Teacher engagement with automated text simplification for differentiated instruction

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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


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;
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_ 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**

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Helen</th>
<th>Lucy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background</td>
<td>Age</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Teaching experience</td>
<td>18 years</td>
<td>21 years</td>
</tr>
<tr>
<td></td>
<td>Number of students in class</td>
<td>73</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Students’ English proficiency level (according to CEFR)</td>
<td>A2</td>
<td>B1</td>
</tr>
</tbody>
</table>

Table 2

**Knowledge of and Intention for DI on Participant Questionnaires**

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Helen</th>
<th>Lucy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of DI</td>
<td>student-centered</td>
<td>3.83</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>assessment and differentiation</td>
<td>3.75</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>material provision</td>
<td>3.50</td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>diversified tasks</td>
<td>3.80</td>
<td>3.80</td>
</tr>
<tr>
<td></td>
<td>grouping</td>
<td>3.75</td>
<td>3.50</td>
</tr>
<tr>
<td>Plan of DI</td>
<td>student-centered</td>
<td>4.00</td>
<td>2.33</td>
</tr>
<tr>
<td></td>
<td>assessment and differentiation</td>
<td>3.75</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>material provision</td>
<td>3.50</td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>diversified tasks</td>
<td>3.40</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>grouping</td>
<td>3.75</td>
<td>2.75</td>
</tr>
</tbody>
</table>

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 ATSSs over the semester. The analysis of interview data went through three phases, 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)

<table>
<thead>
<tr>
<th>Teacher engagement</th>
<th>Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral engagement</td>
<td>Interaction with ATS tools in text simplification</td>
</tr>
<tr>
<td>Cognitive engagement</td>
<td>Simplification strategy use</td>
</tr>
<tr>
<td></td>
<td>Metacognitive operations in employing strategies with ATS tools</td>
</tr>
<tr>
<td>Affective engagement</td>
<td>Interest and willingness to participate in text simplification activity</td>
</tr>
<tr>
<td></td>
<td>Emotional responses toward ATS assisted simplification</td>
</tr>
<tr>
<td>Social engagement</td>
<td>Communication with colleagues and students regarding the process and effect of ATS-assisted simplifications</td>
</tr>
</tbody>
</table>
**Table 4**

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

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

**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*

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

<table>
<thead>
<tr>
<th>Participant</th>
<th>Source text</th>
<th>Simplified text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen</td>
<td>Among the numerous highlights, he scored 20 second-half points against Australia.</td>
<td>Among the so many highlights, he scored 20 second-half points against Australia.</td>
</tr>
<tr>
<td>Lucy</td>
<td>Walking is another great aerobic activity to help you increase your blood circulation.</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Stage</th>
<th>Source</th>
<th>Simplified</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen</td>
<td>text-oriented</td>
<td>5.98</td>
<td>5.54</td>
<td>-0.44</td>
</tr>
<tr>
<td></td>
<td>pedagogy-oriented</td>
<td>6.24</td>
<td>4.46</td>
<td>-1.78</td>
</tr>
<tr>
<td></td>
<td>effectiveness-oriented</td>
<td>5.50</td>
<td>5.48</td>
<td>-0.02</td>
</tr>
<tr>
<td>Lucy</td>
<td>text-oriented</td>
<td>5.10</td>
<td>5.38</td>
<td>+0.28</td>
</tr>
<tr>
<td></td>
<td>pedagogy-oriented</td>
<td>6.13</td>
<td>5.32</td>
<td>-0.81</td>
</tr>
<tr>
<td></td>
<td>effectiveness-oriented</td>
<td>6.93</td>
<td>5.02</td>
<td>-1.91</td>
</tr>
</tbody>
</table>

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*
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 ATs is by nature a contextualized one. The complexity of text simplification for DI can never be fulfilled by ATs solely. Teachers need to have the capacity to engage in coordinated use of AT 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, AT 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 ATs led to teachers’ strategic modification of the simplified text generated by ATs. 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 AT 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 AT systems for DI was driven by teachers’ repositioning of the role of AT 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 AT technology to meet the DI needs in their teaching contexts shaped the nature of their flexible engagement. Thus, to maximize the potential of AT systems for differentiation, professional development should not rest short at the operation level of AT systems, but also enhance teachers’ understanding of the nexus of the teaching content, DI needs, and affordances of AT systems.

Moreover, this study revealed that teachers’ use of ATs in classroom teaching was influenced by various contextual factors. It was found that teachers’ engagement with ATs 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 ATs 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 ATs.

The findings have some implications for the design and use of AT tools. First, it is important to raise teachers’ awareness of the affordances and, more importantly, limitations of AT tools, and foster the mindset that the full realization of the advantages of AT tools occurs when they work in conjunction with teachers’ professional judgements. Although AT 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 AT tools in simplification. Second, it is equally important to expand teachers’ understanding of DI and boost their capacity to use AT tools flexibly in response to the situated interpretation of DI needs in specific teaching contexts. Third, developers of AT 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 AT systems. AT 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.

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**Notes**

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

**References**


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