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The Use of Assistive Technologies in Writing Situations with Dyslexic and Dysorthographic Students

Nadia Rousseau, Michelle Dumont and Carl Beaudoin

Abstract

In the context where dyslexic and dysorthographic students have great difficulties in writing, this study aims to describe and analyze the perceived relationship between the use of assistive technologies (AT) in writing situations as well as academic self-perception, feeling of self-efficacy and exam anxiety in dyslexic and dysorthographic students. Using standardized questionnaires and semi-structured interviews, data were collected at the beginning and end of the school year from 28 dyslexic and dysorthographic students aged 12 to 13. In terms of quantitative analyses, the average score for each of the scales on the questionnaires was calculated. As for the qualitative data, they were analyzed using a network analysis approach. The main results show that students who can use ATs in a writing situation have a significantly higher self-perception and feeling of self-efficacy than those who do not. Moreover, their use is promising since it is associated with less anxiety at the time of exams at both measurement times. The results obtained are discussed in relation to actions to be encouraged in schools.

Keywords: Assistive technology, Dyslexia/dysorthographia, Writing, Self-efficacy, Self-perception, Exam anxiety

1. Introduction

In the early 1980s, [1] proposed a model of written text production. This model, revised a few years later by [2], is still a reference in most French didactic studies [3]. It is based on the implementation of three main writing processes: planning, drafting, and reviewing [1, 3, 4]. While planning involves generating and organizing ideas according to a topic, an audience, an intention, and the type of text to be produced [5], drafting the text involves putting into words and sentences the ideas developed in the planning stage [3]. Reviewing involves redrafting and editing the text [1]. In the case of inexperienced writers, reviewing will begin with the word and will gradually extend to the entire text, depending on writing conventions and ideas they wish to convey [6]. Given the requirements linked to activating and articulating many mental processes, some of which being related to reading, as well as the large number of levels of organization in the text, the writer must have sufficient cognitive abilities to manage and coordinate all the writing processes [3, 7–9]. The production

of written texts in French is even more complicated because French spelling is one of the most complex of the alphabetic languages [10]. In addition to the complexity associated with the writing process and the French language, it is important to focus on dysorthographic and dyslexic students, who present reading and spelling difficulties that persist over time [11–14] and have a major impact on writing skills [15, 16]. Indeed, these students produce shorter texts with a significant number of spelling and punctuation errors [7, 9, 17]. Another consideration is that the writing process in dyslexic students is also associated with the development of a negative academic self-perception, which can lead to anxiety, disengagement in a writing context, and even discouragement and loss of motivation [18–20]. Research shows that dyslexic and dysorthographic students in primary and secondary schools have a lower feeling of self-efficacy when faced with a writing task than their peers without these disorders [21, 22], although this is overestimated with regard to their actual performance [21, 23]. These students also show a lower level of effort when faced with a complex task, which, according to [22], is the result of a low feeling of self-efficacy. Finally, students with dyslexia and dysorthographia are reported to be more prone to exam anxiety than their peers without the disorder [23–25].

Given the difficulties experienced by dyslexic and dysorthographic students, it is important to consider how to better support them academically. Thus, assistive technologies (ATs) attract attention. In fact, technological advances have allowed the development of ATs associated with the writing process, namely lexical/syntactic proofreader, speech synthesizer, word predictors and voice dictation. Several US studies reveal the contribution of reviewers on the correction of spelling errors [26] as well as lexical and syntactic spelling, readability, organization, and coherence of the texts produced [27–29], although reviewers fail to identify one third of lexical homophone errors [30]. As for the word predictor, severe dysorthographic students show great difficulty in using this AT effectively, while a gain is observed in those with moderate difficulties [31]. Finally, voice dictation was associated with significant improvements in the quality of writing and in the accuracy of lexical and syntactic spelling, compared to unassisted writing in students with dyslexia-dysorthographia. These results are not observed for ordinary students [32, 33]. Since almost all the studies on the effectiveness of ATs on the act of writing are from the USA and focus on the analysis of the texts produced, it is necessary to study this means of adaptation, in particular on academic self-perception, feeling of self-efficacy and exam anxiety in a writing situation.

2. Terms of reference

2.1 Self-perception

Self-perception refers to how a person perceives themselves [34]. The educational psychology perspective recognizes the importance of the self in learning. This is referred to as the “self as learner” [35]. This growing interest in the self as learner is also present in the conceptualization of self-perception proposed by [36], who subdivide the school dimension of self-perception into two domains: “learner” self-perception (felt in relation to one’s own ability to learn) and “student” self-perception (felt in relation to one’s own ability when faced with school tasks). As explained by [36], as a person’s self-perception develops, he or she distinguishes between his or her ability to perform, look good, stand out, excel in school (student self-perception) and his or her ability to develop new learning (learner self-perception).

Students with learning disabilities often exhibit negative self-perceptions [20, 22], which are characterized by feelings of not being up to the task, being inferior to peers,

or being different [37]. In addition, researchers find that the difficulties engendered by writing contribute to the development of a negative academic self-perception, which can lead to anxiety, disengagement in the writing context, and even discouragement and loss of motivation [19, 20].

Scientific literature also reports positive relationships between low self-perception and different components of school life: lower academic performance and increased academic difficulties [38, 39], less academic effort and perseverance [34], lower confidence in one's academic abilities [36], lower academic motivation [22, 38, 39], as well as lower expectations and less ambitious academic aspirations [36].

2.2 Feeling of self- efficacy

To be effective in the school context, learning French spelling must be supported by strong motivation throughout the school years. According to Bandura's social-cognitive theory [38, 39], the feeling of self-efficacy refers to a person's confidence in his or her ability to deal with demanding, new or problematic situations. Several research findings suggest that students who report high levels of self-efficacy compared to those who report low levels of self-efficacy have less psychological and physical distress, higher levels of academic achievement [40], higher academic aspirations, spend more time on homework, feel more effective in managing their school activities [41], and demonstrate a more serene attitude toward even complex tasks [40]. In terms of writing, students who have a high feeling of self-efficacy engage more easily in the task, are more motivated, participate more in class, persevere in the face of difficulties, and are better able to manage the anxiety they feel in exam situations [42]. On the other hand, learners with significant learning difficulties have a lower feeling of self-efficacy than their peers without difficulties [21, 22]. Specifically, in spelling, students who overestimate their proficiency perform above expectations, while students who underestimate themselves perform less well [43]. Research shows that dyslexic and dysorthographic students in primary and secondary schools have a lower feeling of self-efficacy when faced with a writing task than their peers without dyslexia and dysorthography [21, 22].

2.3 Exam anxiety

Students who suffer from exam anxiety anticipate failure, believing they will not be able to meet requirements; for them, their performance is indicative of their personal worth [44]. They also tend to anticipate all sorts of situations in which their personality might be threatened [45], especially if they are likely to be judged, lose face, or be publicly humiliated. Moreover, exam anxiety is thought to be related to fear of meeting social expectations, lack of confidence in their own abilities, fear of failure, fear of memory loss, and physiological manifestations of stress [46].

More specifically, [47] report that students with academic difficulties who experience exam anxiety have higher scores for worry, defeatist cognitive blocking, and inattention than those who do not have learning problems. According to the same authors, anxiety could absorb students' ability to activate the working memory needed to solve complex problems. They also find that students with learning disabilities are likely to have had fewer positive academic experiences due to repeated failures, which would make them even more nervous in exam situations. Although anxiety experienced during an assessment is commonly observed in many students, if severe, it can have a negative impact on their academic progress [48], which could jeopardize their future. Given the many factors associated with this type of anxiety, it is not surprising that students with dyslexia and dysorthographia suffer from it to a greater extent than their peers without dyslexia and dysorthographia [25].

2.4 Word processing and assistive technologies

In order to better support the learning of students who have more difficulty in French than others, the ATs associated with the writing process (lexical/syntactic proofreader, speech synthesis, word predictor, and voice dictation) are used to support this type of problem. Indeed, there is a positive effect of the use of word processing on the quality, organization and length of students' writing, spelling performance [49], self-perception and engagement, in addition to being a teaching and learning aid [50]. However, it should be noted that the use of text processing is not in itself a sufficient support to improve the act of writing in all its complexity [51].

2.5 Research objectives

The purpose of this research is to describe and analyze the perceived relationship between the use of ATs in writing situations as well as the academic self-perception, feeling of self-efficacy, and exam anxiety of dyslexic and dysorthographic junior high school students.

3. Research methodology

This research combines a multi-case study [52] and the use of quantitative and qualitative tools [53]. In the context of this research, each school setting participating in the study ($n = 3$) is a case in itself, and each student with dyslexia and dysorthography also refers to unique cases ($n = 28$), which makes reference to literal replication rather than theoretical replication design. While the former aims at studying similar cases, the latter aims at studying contrasting cases.

3.1 Participants

The participants come from 3 high schools in 2 administrative regions. The students, aged 12 to 13 (16 boys and 12 girls), are all French-speaking (first language), AT users, entering their first year of secondary school, and identified by the school community as having dysorthography or dyslexia problems ($n = 28$). The preliminary assessment of the degree of difficulty in writing of the students participating in the research using the Chronodictée tool [54] reveals the presence of very severe spelling difficulties for all the participants, ranging from very severe (3), very, very severe (10) to extremely severe (15).

3.2 Data collection process

Data collection took place through a sequence of activities involving or not ATs in a writing situation, both in the fall and spring of the same school year and only in the spring of the following school year. More precisely, they were asked to write a summary, with and without technological assistance (at one-week intervals), and then to complete the questionnaires mentioned above. A 5–6 minute video vignette (silent short film featuring various characters in a short story sequence) is viewed twice (as a group). First, the students watch the video carefully, and then watch it again, while taking notes in a notebook provided for this purpose. These notes can then be used when writing the summary.

3.3 Time period for data collection

The data collection tools include three standardized questionnaires and an interview protocol. Standardized tools include Fleming and Courtney's *Feeling of Inadequacy Scale* [55]—alpha = 0.93). This questionnaire includes 36 items measuring 5 dimensions of self-perception using a 5-point Likert scale, ranging from “very often” (1) to “almost never” (5). However, based on the work of [22], only the dimensions of confidence (12 items) and academic skills (7 items) were used (Cronbach's alphas in order: 0.87 and 0.77). Building on the work of [43], inspired by [56, 57], participants also completed a questionnaire probing their feeling of self-efficacy with regard to writing [43]. This questionnaire consists of 8 items on which participants are asked to comment using a 6-point Likert scale, ranging from “strongly disagree” (1) to “strongly agree” (6). The original questionnaire [43] has satisfactory internal consistency and good construct stability (pilot study 0.80 and main study 0.79). Finally, the Exam Anxiety Scale (*Friedman Exam Anxiety Scale* [58], translated and adapted by [59]—alpha 0.91), a 6-entry Likert-type scale ranging from “doesn't look like me at all” (1) to “looks like me perfectly” (6), is used. The tool includes 23 items divided into 3 subscales: a) social anxiety; b) cognitive interferences (worry); and c) physiological reactions (emotionality).

On the other hand, the semi-structured interview protocol, inspired by the Steinhoff and Owens questionnaire [60], invites students to express themselves on the object under study by using a brief description, an image or a metaphor (e.g., *For me, writing with [name of the tool or assistance function] is... because...*). This type of question has been shown to be beneficial in several studies on the experience of young people with academic difficulties, in particular because of the structure of the question which facilitates the expression of a key idea, while encouraging the verbalization of an individual response free from any influence on the part of the interviewer [61–63].

3.4 Data analysis

First, in terms of quantitative analysis, the average of the scores on the different scales of the three standardized questionnaires is calculated using the *SPSS Statistics* software (version 23). This data processing makes it possible to position the participants in terms of their feeling of self-efficacy, their perception of self in writing, and their exam anxiety, depending on whether they use ATs in a writing situation. Second, an inductive analysis of the qualitative data obtained from the semi-structured interviews was conducted using the network analysis approach [64], using the ATLAS Ti qualitative analysis software, a key tool in network analysis [65].

4. Results

In what follows, we will first present the quantitative results for each of the three dimensions studied (feeling of self-efficacy, self-perception, and exam anxiety). Next, we will highlight the qualitative results obtained on the use of ATs by participants.

4.1 Self-perception in writing

Whether at the beginning or at the end of the school year, the results indicate that students with dysorthographia or severe dyslexia who can use an AT to

summarize a story report a statistically significantly higher self-perception feeling than when they cannot ($t [26] = -2,601, p = 0.05$). This result was expected.

4.2 Feeling of self-efficacy in writing

As expected, the results indicate that students with severe writing difficulties who have the opportunity to use an AT to summarize a story have a statistically significantly higher feeling of self-efficacy than those who do not, both in the fall ($t [26] = -6,382, p = 0.001$) and in the spring of the same school year ($t [26] = -4,493, p = 0.001$). It should be noted, however, that contrary to expectations, the use of ATs was associated with a statistically significant decrease in feelings of self-efficacy as the school year progressed ($t [26] = 2,142, p = 0.05$).

4.3 Writing exam anxiety

Contrary to expectations, the use of ATs was not associated with a significant decrease in the three components used to describe the writing exam anxiety questionnaire (social depreciation, cognitive blocking and body tension) for students with severe dysorthographic and dyslexic difficulties. On the other hand, the results associated with social depreciation as well as cognitive blocking are in line with expectations, since the score obtained on these two subscales is lower at the end of the school year, when the student has had the opportunity to become more familiar with technological tools.

Although the result is marginal ($t [26] = 1,136, p = 0.059$), the overall mean writing exam anxiety score is consistent with expectations, as it is lower in a context with ATs at both measurement times, particularly in the spring, than in the context without ATs.

4.4 Minimal use of the assistance functions available to participants

In the individual interviews, the students' comments highlight both the benefits and limitations associated with the use or non-use of technological tools in the writing context. As such, the benefits associated with the use of ATs mentioned by the students include the possibility of obtaining a better performance (*"Well, assistive technologies help me do better, it's basically like a part of my brain"*) and the improvement of their working methods (*"It helps me to proofread properly..."*). Similarly, they mentioned feeling a greater sense of well-being (*"It makes you feel more confident"*) and having the perception that significant help is given to them (*"It's for learning well, I don't really know how to say it... Then, that's it, it helps me learn"*).

As for the limitations associated with these technologies, students sometimes mention limiting features (*"Well sometimes it bugs, then sometimes when you don't record, it gets erased."*) and the feeling of being different from other classmates (*"I feel embarrassed in front of everyone to have a computer... I feel as if I am different, and I don't like it."*). On the other hand, students verbalize the presence of some persistent difficulties in writing (*"Well, I still have difficulty, even though I have my assistive technologies."*), a less accessible performance (*"Well, I feel like ... you have to like to read it a few times, a few times to understand."*) and more difficult to establish work methods (*"Disorganized..."*). Finally, some students mentioned a lower sense of well-being (*"I think that I have more difficulties, that I have real problems"*) as well as a number of difficulties experienced with regard to writing (*"And there, the maximum that I can do is to take the dictionary, and for that, well, I need you to check my agreements, and so on"*).

The analysis of the video recordings made during the drafting process shows that little use was made of the AT provided to the participants. Thus, for Antidote

users, only three of the 239 available functions are used by students. For Word Q users, only 9 out of 12 functions are used. Regarding the use of the Lexibar software, the video recordings show that the students use 7 of the 10 functions of the software. For Lexibar users, 7 of the 10 available functions are used. From these results, we can see that, regardless of the software, the assistance functions used by the students are particularly present at the text drafting stage and often absent at the text correction stage. Also of interest is the fact that many participants use Word as their primary word processor, including clicking on underlined words to assist in the correction process. However, this software is not in itself a technological assistance tool.

5. Discussion

The results of this study confirm those of the scientific literature to the effect that the use of a technological assistance tool is associated with benefits, including a more favorable self-perception in writing as well as a greater feeling of self-efficacy than if one is left to deal with one's writing difficulties [66]. This increased perceived self-confidence and feeling of self-efficacy were observed both at the beginning and at the end of the school year. On the other hand, the current analyses do not demonstrate whether the technological assistance tool promotes better performance on the writing task than without it. In contrast, responses to open-ended questions about self-perception in writing suggested that students with dysorthographia or severe dyslexia felt more worried, stressed, and anxious in the absence of technological support than when it was available. Perform A previous qualitative study also highlighted the increase in stress for dyslexic/dysorthographic students when they were required to perform tasks without technological support [67]. This qualitative analysis also shows that the use of ATs is associated with stress management strategies that de-stress them and increase their confidence in writing. For example, some report feeling more competent, well, confident, less stressed or stress-free, better prepared, more successful, as if they were writing by hand, well organized, "normal."

On the other hand, and contrary to all expectations, the feeling of self-efficacy in writing showed a statistically significant decrease between the beginning and the end of the school year, in the condition allowing the use of ATs. Three explanatory hypotheses can be proposed to explain this unexpected result. First, it is possible that students at the end of the school year become more aware of the severity of their difficulties in the French language, particularly in spelling, which in turn would affect their feeling of self-efficacy. In fact, the requirements in French, particularly in writing, increase between the end of elementary school and the beginning of secondary school (length of texts, types of texts) [68]. Second, as the school year progresses, teachers and parents may lower their performance expectations (grammar, syntax, etc.), which has a downward effect on feelings of self-efficacy. Third, it should be noted that for all students, entry into secondary school corresponds to a decline in their feeling of self-efficacy [42].

Contrary to what was expected, the use of ATs was not associated with a significant decrease in the "social depreciation" dimension of anxiety relative to writing exams for these dysorthographic or severe dyslexic students. "Social devaluation" was the concern that one would no longer be loved by one's parents or that one would be judged "stupid" if one failed an exam. Although the score is lower at the end of the school year than that observed in a context without AT, it appears that these technologies are insufficient to significantly reduce this component of exam anxiety in this type of student.

The study shows similar results for the “cognitive blocking” dimension of the writing exam anxiety questionnaire. This component of the questionnaire highlights the feeling of having “*an empty brain,*” of having “*forgotten everything you have learned, ideas you have organized or ordered in your head.*” Again, although the score on this scale is lower at the beginning and at the end of the school year than that obtained in the context without ATs, it is possible that the use of ATs for students with significant writing difficulties is insufficient to compensate for deficits in metacognitive skills such as organizing, synthesizing, and understanding the content of a text. This hypothesis is supported by [69], who reports that the negative effects associated with exam anxiety may be exacerbated by poor metacognitive skills and less effective use and selection of study strategies, as evidenced by the poor performance of the participants in his study under conditions that did not present any external exam pressure. According to this author, being aware of their deficiency in preparing adequately for exams, the emotionality and helplessness felt at the time may prevent students from dealing effectively with the exam situation. This interpretation would apply all the more to students who are severely affected in the learning of a language as complex as French.

For the “body stresses” component of the writing exam anxiety questionnaire, again, the use of ATs was not associated with fewer symptoms in the spring, while there was no difference for students with or without ATs at the beginning of the school year. We even find that this type of stress measured in the spring (being stressed, agitated, having a rapid heartbeat, being afraid of an exam) is slightly higher in a context of ATs than in the one without the possibility of using them. This result is contrary to expectations. It is possible, however, that the use of ATs for dysorthographic or dyslexic students is imperfect or insufficient to compensate for the presence of physiological symptoms often observed in stressful situations and which may prove to be a detriment to concentration and memorization of the subject matter [70]. It is not uncommon to hear adolescents express such stressful reactions in the context of an exam: “*I froze on the spot during a public performance,*” “*I had studied, but I forgot everything at the time of the exam*” [71].

Finally, as expected, the average overall writing exam anxiety score was borderline to being statistically lower at the beginning and at the end of the school year when the student used ATs. This result is most apparent when students have been able to familiarize themselves with the software at the end of the school year. Although encouraging, ATs alone are not associated with a significant reduction in writing exam anxiety.

5.1 Actions to be encouraged in schools

This study suggests that efforts in schools should be encouraged by promoting the development of self-knowledge and self-esteem in young people, thus contributing to their action planning and reflective action [72]. Already, experimentation with activities related to self-awareness, learning disability, and compensatory functions of ATs in a secondary school is proving promising [67]. [73] furthermore states that behaviors aimed at self-awareness are one of the themes related to the success of schooling. Another intervention target is to develop a feeling of self-efficacy in writing through workshops on self-esteem, story co-construction [74], and more effective work methods for exam preparation. Both qualitative and quantitative data from this study suggest the need to reduce writing exam anxiety through stress management workshops [75]. Finally, the school needs to ensure that students have an understanding of and facility in using the full potential of ATs in the completion of academic tasks.

6. Conclusion

Whether at the beginning or at the end of the school year, the results indicate that dyslexic and dysorthographic students who can use assistive technologies to summarize a story show significantly higher self-perception and self-efficacy than those who do not. Although the use of ATs was not associated with a significant decrease in writing exam anxiety, the results showed a trend for marginal significance since the scores obtained were lower in a context of assistive technologies than in a context without ATs. Given the numerous testimonies of young people suffering from exam anxiety and the observation of teachers and psychosocial workers, it is important that research be able to better understand this type of anxiety, because negative concerns in exam situations (before, during and after) could cause students to underperform in relation to their real potential, which will certainly have consequences on their life choices. In addition, considering these results, a review of teaching and assessment practices in spelling is required. These practices must be considered in such a way that consolidates the self-assessment of students' competence rather than weakens it. In particular, the teacher must take his time. There is no point in rushing through an array of grammatical concepts and rules that make students feel dizzy and incompetent because the task seems impossible. It is important to ensure that essential learning is solid before introducing exceptions that will undermine the students' knowledge system. The teacher must provide adequate support for the concepts and not rush their teaching.

In conclusion, the original contribution of this study lies in a conception in which students' achievements are not only related to their cognitive background, but also to a complex interface between the latter and their affective and motivational system [76], hence the variables that were analyzed in this study. Thus, a better self-perception in writing as well as a greater feeling of self-efficacy in writing are associated with the use of ATs when completing an academic task. To a lesser extent, however, ATs-assisted writing appears to be associated with slightly less anxiety on exams than when students are left to their own knowledge. Let us not forget that the school has a role to play in making ATs available and the best ways to use them for students. Therefore, it is important to focus on three types of support in order to gain a better understanding of the use of ATs in writing contexts [77]: remedial support (students take ownership of the assistive features in the writing process with the support of the remedial teacher), learning support (students use the assistive features to learn in the classroom in a writing situation) as well as instructional support (the teacher models their use in the classroom, for all students). Finally, it should be noted that the results of this study cannot be generalized to clients other than those with dyslexia or dysorthographia.

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Conflict of interest

The authors declare no conflict of interest.

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