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Digital tools for the learning of grammatical revision with French L1 learners: Results from a systematic approach study

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Abstract: French L1 students face difficulties in text revision, particularly in applying grammatical knowledge to their writing and navigating the complexities of French spelling. Online digital learning tools may offer valuable support in overcoming these challenges. What is the real potential of these tools for developing revision skills? To what extent do they help students apply their grammatical knowledge in writing? Based on a previous study (Arseneau & Geoffre, 2023), this article presents the findings of a systematic approach study that examined 126 digital tools for grammatical text revision in French as a first language, using three main variables: grammatical content, task type, and feedback. The results reveal that the majority of the surveyed tools (92.9%) focus on specific grammatical content (primarily grammatical spelling) and engage users in only one type of task (87.3%). Furthermore, the most crucial tasks for learning text revision –such as identifying and correcting errors– are surprisingly addressed by only a few tools. However, the feedback provided to learners is generally comprehensive, often combining various forms, including metalinguistic explanations or cues (76.2%). The results are discussed in light of principles for revision and grammar instruction, along with a reflection on pedagogical implications and on what an "ideal tool" design might look like, potentially incorporating AI.

Keywords: grammatical revision; French L1; online digital tools.

EINES DIGITALS PER A L'APRENENTATGE DE LA REVISIÓ GRAMATICAL AMB APRENENTS DE FRANCÈS L1: RESULTATS D'UN ESTUDI D'ENFOCAMENT SISTEMÀTIC

Resum: *Els estudiants de francès L1 presenten dificultats en revisar textos, especialment en l'aplicació dels seus coneixements gramaticals a l'escriptura i per la complexitat de l'ortografia francesa. Les eines d'aprenentatge digital en línia poden ajudar, però quin és el potencial real d'aquestes eines per desenvolupar habilitats de revisió? Basant-nos en Arseneau i Geoffre (2023), presentem els resultats d'un estudi d'enfocament sistemàtic en què examinem 126 eines digitals per a la revisió gramatical de textos en francès com a L1, utilitzant tres variables: contingut gramatical, tipus de tasca i retroalimen-*

tació. Trobem que 92.9 % de les eines se centren en continguts gramaticals específics (principalment ortografia gramatical) i impliquen un sol tipus de tasca (87.3 %). A més, les tasques més importants per a l'aprenentatge de la revisió de textos, com identificar i corregir errors, les aborden molt poques eines. No obstant això, la retroalimentació proporcionada als alumnes és generalment exhaustiva, sovint combinant diversos modes, incloent explicacions o indicis metalingüístics (76.2 %). Discutim els resultats tenint en compte els principis per a la revisió i l'ensenyament gramatical, juntament amb una reflexió sobre les implicacions pedagògiques i sobre com podria ser un disseny d'"eina ideal", que podria incorporar intel·ligència artificial.

Paraules clau: *revisió gramatical; francès L1; eines digitals en línia.*

HERRAMIENTAS DIGITALES PARA EL APRENDIZAJE DE LA REVISIÓN GRAMATICAL CON APRENDICES DE FRANCÉS L1: RESULTADOS DE UN ESTUDIO DE ENFOQUE SISTEMÁTICO

Resumen: *Los estudiantes de francés L1 presentan dificultades en la revisión de textos, especialmente en la aplicación de sus conocimientos gramaticales a la escritura y por la complejidad de la ortografía francesa. Las herramientas de aprendizaje digital en línea pueden ayudar, pero ¿cuál es el potencial real de estas herramientas para desarrollar habilidades de revisión? Basándonos en Arseneau y Geoffre (2023), presentamos los resultados de un estudio de enfoque sistemático en el que examinamos 126 herramientas digitales para la revisión gramatical de textos en francés como L1, utilizando tres variables: contenido gramatical, tipo de tarea y retroalimentación. Encontramos que 92.9 % de las herramientas estudiadas se centran en contenidos gramaticales específicos (ortografía gramatical) e implican un solo tipo de tarea (87.3 %). Además, muy pocas herramientas abordan las tareas más importantes para el aprendizaje de la revisión de textos, como identificar y corregir errores. Sin embargo, la retroalimentación proporcionada es generalmente exhaustiva, a menudo combinando diversos modos, incluyendo explicaciones o indicios metalingüísticos (76.2 %). Discutimos los resultados considerando los principios para la revisión y la enseñanza gramatical, junto con una reflexión sobre las implicaciones pedagógicas y sobre cómo podría ser un diseño de "herramienta ideal", que podría incorporar inteligencia artificial.*

Palabras clave: *revisión gramatical; francés L1; herramientas digitales en línea.*

1. Introduction

For several years, the field of education has undergone significant changes due to the widespread integration of technology both inside and outside classrooms. These challenges are further intensified by the rise of artificial intelligence. The use of specialized digital learning tools can offer certain advantages or "value add" (Leading Educators, 2023) for learning, such as easy online access, increased motivation from gamified environments, and immediate feedback (Karakoç et al., 2022).

These digital tools could prove beneficial for French L1 students, who often struggle with text writing, particularly in areas like grammatical spelling, syntax, and punctuation (Boivin & Pinsonneault, 2018; Brissaud & Fayol, 2018). One of the main challenges students face is transferring their grammatical knowledge into writing, particularly during the revision phase, due to the heavy cognitive load imposed by the writing process (Roussey & Piolat, 2008). When

revising their texts to improve its quality, writers must address various potential issues, including text coherence, audience adaptation, vocabulary, syntax, punctuation, and grammatical spelling. The knowledge required for this 'critical reading' and text editing is often taught and learned in isolation, such as through decontextualized grammar exercises that"[…] generally fail to improve students' writing" (van Rijt et al., 2019, p. 78). In addition, French spelling is known for its "opacity," meaning that many phonemes correspond to multiple graphemes, leading to spelling irregularities (Fayol et al., 1999). An increasing amount of research suggests that using digital tools can positively impact the learning of grammatical spelling (e.g., Arseneau et al., 2022; Brissaud et al., 2019). Existing studies in the didactics of grammar and spelling in French L1 typically focus on a single, specific tool considered in isolation, such as *Orthodyssée des Gram* (Rodi et Geoffre, 2020) or *Syntaxe interactive* (Arseneau et al., 2022).

To provide a broader perspective, we conducted a systematic approach study of digital tools available online for learning grammar and grammatical text revision in general (Arseneau & Geoffre, 2023a; *n* = 590) and specifically for the learning of a challenging topic: past participle agreement (Arseneau & Geoffre, 2023b; *n* = 35).

Given the specific challenges of text revision (Hayes, 2004) combined with the complexities of French grammar and spelling (Fayol & Jaffré, 2008), it is important to closely examine digital tools that focus on grammatical activities within text contexts. How can these tools be described and analyzed from an instructional and didactic perspective? What potential do they have to enhance learners' abilities to revise spelling, syntax, and punctuation in their own writing?

Building on the methodology, data collection, and analysis from the previous study (Arseneau & Geoffre, 2023a), this article presents a study drawing on systematic approach methodology of 126 digital tools designed for learning grammatical revision with French L1 learners.

2. Conceptual framework

This section covers key concepts related to grammar instruction and the types of tasks involved (1.1), the revision process and transfer of grammatical knowledge (1.2), and digital tools and feedback (1.3).

2.1 Grammar instruction and types of tasks involved

Learning content related to sentence grammar can be classified into three main dimensions: grammatical spelling, syntax, and punctuation (Riegel et al., 2016). Grammatical spelling involves the spelling of words in relation to other words and phrases within a sentence, typically concerning agreement between elements (e.g., verb-subject agreement). Syntax pertains to the arrangement and combination of words and phrases within a sentence (such as sentence types and forms, or the use of coordination and subordination) as well as syntactic analysis tools (e.g., syntactic operations, basic sentence model). Punctuation involves the correct placement of punctuation marks, such as using a comma to separate sentence adverbials.

During grammar instruction in the classroom, regardless of the students' level, learners are asked to perform a variety of tasks. Researchers have categorized these tasks into different

typologies through the analysis of textbooks and teaching practices. For example, Nadeau and Fisher (2006) identified four main types of exercises: identification, transformation, constrained production, and correction. This aligns with the findings of Simard, Dolz, Dufays, and Garcia-Debanc (2010), who identified the same four task types and added explicitation. Gourdet (2017), following an analysis of practices in elementary classes, proposed a six-task typology that includes the restitution of a standardized form, identification, transformation, production based on grammatical constraints, explicitation, and writing words, sentences, or texts from dictation. Bulea Bronckart, Marmy Cusin and Panchout Dubois (2017) analyzed a corpus of exercises to identify all the actions expected from students, resulting in 18 "actions" group-ed into five main types: actions on linguistic examples, definition actions, denomination and identification actions, linking actions, and concept application actions.

Building on these typologies from previous studies (Arseneau & Geoffre, 2023a, 2023b) and the adaptation of the anthropological theory of didactics to the field of French morphography proposed by Geoffre (2022), we selected eight task types based on the eight general "action" verbs used to model the French domain. These task types are outlined in Table 1.

Type of task (Geoffre & Colombier, 2019; Geoffre, 2022)	Subtype of task
1. SORT: Linguistic units provided, it is asked to group them according to gram. characteristics.	Sort linguistic units (words, groups of words, sentences, etc.) without given categories
2. CLASSIFY: Unit previously identified, it is asked to classify it among given categories (e.g. word class, syntactic function, type of error).	Choose category *– drag and drop in a box, drop down menu*
	Choosing spelling, syntactic construction or punctuation mark
	Choose definition or justification
3. IDENTIFY: Given category(ies) (e.g., class of words, type of error), it is asked to identify one or more linguistic units that fall under it.	Identify linguistic units (e.g. words, groups of words, classes, functions, …) *- Highlight, circle, "click on"*
	Detect an error of spelling, syntax or punctuation
4. LINK: The linguistic unit is previously identified, it is asked to link it to one or more linguistics units.	Link grammatical units (e.g., agreement trigger with receiver; interrogative sentence with corresponding declarative sentence)
5. MODIFY: The linguistic unit is previously identified, it is asked to modify it.	Transform a sentence (type and/or form; words in order)
	Manipulate a sentence (syntactic manipulation)
	Reconstruct the basic sentence
	Correct an error of spelling, syntax or punctuation
6. PRODUCE: It is asked to produce a linguistic unit (word, group of words, sentence, text) from a given category or instruction.	Produce a spelling, syntactic construction or punctuation mark (with or without constraint)
	Produce a syntagmatic representation (syntactic tree)
7. DEFINE: It is asked to provide the definition of a teaching/learning content	Provide a definition for a grammatical concept
8. JUSTIFY: It is asked to provide grammatical justification or reasoning	Justify an answer or a spelling, syntactic construction or punctuation marking

Table 1. Types of tasks for grammar instruction (based on Arseneau & Geoffre, 2023a)

To develop a range of abilities useful for grammatical reasoning and the application of grammatical knowledge in text writing and revision, learners must engage in various and combined tasks (Simard et al., 2010). This includes tasks involving error detection (type 3 - Identify)

and correction (type 5 - Modify), which require both metalinguistic analysis of written material and control over it (Bourdages et al., 2021; Roussey & Piolat, 2005). Detached or "isolated" sentences (Combettes, 2009) are traditionally used in most grammatical exercises (Gourdet, 2017) because their lack of semantic significance and context makes it easier for learners to focus on syntactic structures during metalinguistic reasoning. However, working exclusively with detached sentences may not be the most effective way to prepare learners for transferring their grammatical knowledge to the writing and revision process.

2.2 Revision process and transfer of grammatical knowledge

From a cognitive perspective, revision is a sub-process of writing that aims to improve the produced text by utilizing various stored knowledge and strategies (Allal et al., 2004; Hayes & Flower, 1981). Revision typically involves critically rereading the text, detecting, and correcting potential issues (Hayes, 2004; Roussey & Piolat, 2005) across different levels, including pragmatic, textual, lexical, and grammatical (Simard et al., 2011).

In the context of writing, which imposes a high cognitive load, there is no guarantee that grammatical knowledge will be readily accessible for retrieval and application in the text, especially if this knowledge has not been fully automatized (Largy et al., 2004). From the perspective of knowledge transfer (Gick & Holyoak, 1987; Nokes, 2009), increasing the likelihood of successfully transferring knowledge in problem-solving contexts (such as text writing) requires that the writer perceives similarities between the source task –where the grammatical content was learned– and the transfer or "target" task—where the knowledge is applied.

To enhance the perception of similarities between the source task and the transfer task, it is crucial to engage students in grammatical work involving longer linguistic material. When learners work on a linguistic unit that conveys a stronger meaning, such as paragraphs or texts (regardless of the textual genre), it becomes more challenging for them to distance themselves from the meaning and focus on the structure, which is the essence of metalinguistic activity (Bialystok, 2001; Bourdages et al., 2021). This challenge is even greater when the text in question is one the learner has produced themselves: "[the writer] tends to perceive what they believe they have written rather than what they have actually written [...], making them a more effective editor of others' texts than of their own" (Gombert, 1991, p. 151). However, it is in these meaningful contexts of language communication that students ultimately need to maximize their skills.

Another challenge in text revision from a grammatical perspective is the need to ensure both fluidity and accuracy in sentences, drawing on various content knowledge. While many grammatical exercises focus on isolated content (such as past participle agreement), the contexts of writing and revision require the retrieval and integration of multiple grammatical elements, such as comma usage, the choice of relative pronouns, and spelling rules (Flower et al., 1986; Myhill, 2005). To better align the source and transfer tasks, learning activities should present learners with combined grammatical content, leading to more authentic and contextualized learning experiences. "While traditional parsing exercises generally fail to improve students' writing, there is a growing body of empirical evidence indicating positive effects of contextualized grammar teaching on writing development" (e.g., Fearn and Farnan, 2007; Fontich, 2016; Jones et al., 2013; [...] Watson & Newman, 2017; cited in Van Rijt et al., 2019).

2.3 Digital tools and feedback

In the field of education, feedback is defined as a process through which learners receive information about their work, enabling them to recognize the similarities and differences between the standards expected for a task and the quality of their own performance, with the aim of improving future work (Boud & Molloy, 2013). In a grammar and writing instruction context, the feedback is essential since it provides the learner with "[…] not only information about performance [in grammatical spelling for instance] and an indication of deviation from the goal, but can also be useful for improving in subsequent similar or more complex tasks." (Bosc-Miné, 2014, p. 317; free translation)

Unlike a resource available in digital format (such as online dictionaries or PDF downloadable exercises), a digital *tool* has been defined in the previous study as a tool that provides immediate feedback to the learner during or following a task (Arseneau & Geoffre, 2023a). Three types of feedback were distinguished. The first is binary feedback, also knows as "knowledge of response" feedback (Bosc-Miné, 2014), which occurs when the digital tool indicates whether the learner's answer is correct or incorrect. The second type of feedback, known as quantitative or "knowledge of performance" feedback (*ibid*), consists of a score (in points, percentage or success rate). The third type of feedback, known as qualitative or "elaborated" feedback (*ibid*), consists of an explanation or metalinguistic clue that clarifies for the learner the grammatical phenomenon at play in the exercise, using metalanguage. These types of feedback can be combined. For example, in an online exercise where the learner is asked to choose between different spellings in a text (type 2 task, see Table 1), the feedback could include three pieces of information: if each choice is correct or not (binary feedback), the rate of correct answers for the entire text (quantitative feedback) as well as an explanation developing on why each answer was correct or not (qualitative feedback).

Elaborated type of feedback is generally known to be more efficient for learning than the two other types (Bosc-Miné, 2014), which includes binary and quantitative feedback. More specifically to language learning, feedback that contains a metalinguistic explanation or clue is said to be more effective and appreciated by learners than other types of corrective feedback (Ammar et al., 2015). Also, the use of metalanguage concepts and terms has greater potential for generalization to other contexts (Fontich, 2016; van Rijt et al, 2019).

2.4 Synthesis and research questions

Building on the previous concepts and assertions, we propose that an ideal learning activity for developing grammatical revision skills, whether in digital or non-digital contexts, should incorporate the following four features:

a) Engagement with longer written materials, such as paragraphs or texts, that convey meaning and make metalinguistic reasoning more challenging. Ideally, these texts should be self-written or peer-written for greater authenticity;

b) Integration of combined grammatical elements, including grammatical spelling, syntax, and punctuation;

c) Inclusion of tasks that target both error detection (type 3 - Identify) and correction (type 5 - Modify);

d) Provision of enriched feedback on the responses, incorporating explanations, metalinguistic terms and cues.

Consequently, when focusing only on digital tools that engage with longer written materials such as paragraphs or texts (a.), our research questions (RQ) are as follows:

1. What grammatical categories of content do the digital tools target? To what extent are these categories addressed in isolation versus in combination by the tools?

2. What types of tasks are emphasized by the digital tools? How frequently are these tasks presented in isolation vs. in combination? Specifically, how are correction, detection, and justification tasks represented among the tools listed?

3. What types of feedback do the digital tools provide? How prevalent are metalinguistic explanations and cues within the tasks offered by the tools?

3. Method

We conducted a study inspired by the systematic literature review methodology (Sacré et al., 2021) and adapted for the study of digital learning tools available online. This study of digital tools is coupled with coding and quantitative and qualitative analysis of the data collected. This study also functions similarly to a benchmark study, serving as a "methodology [that] enables individuals and organizations to think imaginatively about what often constrains our practices and to compare and question, in a structured and analytical way, their own activities with those of other institutions" (Mancuso, 2001, p. 167). The findings could indeed contribute to enhancing the tools and, by extension, the user experience ("UX")—specifically, the learner experience and learning outcomes—much like how a benchmark study using surveys might (Diaz & Young, 2022). However, unlike studies driven by organizational or corporate needs that focus on user practices with digital tools, our research is centered on the features of the existing tools themselves. It systematically evaluates these tools in terms of their alignment with scientific findings and instructional principles.

Conducting a systematic approach type of study, here on digital tools, involves five steps: (1) formulation of the research question, (2) establishment of inclusion criteria, (3) identification of relevant digital tools, (4) data extraction and selection, and (5) data interpretation and synthesis (Gough, 2007; Sacré et al., 2021).

To build on the previous study's examination of online digital tools[1] for learning grammar and revising text in French as a language of instruction (Arseneau & Geoffre, 2023a), we established specific inclusion criteria. These criteria, detailed in Table 2, are based on the teaching purpose, learning domain, type of tool, and access requirements.

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[1] In our definition, a digital learning tool is characterized by the presence of one or more targeted grammatical contents, accompanied by instructions for performing specific tasks, typically on defined linguistic material (e.g., word groups, isolated sentences, paragraphs, or text). Additionally, the tool provides feedback after the task is completed (such as binary responses, scores, or explanations) and includes one or more exercises (or items) that stem from the same instruction and focus on the same content.

	Inclusion criteria	Exclusion criteria
Learning content	Relevant to the 3 grammatical dimensions of sentence grammar: grammatical spelling, syntax, punctuation + grammatical revision of text	Others: lexical spelling, "lexical homophones", vocabulary/lexicon, textual grammar, morphology/phonology
Field	French as teaching language/ L1	French as a second language, or foreign language.
Types of tool	Who provide immediate feedback Aimed at learning targeted objects (above)	PDF exercises that do not give feedback, tools that are not aimed at learning (e.g. text correctors, online dictionaries, etc.)
Access	Free access (without an online account); on free subscription (with creation of an account); on paid subscription or with license purchase.	Access restricted to a group of people (Moodle courses for example)

Table 2. Inclusion and exclusion criteria (from Arseneau & Geoffre, 2022)

To identify relevant digital tools (step 3), we used the keyword combination "grammar*game" (or "*grammaire*jeu*" in French) in the Google search engine from Montreal, Quebec. Google was selected because it was the most widely used search engine globally, including in Canada, at the time of data collection (Statcounter, 2024) and still is nowadays. This makes it a common resource for learners and teachers seeking interactive learning activities and exercises. Although we initially considered using a broader set of keywords to describe content (e.g., agreement, verb) and tool types (e.g., application, software), we quickly found that the "grammar*game" combination alone generated a substantial number of results.

The extraction and selection of data from the digital tools (step 4) were organized using an Excel sheet to compile relevant details, including the tool name/identifier, URL, and the number of exercises/items. Additional information was also noted, such as how each tool was identified (e.g., via hyperlink, secondary source, or access through another website). This stage involved coding phases, with categories based on the inclusion criteria and variables initially proposed by Arseneau and Geoffre (2021). The complete coding grid is available in Appendix 1. The process of evaluating and selecting tools from both the previous and current studies is summarized in Figure 1.
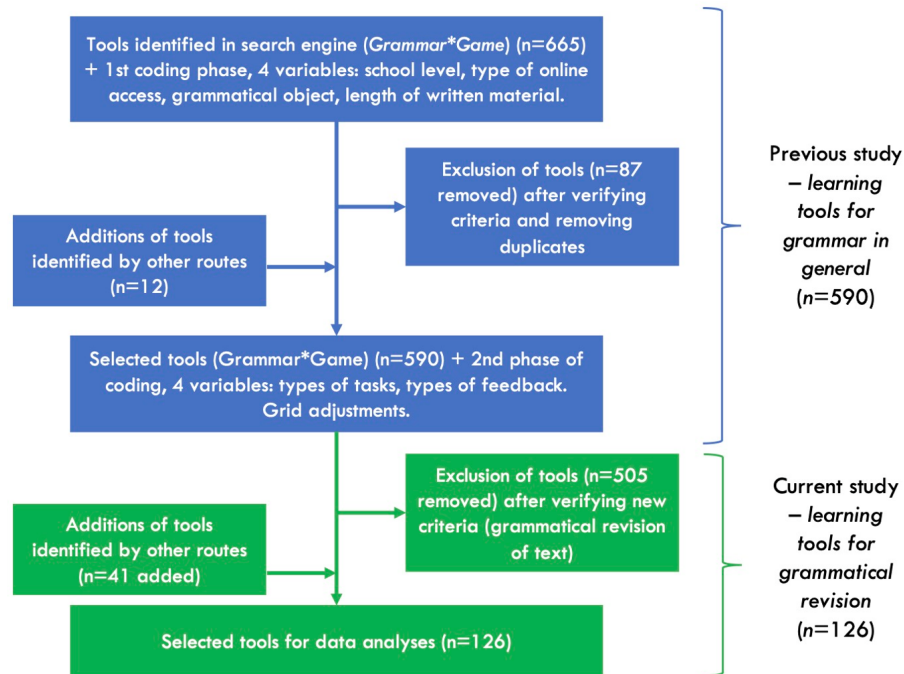
Figure 1. Assessment and selection of digital tools (step 4) (inspired by Cuko et al., 2019)

Based on the coding of the initially listed and analyzed tools (n=590), we selected those that focused on longer linguistic units (paragraphs, texts) for further analysis related to text writing and revision. This selection narrowed the pool to 85 digital tools, which accounts for 14.4% of the original corpus. We then expanded this list by adding 41 new tools, identified by the author, that met the same criteria—specifically those that utilized paragraphs or texts as the linguistic unit, as outlined in Table 2. This brought the total to 126 tools, detailed in Appendix 2. In alignment with the research questions, the newly added tools were coded using the same grid (Appendix 1) to analyze variables such as grammatical content (general categories), type of task, and type of feedback.

4. Results

This section presents results regarding the variables of grammatical content (3.1), type of tasks (3.2) and feedback (3.3).

4.1 Results regarding the grammatical content (RQ1)

Figure 2 presents the percentage of digital tools, according to the type of grammatical content targeted.
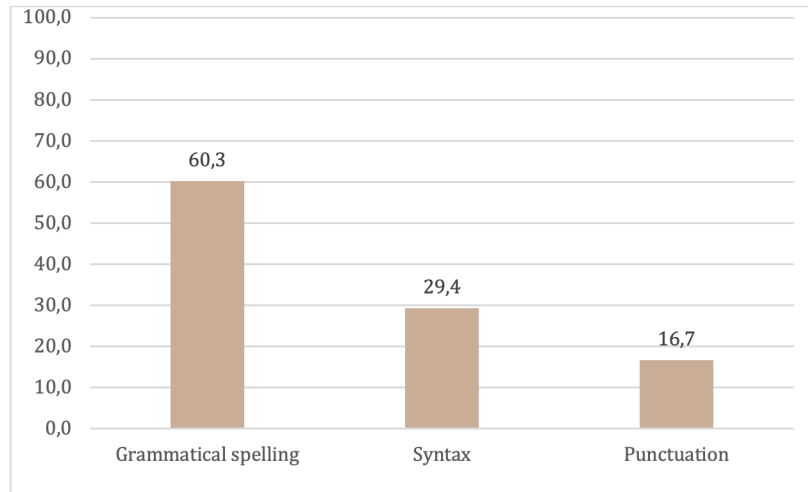
Figure 2. Percentage of digital tools, according to the type of grammatical content targeted (n=126)

Tools focusing on grammatical spelling are predominant, accounting for more than twice the number of tools targeting syntax, which ranks second (29.4% of tools working on para-graphs or texts). Punctuation is rarely addressed, with only one in six tools (16.7%) targeting this aspect.

Content categories can be combined within the same tool. For example, a tool might target both a type of agreement and punctuation marks. The figure presents the percentage of digital tools based on the number of different types of grammatical content they combine.
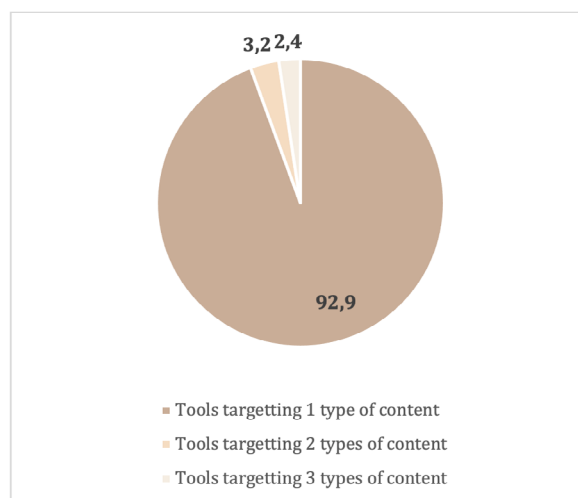
Figure 3. Percentage of digital tools, according to the number of different type of grammatical content
combined (*n* = 126)

As expected with Figure 3, the results indicate that the majority of digital tools designed for grammatical revision on longer linguistic units focus on only one type of content, representing 92.9% of the tools available. A much smaller portion of tools target two (3.2%) or three (2.4%) different types of content simultaneously.

Figure 4 (below) exemplifies a typical tool that operates in a contextualized manner (Jones et al., 2013) – here by using an excerpt from a Jules Verne literary text. However, it focuses solely on isolated content, in this case, grammatical spelling.

Figure 4. Example of a tool that targets one category of content (grammatical spelling)[2]

The user is required to "complete the text" by filling in each gap with the correct form of the article, choosing between masculine ("le," "un") and feminine ("la," "une"). The tool not only isolates the content but also focuses on a specific type of task (type 6 - Produce; see Table 1).

4.2 Results regarding the type of task (RQ2)

Regarding research question 2, Figure 5 presents the percentage of digital tools according to the type of task mobilized by the tool. As for content, a digital tool can mobilize tasks of different types at the same time.

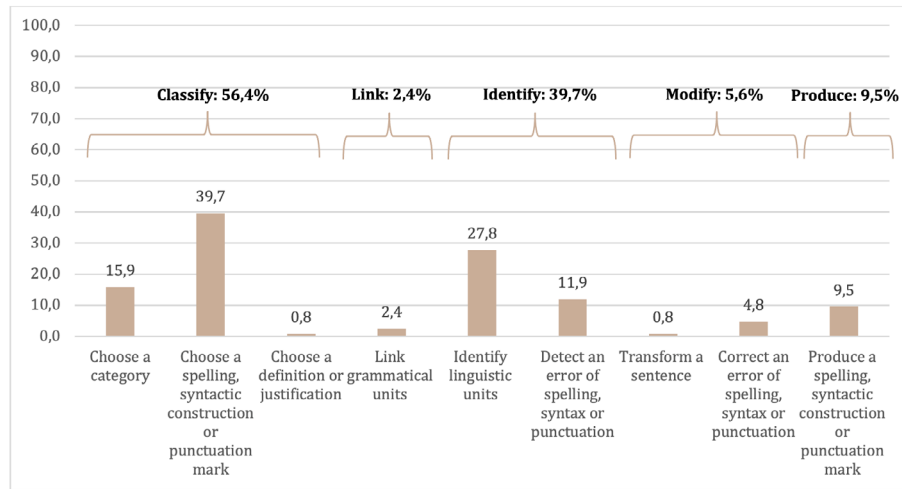[2] Ortholud: https://www.ortholud.com/grammaire/article/index.php

Figure 5. Percentage of digital tools, by type of task mobilised (*n* = 126)

The most frequent task subtype involves choosing the correct spelling, syntactic construction, or punctuation (39.7% - type "Classify"). This often takes the form of a drop-down menu with various options to select from. The second most common task subtype is identifying a linguistic unit (27.8% - type "Identify"), where the learner must, for example, go through the text and click on correctly spelled past participles. The third-ranked task subtype is also a classification task (15.9% - type "Classify"), where learners typically select from a drop-down menu containing conceptual terms related to word categories and syntactic functions. Sub-tasks more directly associated with grammatical revision and writing are ranked further down: detecting an error (11.9% - type "Identify"), correcting an error (4.8% - type "Modify"), and producing the correct spelling, syntactic construction, or punctuation (9.5% - type "Produce"). None of the listed tools require the learner to provide their own definitions or justifications (type "Define and Justify," 0%), although some rare cases do ask the learner to choose from a list of justifications for a given spelling, construction, or punctuation.

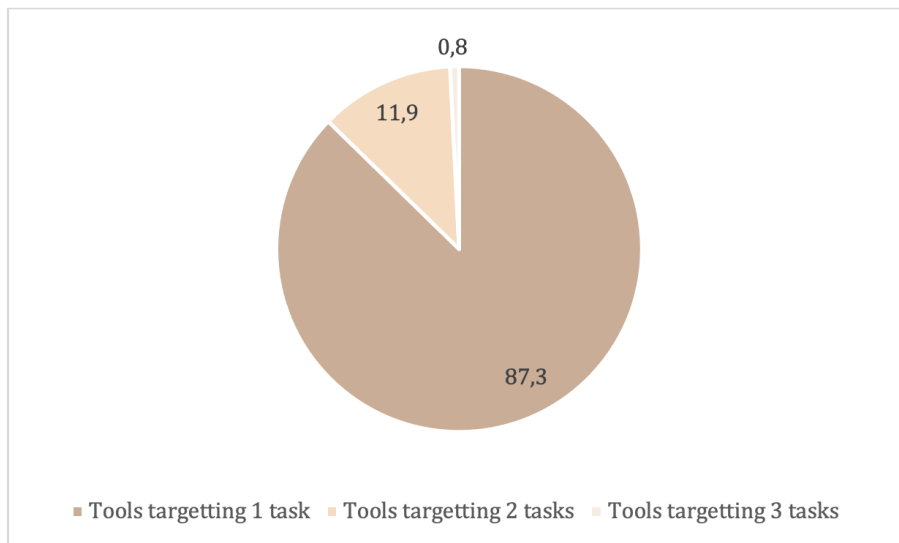Figure 6 presents the percentage of digital tools, according to the different tasks combined.

Figure 6. Percentage of digital tools, according to the number of different sub-tasks combined (*n* = 126)

Regarding grammatical content, the vast majority of digital tools analyzed focus on a single isolated (sub)task (87.3%), as shown in Figure 6. Only about one in ten tools combines two subtasks (11.9%), while the combination of three subtasks is rare (0.8%).

Figure 7 exemplifies the tendency of many tools in the corpus to target one single task. Here, the learner is asked to choose among punctuation marks (dash, comma, colon, semicolon, question mark, etc.) the one that applies at this location in the text.
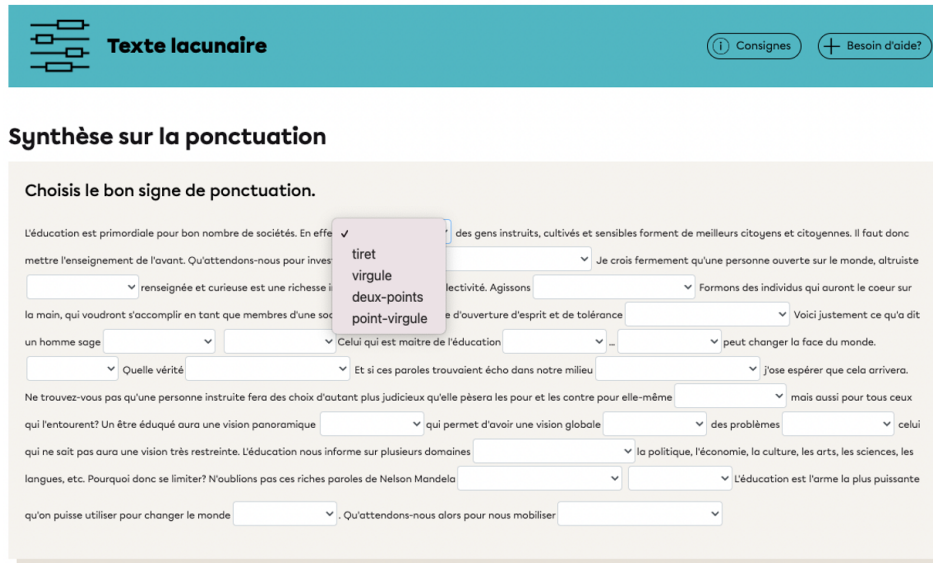
Figure 7. Example of a tool that targets one subtasks (*Choosing spelling, syntactic construction or punctuation mark*)[3]

4.3 Results regarding the type of feedback (RQ3)

Figure 8 present the percentage of digital tools, according to the type of feedback provided.
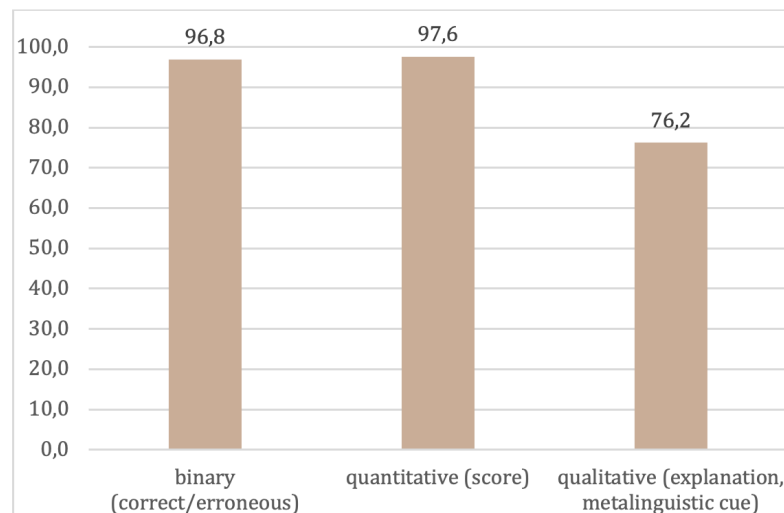
Figure 8. Percentage of digital tools, according to the type of feedback provided ($n = 126$)

[3] Alloprof: https://exercices.alloprof.qc.ca/app/client.php?demande=questionnaire_debuter&projet=11&questionnaire=78

The three types of feedback are highly represented in the tools listed. Almost all of them present quantitative score (97.6%), followed closely by binary feedback (96.8%). As for qualitative feedback, more than 3 tools in four present explanations or metalinguistic cues.
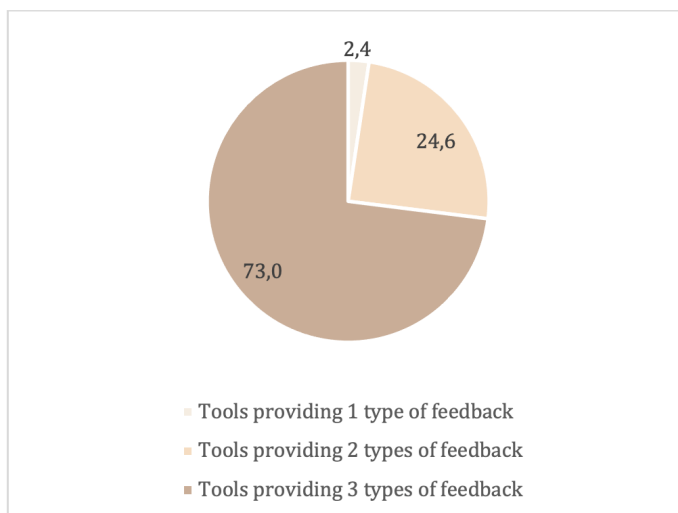

Figure 9. Percentage of digital tools, according to the number of feedback types provided (n = 126)

Consequently, the tools' feedback combines in most cases the three types (73%, Figure 9). In one case out of four (24.3%), two types of feedback are combined, and in rare cases (2.4%), an isolated type is featured.

To illustrate the different types of feedback, Figures 10a and 10b below show the feedback provided to a learner when the exercise on punctuation shown previously (Figure 7) is completed. Each item of the exercise is addressed, indicating the learner if the answer was correct or wrong (using green check or red cross), defined as binary feedback. Directly under this indication, qualitative feedback elaborates on the nature of the answer using metalinguistic explanation such as "Good job! A comma is necessary after a connector at the beginning of a sentence.".
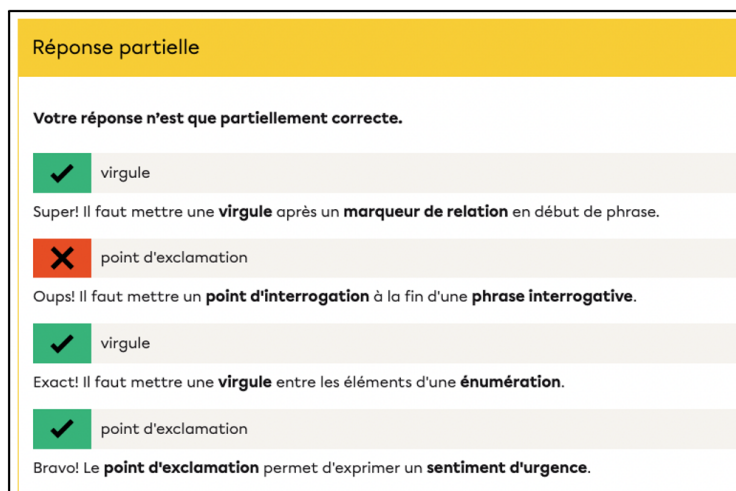

Figure 10a. Example of a tool that provides three types of feedback (binary and metalinguistic shown)[4]

[4] Alloprof: https://exercices.alloprof.qc.ca/app/client.php?demande=questionnaire_debuter&projet=11&questionnaire=78&evaluation=44&mode=

The following webpage provides the learner with an overview of the total score in percentage, which consists of the "quantitative feedback" type.

Figure 10b. Example of a tool that provides three types of feedback (quantitative type shown)

This tool illustrates one of the most complete feedback types found in the corpus.

5. Discussion and conclusion

Regarding RQ1 (content variable), grammatical spelling is less concerned with the pragmatic aspects of a text, whereas syntax and punctuation are more closely linked to the interaction between sentences and the overall text, particularly in relation to genre (Bazerman, 2009). It is therefore somewhat surprising that only a minority of text-based tools focus on syntax and punctuation (Figure 2). Punctuation, in particular, plays a crucial role in text organization, much like connectors (Favart & Passerault, 2009). However, considering the tradition of writing instruction in French L1, which heavily emphasizes spelling mastery, these results become more understandable. The historical emphasis on spelling appears to have been carried over into the design of available digital tools for text work, despite the fact that students also struggle significantly with sentence construction and punctuation (Boivin & Pinsonneault, 2018).

Compared to the overall study results on all tools (n=590), the findings showing the isolation of content are somewhat unexpected. Tools that work with any linguistic material, including detached sentences and isolated words, are proportionally more likely to offer integrated work on multiple content areas simultaneously (13.9% vs. 5.6% here). However, it is precisely when working on a complete text, which more closely resembles an authentic communicative situation (reading-writing), that it becomes crucial to engage a variety of concepts. This preparation is essential for students to effectively analyze and control any 'self-produced' linguistic material (Gombert, 1990). During revision, students must critically reread their texts, seeking ways to enhance them, including detecting and correcting all types of errors. If the learner hasn't developed this competency during the source (or learning) task, they will struggle to apply it to their own text, where maintaining an objective distance is even more challenging. This can quickly lead to cognitive overload (Becker, 2006).

Regarding RQ2 (task variable), identifying words of a specific class is crucial for spelling reasoning. To prevent learners from incorrectly applying or 'generalizing' a rule for plural agreement of adjectives and nouns (such as adding -s) to verbs (adding -nt, for example) (Totereau et al.,

1998), it is essential that they can identify a series of words or groups of words with shared characteristics. Therefore, it is both expected and desirable for tools to promote this task (27.8%, Figure 5). Choosing the correct spelling (39.7%) is also important in the grammatical revision process, but the digital environment, with its drop-down menus, can feel artificial compared to authentic writing and revision situations. Conversely, the ability to detect errors in a text and correct them is directly relevant to the revision task. Surprisingly, however, these task subtypes are rarely used (11.9% and 4.8% respectively) compared to others. Proposals that make greater use of these tasks would significantly contribute to developing metalinguistic skills for the control component, potentially leading to the automatization of this knowledge (Bourdages et al., 2021; Gombert, 1990). Ideally, these tasks should be targeted by the same tool in a combined manner, following a detection-correction sequence. Given the low rate of tools that combine tasks (11.9% and 0.8%, Figure 6), this learning context seems to be infrequent.

With the rise of generative AI and language models like GPT-4, integrating AI to introduce "define" and "justify" tasks could be eventually beneficial. Learners could be prompted to provide authentic definitions or justifications, which the system would then process. This approach would enhance the development of metalinguistic skills associated with the analysis component (*ibid*). AI could also enable learners to work on their own texts, offering more detailed feedback on error detection, correction, and justification. On this front, the existing tools already perform well, with 76.2% providing metalinguistic explanations or cues (Figure 8) and 73% offering a combination of three types of feedback (Figure 9).

Is there such a thing as an "ideal tool" among the ones listed?

The study did not reveal an "ideal tool" in the corpus that meets all the criteria for an ideal learning activity aimed at developing grammatical revision skills in both digital and non-digital contexts (section 2.4). However, the tool depicted in Figure 11 below does include some crucial features: a sequence of detection and correction tasks on a substantial piece of written material. The text, presented as a detective story, contains various grammatical errors, such as verb agreement and past participle agreement. The learner (or "player") is tasked with clicking on words containing errors. If the detection is accurate, a window prompts the learner to correct the spelling and validate the change. The feedback provided is immediate and binary (indicating whether the correction is correct), with a global score given at the end.
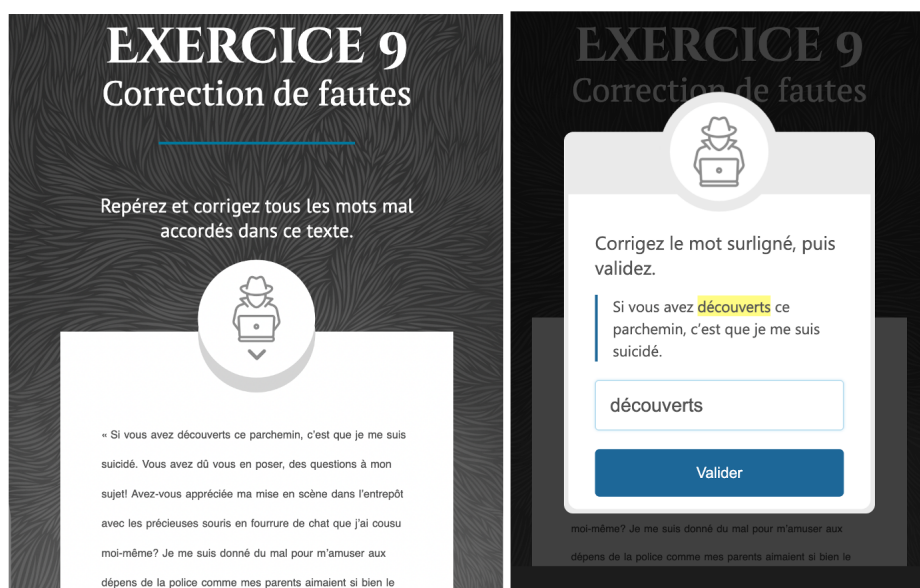
Figure 11. Screen shots of a tool that present many features for efficient grammatical revision learning[5], steps of detection and correction of spelling errors

An ideal tool, based on the established variables and criteria, would feature the same task ("find and correct all the words with agreement errors," free translation). However, the text would include not only spelling errors but also syntactic and punctuation errors. Additionally, the feedback would be more comprehensive, offering metalinguistic explanations that identify the source of the problem using grammatical concepts, as shown by the general results (73% of tools, Figure 8). Furthermore, with the integration of AI language models, learners could be prompted to enter their own justifications using relevant concepts and rules, which would then be evaluated by the system. This approach would foster metalinguistic development in both the control (detection-correction) and analysis (justification) components.

Some pedagogical implications of the findings

It is clear that learning French L1 grammar and developing grammatical revision skills require teaching and instruction that cannot be fully replaced by available digital tools. Effective learning activities must simultaneously integrate various types of content, tasks, and feedback to strengthen grammatical revision skills (Arseneau & Geoffre, 2023a) and to help students "[make] connections between a linguistic feature and its effect in writing" (Jones et al., 2013, p. 1242). The analysis of the 126 tools reveals a tendency to work in isolation, highlighting gaps in this area. Additionally, metalinguistic discussions and verbal interactions that involve justifications are crucial for grammar and revision learning (Nadeau & Fisher, 2006; Fontich, 2016; Myhill et al., 2013). However, facilitating these interactions is not easily achievable in a digital environment.

Given the motivational and instructional strengths of certain digital tools, such as the immediacy of feedback, integrating selected learning games both inside and outside the classroom

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[5] https://accords.ccdmd.qc.ca/module4/accord_participes_passes_particuliers_009.html

learning activities could be beneficial. For example, to compensate for the lack of justification and verbalization typically elicited by these tools while still taking advantage of immediate feedback, a teacher might use the tool shown in Figure 11 for detecting and correcting spelling errors, but in dyads or groups. Students would negotiate spelling issues and reach a consensus to achieve the best possible score, since collaborative writing and revision are known to enhance grammatical accuracy (Blain & Lafontaine, 2010; Storch, 2005). In this collaborative setup, one team member could be assigned the role of noting down questions or items to clarify with the teacher if the tool's feedback lacks sufficient explanation. Similarly, the teacher could introduce a non-digital activity like "cooperative error hunting" (Arseneau et al., 2018), where students work in cooperative groups, competing in a tournament to detect and correct various types of errors in a text, as well as provide accurate metalinguistic justifications to increase their score.

Limitations and future research and development

This study has its limitations. We only used 2 keywords into the Google search engine from Quebec in the previous study. The new tools added during this analysis (see Method) were already known to the author, which may not represent other tools that became available online between the initial study and the present one. The results from any search engine query are not standardized; they are influenced by factors such as the time span covered, website referencing ("search engine optimization" or SEO), and the algorithms that identify and rank the results. However, this study examines 126 referenced tools, providing a broad overview of the digital tools available for grammatical revision, accessible not only from Quebec but also from France and other parts of Europe.

Regarding future research, it appears that very few empirical studies have examined the impact of specific tools on the learning of grammatical concepts and their application in writing within French L1 instruction. Naturally, the lack of impact studies also implies a lack of implementation studies and empirical data on how teachers and students may or may not engage with these tools. Before conducting impact studies, it would be necessary to develop a tool deemed optimal and potentially effective, based on variables and principles like those highlighted in this contribution. The development and research processes should go hand in hand to optimize online resources and improve the learner's experience.

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Appendix 1. Coding grid (translated from Arseneau & Geoffre, 2023a)		
Variables	**Categories**	**Coding subcategories**
Linguistic unit (5)	Word, phrases or subordinate clause (excluding graphic sentence)	
	Detached (isolated) sentence	
	Paragraph	
	Text (two or more paragraphs)	
	Conceptual question (no linguistic unit to work on)	
Grammatical content (3)	Grammatical spelling (3)	Agreements
		Conjugation
		« Homophones »
	Syntax (5)	Types et forms of sentences
		Sentence junctions (coordination, subordination, juxtaposition)
		Grammatical categories, groups and syntactic functions
		Syntax analysis tools (syntactic manipulations, basic sentence)
		Other syntax contents (e.g., tense concordance, anacoluthe)
	Punctuation (1)	Punctuation marks
Type of task (8)	Sort (1)	Sort linguistic units (words, groups of words, sentences, etc.) without given categories
	Classify (3)	Choose category
		Choosing spelling, syntactic construction or punctuation mark
		Choose definition or justification
	Identify (2)	Identify linguistic units (e.g. words, groups of words, classes, functions, …)
		Detect an error of spelling, syntax or punctuation
	Link (1)	Link grammatical units (e.g., agreement trigger with receiver; interrogative sentence with corresponding declarative sentence)
	Modify (4)	Transform a sentence (type and/or form; words in order)
		Manipulate a sentence (syntactic manipulation)
		Reconstruct the basic sentence
		Correct an error of spelling, syntax or punctuation
	Produce (2)	Produce a spelling, syntactic construction or punctuation mark (with or without constraint)
		Produce a syntagmatic representation (syntactic tree)
	Define (1)	Provide a definition for a grammatical concept
	Justify (1)	Justify an answer or a spelling, syntactic construction or punctuation marking
Retroaction type (3)	Binary retroaction (correct or incorrect answer)	
	Quantitative retroaction (points, percentage or success rate)	
	Qualitative retroaction (explanation or metalinguistic clue)	

Appendix 2. Digital tools analyzed (*n*=126)

Publishers and URLs[6]	Number of tools identified for each[7]
Ortholud (https://www.ortholud.com/index.html)	23
Bescherelle (https://www.bescherelle.com/nos-entrainements-en-ligne/)	1
Alloprof (https://www.alloprof.qc.ca/)	44
Fondation Paul-Gérin-Lajoie (https://dictee.fondationpgl.ca/audio/dictee/)	2
Centre collégial de développement de matériel didactique (CCDMD) (https://www.ccdmd.qc.ca/fr/)	50
Clic ! Ma classe (https://clicmaclasse.fr/)	2
Classe de Florent (https://classedeflorent.fr/index.php)	1
L'instit (https://www.linstit.com/)	3
Total	**126**

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[6] Order of appearance during keyword search. General URL at time of data collection; some pages may have been moved.

[7] A tool generally contains several exercises (or items). They are considered to be a single tool when they are based on the same instructions, involve the same task(s) and relate to the same concepts (see definition of tool in footnote on page 7).