). Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review*, *5*(3), 243–260. https://doi.org/10.1016/j.edurev.2010.06.001

Baleghizadeh, S. (2010). The impact of student-initiated interaction on EFL reading comprehension. *Studies in Literature and Language*, *1*(4), 20–28.

Bateson, J., Somerville, M., Griffin, R., & Hancock, D. (2018). Different people, different views, different ideas: do widening participation definitions influence the impact and practice of widening access in healthcare? *Widening Participation and Lifelong Learning*, *20*(1), 102–122. https://doi.org/10.5456/WPLL.20.1.102

Baumgartner, T., Lipowski, M. B., & Rush, C. (2003). Increasing reading achievement of primary and middle school students through differentiated instruction. (ED479203). ERIC. http://files.eric.ed.gov/fulltext/ED479203.pdf

Beasley, J. G., & Beck, D. E. (2017). Defining differentiation in cyber schools: What online teachers say. *TechTrends*, *61*(6), 550–559. https://doi.org/10.1007/s11528-017-0189-x

Bingel, J., Paetzold, G., & Søgaard, A. (2018, August). Lexi: A tool for adaptive, personalized text simplification. In E. M. Bender, L. Derczynski, & P. Isabelle (Eds.), *Proceedings of the 27th International Conference on Computational Linguistics* (pp. 245–258). Association for Computational Linguistics. https://aclanthology.org/C18-1021/

Bliss, T., Robinson, T. J., Hilton, J., & Wiley, D. (2013). An OER COUP: College teacher and student perceptions of open educational resources. *Journal of Interactive Media in Education*, *1*, 1–25. https://doi.org/10.5334/2013-04

Boelens, R., Voet, M., & De Wever, B. (2018). The design of blended learning in response to student diversity in higher education: Instructors' views and use of differentiated instruction in blended learning. *Computers & Education*, *120*, 197–212. https://doi.org/10.1016/j.compedu.2018.02.009

Canals, L., & Al-Rawashdeh, A. (2019). Teacher training and teachers' attitudes towards educational technology in the deployment of online English language courses in Jordan. *Computer Assisted Language Learning*, *32*(7), 639–664. https://doi.org/10.1080/09588221.2018.1531033

Cao, J., Lin, Z., Sun, W., & Wan, X. (2021). Comparing knowledge-intensive and data-intensive models for English resource semantic parsing. *Computational Linguistics*, *47*(1), 43–68. https://doi.org/10.1162/coli_a_00395

Chen, X., & Meurers, D. (2019). Linking text readability and learner proficiency using linguistic complexity feature vector distance. *Computer Assisted Language Learning*, *32*(4), 418–447. https://doi.org/10.1080/09588221.2018.1527358

Collins-Thompson, K. (2014). Computational assessment of text readability: A survey of current and future research. *International Journal of Applied Linguistics*, *165*(2), 97–135. https://doi.org/10.1075/itl.165.2.01col

Connell, B. R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., Vanderheiden, G. (1997). *Principles of Universal Design*. North Carolina State University, Center for Universal Design.

Crossley, S. A., Louwerse, M. M., McCarthy, P. M., & McNamara, D. S. (2007). A linguistic analysis of simplified and authentic texts. *Modern Language Journal*, *91*(1), 15–30. https://doi.org/10.1111/j.1540-4781.2007.00507.x

Dong, Y., Wu, S. X., Wang, W., & Peng, S. (2019). Is the student-centered learning style more effective than the teacher-student double-centered learning style in improving reading performance? *Frontiers in psychology*, *10*, Article 2630. https://doi.org/10.3389/fpsyg.2019.02630

Eskenazi, M., Lin, Y., & Saz, O. (2013, June). Tools for non-native readers: The case for translation and simplification. In L. Rello, H. Saggion, & R. Baeza-Yates (Eds.), *Proceedings of the Workshop on Natural Language Processing for Improving Textual Accessibility* (pp. 20–28). Association for Computational Linguistics. https://aclanthology.org/W13-1503.pdf

Farjon, D., Smits, A., & Voogt, J. (2019). Technology integration of pre-service teachers explained by attitudes and beliefs, competency, access, and experience. *Computers & Education*, *130*, 81–93. https://doi.org/10.1016/j.compedu.2018.11.010

Farrow, R., Pitt, R., de los Arcos, B., Perryman, L.-A., Weller, M., & McAndrew, P. (2015). Impact of OER use on teaching and learning: Data from OER Research Hub (2013–2014). *British Journal of Educational Technology*, *46*(5), 972–976. https://doi.org/10.1111/bjet.12310

Gaitas, S., & Alves Martins, M. (2017). Teacher perceived difficulty in implementing differentiated instructional strategies in primary school. *International Journal of Inclusive Education*, *21*(5), 544–556. https://doi.org/10.1080/13603116.2016.1223180

Garbacea, C., Guo, M., Carton, S., & Mei, Q. (2021, August). Explainable prediction of text complexity: The missing preliminaries for text simplification. In C. Zong, F. Xia, W. Li, & R. Navigli (Eds.), *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)* (pp. 1086–1097). Association for Computational Linguistics. https://doi.org/10.18653/v1/2021.acl-long.88

Green, A., & Hawkey, R. (2012). Re-fitting for a different purpose: A case study of item writer practices in adapting source texts for a test of academic reading. *Language Testing*, *29*(1), 109–129. https://doi.org/10.1177/0265532211413445

Griful-Freixenet, J., Struyven, K., Vantieghem, W., & Gheyssens, E. (2020). Exploring the interrelationship between Universal Design for Learning (UDL) and Differentiated Instruction (DI): A systematic review. *Educational Research Review*, *29*, Article 100306. https://doi.org/10.1016/j.edurev.2019.100306

Hiver, P., Al-Hoorie, A. H., Vitta, J. P., & Wu, J. (2024). Engagement in language learning: A systematic review of 20 years of research methods and definitions. *Language Teaching Research*, *28*(1), 201–230. https://doi.org/10.1177/13621688211001289

Jin, T., Li, Z., Xu, M., & Tang, J. (2023). Mianxiang jiaocai wenben zhineng gaibian de jiaoshi yuliaoku suyang ji shijian yingyong [Incorporating teacher corpus literacy into data-driven adaptation of texts in teaching materials]. *Foreign Language World*, (3), 23–30. https://www.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFD&dbname=CJFDLAST2023&filename=WYJY202303004&uniplatform=OVERSEA&v=cYodaHfZfObhrfPGohmvjBbyF_NTusw2Y173dtCT1T_8eKHQ6f54ginssJD_9nij

Jin, T., & Lu, X. (2018). A data-driven approach to text adaptation in teaching material preparation: Design, implementation, and teacher professional development. *TESOL Quarterly*, *52*(2), 457–467. https://doi.org/10.1002/tesq.434

Jin, T., Lu, X., & Ni, J. (2020). Syntactic complexity in adapted teaching materials: Differences among grade levels and implications for benchmarking. *Modern Language Journal*, *104*(1), 192–208. https://doi.org/10.1111/modl.12622

Jin, T., Lu, X., Guo, K., Li, B., Liu, F., Deng, Y., Wu, J., & Chen, G. (2021). *Eng-Editor: An online English text evaluation and adaptation system*. LanguageData. https://www.languagedata.net/tester

Keuning, T., & van Geel, M. (2021). Differentiated teaching with adaptive learning systems and teacher dashboards: the teacher still matters most. *IEEE transactions on learning technologies*, *14*(2), 201–210. https://doi.org/10.1109/TLT.2021.3072143

Lai, C., & Jin, T. (2021). Teacher professional identity and the nature of technology integration. *Computers & Education*, *175*, Article 104314. https://doi.org/10.1016/j.compedu.2021.104314

Ma, Q., Yuan, R., Cheung, L. M. E., & Yang, J. (2024). Teacher paths for developing corpus-based language pedagogy: A case study. *Computer Assisted Language Learning*, *37*(3), 461–492. https://doi.org/10.1080/09588221.2022.2040537

Maddela, M., Alva-Manchego, F., & Xu, W. (2021, June). Controllable text simplification with explicit paraphrasing. In K. Toutanova, A. Rumshisky, L. Zettlemoyer, D. Hakkani-Tur, I. Beltagy, S. Bethard, R. Cotterell, T. Chakraborty, & Y. Zhou (Eds.), *Proceedings of the 2021 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies* (pp. 3536–3553). Association for Computational Linguistics. https://doi.org/10.18653/v1/2021.naacl-main.277

Martin, L., Villemonte de la Clergerie, É., Sagot, B., & Bordes, A. (2020, May). Controllable sentence simplification. In N. Calzolari, F. Béchet, P. Blache, K. Choukri, C. Cieri, T. Declerck, S. Goggi, H. Isahara, B. Maegaard, J. Mariani, H. Mazo, A. Moreno, J. Odijk, & S. Piperidis (Eds.), *Proceedings of the Twelfth Language Resources and Evaluation Conference* (pp. 4689–4698). European Language Resources Association. https://aclanthology.org/2020.lrec-1.577.pdf

McCrae, J. P., Rademaker, A., Bond, F., Rudnicka, E., & Fellbaum, C. (2019). English wordnet 2019–an open-source wordnet for English. In P. Vossen, & C. Fellbaum (Eds.), *Proceedings of the 10th Global Wordnet Conference* (pp. 245-252). Global Wordnet Association. https://aclanthology.org/2019.gwc-1.31

Meurers, D., Ziai, R., Amaral, L., Boyd, A., Dimitrov, A., Metcalf, V., & Ott, N. (2010). Enhancing authentic web pages for language learners. In J. Tetreault, J. Burstein, & C. Leacock (Eds.), *Proceedings of the NAACL HLT 2010 Fifth Workshop on Innovative Use of NLP for Building Educational Applications* (pp. 10–18). Association for Computational Linguistics. https://aclanthology.org/W10-1002.pdf

Odo, D. M. (2023). The effect of automatic text simplification on L2 readers' text comprehension. *Applied Linguistics*, *44*(6), 1030–1046. https://doi.org/10.1093/applin/amac057

O'Donnel, M. E. (2009). Finding middle ground in second language reading: Pedagogic modifications that increase comprehensibility and vocabulary acquisition while preserving authentic text features. *Modern Language Journal*, *93*(4), 512–533. https://doi.org/10.1111/j.1540-4781.2009.00928.x

Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education*, *55*(3), 1321–1335. https://doi.org/10.1016/j.compedu.2010.06.002

Paetzold, G. H., & Specia, L. (2017). A survey on lexical simplification. *Journal of Artificial Intelligence Research*, *60*, 549–593. https://doi.org/10.1613/jair.5526

Pérez-Paredes, P., Ordoñana Guillamón, C., & Aguado Jiménez, P. (2018). Language teachers' perceptions on the use of OER language processing technologies in MALL. *Computer Assisted Language Learning*, *31*(5-6), 522–545. https://doi.org/10.1080/09588221.2017.1418754

Rets, I., Astruc, L., Coughlan, T., & Stickler, U. (2022). Approaches to simplifying academic texts in English: English teachers' views and practices. *English for Specific Purposes*, *68*, 31–46. https://doi.org/10.1016/j.esp.2022.06.001

Rets, I., & Rogaten, J. (2021). To simplify or not? Facilitating English L2 users' comprehension and processing of open educational resources in English using text simplification. *Journal of Computer Assisted Learning*, *37*(3), 705–717. https://doi.org/10.1111/jcal.12517

Richards, M. R. E., & Omdal, S. N. (2007). Effects of tiered instruction on academic performance in a secondary science course. *Journal of Advanced Academics*, *18*(3), 424–453. https://doi.org/10.4219/jaa-2007-499

Saggion, H. (2017). *Automatic Text Simplification*. Springer.

Scarton, C., Aprosio, A. P., Tonelli, S., Wanton, T. M., & Specia, L. (2017, November). MUSST: A multilingual syntactic simplification tool. In S. B. Park & T. Supnithi (Eds.), *Proceedings of the IJCNLP 2017, System Demonstrations* (pp. 25–28). Association for Computational Linguistics. https://aclanthology.org/I17-3007.pdf

Siddharthan, A. (2006). Syntactic simplification and text cohesion. *Research on Language and Computation*, *4*, 77–109. https://doi.org/10.1007/s11168-006-9011-1

Srikanth, N., & Li, J. J. (2021, August). Elaborative simplification: Content addition and explanation generation in text simplification. In C. Zong, F. Xia, W. Li, & R. Navigli (Eds.), *Findings of the Association for Computational Linguistics: ACL-IJCNLP 2021* (pp. 5123–5137). Association for Computational Linguistics. https://doi.org/10.18653/v1/2021.findings-acl.455

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research techniques*. Sage.

Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Association for Supervision and Curriculum Development.

Tomlinson, C. A. (2005). *How to differentiate instruction in mixed-ability classrooms* (2nd ed.). Pearson Education, Inc.

Tomlinson, C. A. (2017). *How to differentiate instruction in academically diverse classrooms*. Association for Supervision and Curriculum Development.

Tomlinson, C. A., & McTighe, J. (2006). *Integrating differentiated instruction and understanding by design: Connecting content and kids*. Association for Supervision and Curriculum Development.

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology*, *50*(3), 1189–1209. https://doi.org/10.1111/bjet.12748

Wenk, B. (2010, April). Open educational resources (OER) inspire teaching and learning. In M. Castro, E. Tovar, & M. E. Auer (Eds.), *Proceedings of the IEEE EDUCON education engineering 2010 – the future of global learning engineering education* (pp. 435-442). IEEE. https://doi.org/10.1109/EDUCON.2010.5492545

Wiley, D., Hilton III, J. L., Ellington, S., & Hall, T. (2012). A preliminary examination of the cost savings and learning impacts of using open textbooks in middle and high school science classes. The *International Review of Research in Open and Distributed Learning*, *13*(3), 262–276. https://doi.org/10.19173/irrodl.v13i3.1153

Woodsend, K., & Lapata, M. (2011, July). Learning to simplify sentences with quasi-synchronous grammar and integer programming. In R. Barzilay & M. Johnson (Eds.), *Proceedings of the 2011 Conference on Empirical Methods in Natural Language Processing* (pp. 409–420). Association for Computational Linguistics. https://aclanthology.org/D11-1038.pdf

About the Author

Fengkai Liu is a graduate student pursuing his PhD in the department of Linguistics and Translation at City University of Hong Kong, China. His research interest primarily focuses on computational linguistics.

E-mail: fengkaliu3-c@my.cityu.edu.hk

ORCiD: https://orcid.org/0000-0002-0422-3362

Yishi Jiang is a PhD student in the School of Foreign Languages at Shanghai Jiao Tong University, China. His research interests include corpus linguistics and computer assisted language learning.

E-mail: eashjiang@sjtu.edu.cn

ORCiD: https://orcid.org/0009-0008-6650-3766

Chun Lai is an Associate Professor at the Faculty of Education, The University of Hong Kong, China. Her research interest is technology-enhanced language learning. Her recent research focuses on self-directed language learning with technology beyond the classroom.

E-mail: laichun@hku.hk

ORCiD: http://orcid.org/0000-0002-7915-113X

Tan Jin is a professor at South China Normal University, China. His research interests include corpus linguistics, computer assisted language learning, and language assessment. He has published extensively in journals such as *Applied Linguistics*, *Language Learning & Technology*, *Language Testing*, *Modern Language Journal* and *TESOL Quarterly*. Tan Jin is the corresponding author.

E-mail: tjin@scnu.edu.cn

ORCiD: https://orcid.org/0000-0002-6421-0977