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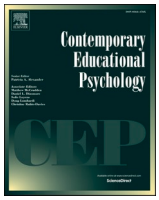

Writing quality from different latent profiles of revision subprocesses in upper-primary students

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ABSTRACT

Text revision is a complex process involving various subprocesses such as error detection, diagnosis and correction. These processes focus on various levels of text, from editing mechanical errors to substantial changes. The present study was designed with two main goals. First, to analyze the existence of homogeneous groups of upper-primary students according to how much they use the different revision subprocesses and their focus, assessed through a specifically created revision task. The distribution of these profiles was analyzed for individual characteristics, such as grade and gender. The second goal was to explore relations between the profiles in terms of text quality. 834 upper-primary students (age 9–13, 4th–6th grade) participated in the study. Students were asked to write a story to assess their narrative writing performance and to revise a prepared narrative text to detect, diagnose and correct six mechanical and six substantive errors. A four-profile model exhibited the best fit, classifying students as poor, mechanical, substantive and good reviewers. A gender effect was observed with more boys than girls in the poor reviewer profile, and more girls than boys in the good reviewer profile, with no effects of gender for the other two profiles. The results also indicated a clear progression in revising skills through schooling, with a higher percentage of poor reviewers in fourth-grade, mechanical reviewers in fifth-grade and good and substantive reviewers in sixth-grade. Finally, a relationship was found between text quality and student reviewer profiles, with poor reviewers writing lower quality texts and good reviewers writing higher quality texts. The identification of different revision profiles in upper-primary students has important theoretical and educational implications.

1. Introduction

The critical role of writing in society is undeniable. Academic, social, and workplace environments require proficient writing. However, the acquisition of the writing competence places multiple cognitive demands on the writer. According to the Not-So-Simple View of Writing (Berninger & Chanquoy, 2012), it involves the recurrent, combined activation of low-level transcription skills (e.g., handwriting and spelling processes) and high-level cognitive skills, such as planning and revising. Activation of these processes occurs under the constraints of the capacity of working memory (McCutchen, 2011). Writers need to shift their attention during composition between the different writing processes to tailor their text to conventional writing standards as well as to the needs of readers. Thus, compositions usually contain shortcomings, varying from errors in spelling, grammar and syntax to weak reader adaptation in text structure, content or coherence, among others (MacArthur, 2012; 2016).

Such imperfect texts therefore require revision skills, which are not only critical for children learning to write, but also for more experienced adult writers. In fact, cognitive models of writing (e.g., Graham, 2018; Hacker, 2018) give revising a central role in both production and refinement of written text, as revision reflects the representation of what a good text entails and the self-initiated actions to improve the quality of a draft. The present study focuses on this revising process, given that

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little research has been conducted on revision specifically with school-aged students (Graham & Alves, 2021).

1.1. Textual revision

Research indicates that elementary students face significant challenges in effectively applying revision skills to their own texts (Cuenat, 2022). For instance, upper-primary students spend only 5 % of their writing time revising their texts (López et al., 2019), most of which is spent reading what they have written. Younger writers' difficulties with revision can probably be explained by the complexity of the revision process.

Fitzgerald and Markham (1987) defined revision as the action of making any changes at any point in the writing process involving the detection of mismatches between intended and instantiated texts, decisions about how to make desired changes, and making the desired changes (p. 4). According to this definition—and the major models of writing and revision (e.g., Bereiter & Scardamalia, 1987; Hayes, 2012; Flower et al., 1986)—revision includes the three subprocesses of detection, diagnosis and correction. Detection requires rereading the text-so-far to find any mismatches between the written text and the writer's initial representation of the text. Diagnosis requires deciding what needs to be changed. Finally, the writer makes the actual change. These revision subprocesses were tested by Scardamalia and Bereiter's with developing writers (1983). According to their CDO model, writers first compare (C) the text to identify problems (detection), then diagnose (D) problems, and finally operate (O) to improve the text (correction). These processes are applied recursively during revision, establishing what the authors called revision cycles.

However, it is important to bear in mind that, despite the theoretical relation between these processes, they may be only loosely connected. One reason for this lack of connection may be that students lack the knowledge and skills involved in implementing each process. Thus, while detection might rely heavily on perceptual skills, as well as reading comprehension and knowledge of writing conventions (Hayes, 1996), diagnosis would require analytical skills and knowledge to understand why a particular part of the text is problematic and what specific changes are needed (Bereiter & Scardamalia, 1987). Finally, correction will require the practical writing skills needed to make the changes (Flower et al., 1986). Consequently, a student might have the practical skills to correct an error once identified by someone else but lack the perceptual or analytical skills to detect or diagnose it themselves. These differences in skills and knowledge may mean one or more subprocesses being skipped or done improperly. Because mastery of the different revision subprocesses would increases students' chances of success revising their texts, it is important to explore their difficulties with these processes.

1.2. Revision subprocesses

Researchers have explored the intricate relationships between revision subprocesses, aiming to provide a comprehensive understanding of their interaction and mutual influence. Besides the research to date being limited, it has indicated an unclear relationship between the different subprocesses. Instead, there appear to be various patterns of interaction between them. For instance, during revision, students have been found to be able to detect errors without being able to diagnose (e.g., Hayes et al., 1987; Rahma & Zen, 2023) or correct them (e.g., Beal, 1990; Søby et al., 2023). However, other studies seem to suggest that students are only able to detect an error if they have knowledge about how to correct it (e.g., Beal et al., 1990; López et al., 2021). The most representative specific findings in this regard are described below.

Detection and diagnosing. There is some evidence showing that writers can detect problems without being able to define what the problem is (Rahma & Zen, 2023; Søby et al., 2023). According to Hayes et al. (1987), inexperienced writers correctly diagnosed 41 % of the issues they detected in their texts, whereas experienced writers correctly diagnosed 74 % of the errors they had previously detected. The larger difference between detection and diagnosis in younger writers might be due to a lack of metacognitive knowledge which, in general, is poorer in younger writers (MacArthur, 2012). This indicates that primary school students may have difficulties diagnosing errors even when they have been previously detected by them.

Detection and correction. Studies have shown that writers may have problems correcting the errors they have detected themselves (Søby et al., 2023). For example, Beal (1990) assessed the detection and correction revision skills of upper-primary students and found that they were able to detect problems that they did not know how to solve because they did not have sufficient knowledge or skills to address that particular mistake.

Conversely, some studies have suggested that writers may only be able to detect an error if they know how to correct it. These studies show that when students detect a problem, they usually make correct revisions (Beal et al., 1990; López et al., 2021). It is worth considering though that these results may be related to students only detecting errors that they are confident they can correct. This result was explored by Hacker et al. (1994), who found that error detection did require knowledge of error correction (i.e., knowledge of how to correct is necessary for detection). However, they also found that knowledge of how to correct an error was not sufficient for error detection. The study by Plumb et al. (1994) confirmed this, showing that for high-school and college students, the biggest stumbling block in correcting errors was not knowledge of how to correct them, but rather a failure to detect them.

Previous research has also suggested that younger students struggle more with detecting errors than correcting them (Limpo et al., 2014; Roussel & Boivin, 2021). For example, Limpo et al. (2014) found that upper-primary students were able to correct more errors, both substantive and mechanical, than they were initially able to detect. Beal (1993) also found that if writers were alerted to specific areas of the text that would benefit from revision, they were often able to successfully fix mistakes.

Considering previous research, individual differences might be expected in the relationships between the three revision subprocesses. Understanding these differences could inform instructional design, allowing for targeted instruction tailored to these individual variations. In fact, findings from previous studies have shown that instruction and practice in each subprocess may need to be explicitly addressed to develop comprehensive revision skills (Bereiter & Scardamalia, 1987).

1.3. Nature of the revisions

The nature of the revisions (mechanical vs. substantive) also seems to be a relevant variable. Mechanical revision involves correcting surface-level errors such as spelling, punctuation, grammar, and formatting. In contrast, substantive revision focuses on improving text content and structure. This may involve reorganizing paragraphs for better flow, enhancing clarity and coherence, expanding on arguments, and providing additional evidence to support claims (Chanquoy, 2009).

Some studies report that developing and skilled writers had more problems detecting and correcting substantive errors than mechanical errors (e.g., Butterfield et al., 1994; Hacker et al., 1994). For example, Limpo et al. (2014) assessed the detection and correction skills of students in the final years of primary school. Their study showed that students had more problems detecting and correcting substantive problems, which included aspects such as a lack of information or inconsistencies, compared to mechanical aspects, which included spelling and grammar problems. López et al. (2021) reported similar findings with sixth grade normally developing students. This pattern has also been found in students with learning-disabilities (De La Paz & Sherman, 2013).

1.4. Revision and text quality

Finally, some studies have tried to analyze whether revision skills were related to text quality (Limpo et al., 2014; López et al., 2019). López et al. (2019) studied fifth- and sixth-grade students' writing processes through analyzing think-aloud protocols collected during a writing task done in pairs. Analysis of the revision process showed that students made very little use of detection and correction subprocesses either at the mechanical or substantive level, and that when they did, it did not produce an improvement in the quality of their text. Limpo et al. (2014) assessed the predictive value of revision skills considering the nature of revisions (i.e., mechanical detection and correction of mechanical and substantive errors) on textual quality in students in grades 4 to 9. This study assessed students' revision skills by having them revise a text created by the researchers that contained various mechanical and substantive errors. The authors found that none of the mechanical or substantive detection and correction skills predicted text quality in upper-primary students. Only substantive correction was found to contribute to text quality in students in the first few years of secondary school.

This result is consistent with previous studies in which revision just led to improvements in text quality at the end of secondary school, when students focused on substantive revisions (Berninger et al., 1996). According to those results, substantive revision is what seems to have had a positive effect on the quality of students' texts. In fact, one of the reasons that could explain why primary school students' revision is not effective is that these students tend to focus their revisions on mechanical rather than substantive aspects, even though mechanical aspects do not influence overall text quality (Graham, 1997; Graham et al., 1993).

1.5. Writing profiles

Previous research indicates that students may differ in their use of the different revision sub-processes as well as focusing those processes on mechanical or substantive revisions. This suggests that there may be different writing revision profiles, which may be related to their writing proficiency. Profiles in the field of writing have begun to be identified in recent years, although there is little research to date. "Profiles of Writing" refers to detailed descriptions or categorizations of a person's writing skills (e.g., revision skills) (Van Waes & Schellens, 2003). By analyzing these profiles, educators and researchers can understand writers' strengths and weaknesses and provide targeted support to improve their writing abilities.

Studies done so far suggest that there are different profiles of writers from the first few years of primary school. For example, Coker et al. (2018) explored the writing profiles of first-grade students by assessing their spelling, sentence writing fluency and writing achievement. The researchers used latent profile analysis to group the students into five profiles labelled At Risk, Low Fluency, Low Writing, Average, and Above Average, with the at-risk students producing the lowest quality texts. Similarly, a recent study identified different writer profiles in upper-primary students considering a variety of writing-related variables, including students' cognitive processes linked to planning (Troia et al., 2022). A five-profile model had the best fit statistics and classified students as Globally Weak, At Risk, Average Motivated, Average Unmotivated, and Globally Proficient, with the first two groups (i.e., Globally Weak and At Risk) producing the lowest quality texts. Thus, identification of different writing profiles indicates that students exhibit distinct patterns of writing-related strengths and weaknesses that require comprehensive yet differentiated instruction to address writing skills to produce desirable outcomes.

However, to our knowledge, no studies have attempted to analyze writer profiles in terms of revision skills. This seems to be especially important in the early years of primary school, where the ability to revise seems to emerge between fourth and sixth grade (Berninger et al., 1996). Examining latent profiles in the revision process would allow a thorough analysis of this process in terms of the different associated revision sub-processes (i.e., detection, diagnosis and correction)—which have not always been considered when dealing with revision—and in terms of the nature of the revision (i.e., mechanical or substantive). The results from this analysis could indicate significant differences in how students use their revising skills, with significant implications for instruction.

1.6. The present study

The present study was designed with two main aims. Firstly, to determine if there were homogeneous groups of individuals based on their use of revision subprocesses and the nature of the revisions (profiles of writing revision subprocesses). Given that the subjects in this study were children in 4th to 6th grade, the makeup of these profiles may be affected by the children's age, so grade was included as a covariate (see Fig. 1). We used grade rather than age because developing revision skills requires explicit instruction; it does not develop naturally in students, as descriptive and instructional studies in this field have shown (e.g., Limpo et al., 2014; López et al., 2021).

In the absence of previous studies exploring students' revision profiles on which to base hypotheses, we can only state that we expect there to be groups of subjects with different combinations of the use of mechanical and substantive revision subprocesses.

The second goal focuses on studying potential differences between the profiles in terms of writing quality. In this second objective, the aim is to explore the extent to which different profiles are associated with different levels of writing quality. As in the first aim, without data from previous studies, we hypothesize that the higher the level of substantive skills in the profile, the better the quality of students' texts (Limpo et al., 2014).

Finally, based on these goals, the study aimed to address the following research questions.

Question 1 What latent profiles are observed for upper-primary students based on their use of revision subprocesses and the nature of the revisions?

Question 2 How does student performance in narrative writing, determined by text quality, vary by latent profile?

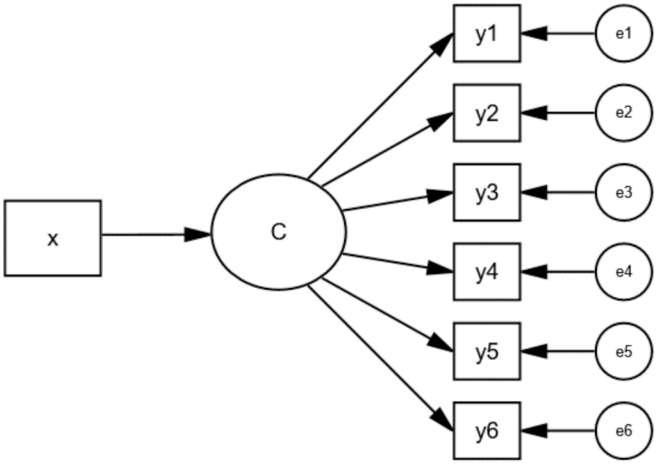

Fig. 1. *Latent Profile Analysis of Writing Revision Subprocesses (with grade level as covariate). Note*: C (latent variable: classes); y1 to y6 (observed variables: mechanical detection subprocesses –y1-, mechanical diagnosis subprocesses –y2-, mechanical correction subprocesses–y3-, substantial detection subprocesses –y4-, substantial diagnosis subprocesses –y5-, substantial correction subprocesses –y6-); x (covariate: grade); e1 to e6 (measurement errors).

2. Method

2.1. Participants

The sample comprised 834 Spanish students in 16 fourth-grade (n = 254, 30.8 %), 16 fifth-grade (n = 305; 36.4 %) and 14 sixth-grade classes (n = 275; 32.8 %) in 11 different schools, including 4 public schools and 7 semi-private schools. While public schools are fully funded and managed by the government and semi-private schools operate with a mixed funding model (receiving both government subsidies and private contributions), both types of schools serve similar student populations and follow comparable methodologies and educational practices.

The students were aged between 9 and 13 (M_{age} = 10.5 years, SD = 0.97) with no differences in terms of female students [51.7 % female students; (Z = 0.023, p = 0.912)] (for a detailed description per grade see Table 1). None of the students had any specific educational needs. Similarly, all students demonstrated a suitable level of reading and writing according to the grade they were in. Most students came from families with medium to high incomes as indicated from school data.

In Spain, compulsory education starts at age six with six years of primary school. By the end of primary education, students are expected to write texts with basic grammar and spelling accuracy, correctly sequencing the content, and use writing strategies (e.g., planning and revising strategies). However, teachers often focus on the mechanical aspects of writing rather than higher-level cognitive processes (Sánchez-Rivero et al., 2021).

2.2. Instruments

2.2.1. Revision measure

A test based on various writing models was created to assess the revision subprocesses of error detection, diagnosis, and correction, following Limpo et al. (2013; 2014). Instead of revising their own texts, students were asked to revise a researcher-created narrative text (see Appendix A in Supplementary Material), with the aim to evaluate their revision skills independently of initial text quality (Butterfield et al., 1994). This text included six mechanical and six substantive errors, adapted from a study with Portuguese upper-primary students (Limpo et al., 2014). The text was translated into Spanish and reviewed by three writing experts to match errors typically made by Spanish primary students (for a description of each error see Appendix B in Supplementary Material). Primary language teachers confirmed the text's suitability for upper-primary students.

Students had three tasks to accomplish in a sequence. In the first phase, students were given the narrative text and were asked to underline the mistakes they found in the text and to number them. They were told that there were twelve errors they had to detect. In the second phase, students were asked to thoroughly describe each of the errors they had previously detected. The students were given about 25 min for these two phases. Then, we collected the students' materials and started the third phase; the students were given a worksheet with the same text with all errors underlined, numbered and described. Students were asked to correct the mistakes. Students were given about another 25 min for this correction phase. The whole test took a single session lasting about 50 min.

Table 1
Data for the Participating Students by Grade.

	Grade		
	4th	5th	6th
Gender			
Female	116	164	151
Male	138	141	124
Age (in years)			
M (*SD*)	9.5 (0.52)	10.4 (0.54)	11.5 (0.54)
Range	9–11	10–12	11–13

The revision tasks were scored by four independent raters. The raters had specific training in the field of education as well as previous experience in correcting writing tasks. In addition, they were trained in the evaluation procedure. Students were awarded one point for each correct revision action (i.e., detection, diagnosis and correction) at the mechanical and substantive levels.

Various measures were extracted from the revision task. The number of mechanical errors accurately detected, diagnosed or corrected and the number of accurate detections, diagnoses, and corrections of substantive errors were used as measures of mechanical and substantive detection, diagnosis and correction, respectively (maximum of six points per score). Both the reliability and validity of the measures were acceptable. The Kuder Richardson coefficient (KR-20) suggests acceptable reliability per variable (mechanical detection: 0.63; mechanical diagnosis: 0.64; mechanical correction: 0.48; substantive detection: 0.73; substantive diagnosis: 0.76; substantive correction: 0.65; detection: 0.73; diagnosis: 0.74; correction: 0.72). Confirmatory factor analysis indicated good measurement validity (mechanical detection: $\chi^2(6) = 17.650$, $p > 0.05$, CFI = 0.951, RMSEA = 0.047; mechanical diagnosis: $\chi^2(6) = 14.971$, p > 0.05, CFI = 0.966, RMSEA = 0.042; mechanical correction: $\chi^2(6) = 2.924$, $p < 0.05$, CFI = 1.000, RMSEA = 0.001; substantive detection: $\chi^2(6) = 21.386$, $p > 0.05$, CFI = 0.985, RMSEA = 0.052; substantive diagnosis: $\chi^2(6) = 20.204$, $p > 0.05$, CFI = 0.989, RMSEA = 0.050; substantive correction: $\chi^2(6) = 23.989$, $p > 0.05$, CFI = 0.937, RMSEA = 0.082).

2.2.2. Text quality measure

Students were asked to write a narrative text. They were given a piece of paper for their draft and another for their final text. They had approximately 40 min to complete the task, although none of the students needed all the time to produce their texts. We chose narrative text because children are expected to have acquired the schema by 4th grade (Berman & Slobin, 1994), which may help to reduce possible differences in the quality of students' texts based on what students know about the topic.

Text quality was assessed by two experienced raters (see Appendix C in the Supplementary Material for a detailed description of the assessment criteria). The texts were scored using a method based on anchor texts (e.g., Van den Bergh & Rijlaarsdam, 1986). To select the anchor texts, a random sample of 75 texts was compared and discussed by the raters according to the evaluation criteria. Based on this process, the raters classified the texts into five groups, aiming to identify texts of medium, high, low, very high and very low quality. Then, the raters identified the most representative texts in each category. These five texts were identified as the anchor texts and were accurately described considering the evaluation criteria, related to the organizational structures that are typically associated with written narratives. These anchor texts represented an average score (arbitrarily set at 100), and 1 and 2 SD above and below that mean. In other words, texts could be scored anywhere between 70 and 130 with the anchor texts representing scores of 70, 85, 100, 115 and 130 (see Appendix D in the Supplementary Material to example of the 70 and 130 anchor texts).

All texts were scored by two independent raters—with previous training in the field of educational psychology as well as previous experience in the use of this procedure—under blind conditions. They received specific training for this assessment. At this stage, texts with score discrepancies of more than 10 points were identified for discussion. The raters discussed the discrepancies and reached agreement via moderation of the first author. After this phase, the raters assessed the texts independently. Cohen's weighed Kappa showed good inter-rater reliability for text quality (0.94). The final score for each text was the average of the two raters' scores.

2.3. Procedure

The study was conducted in accordance with The Code of Ethics from the World Medical Association (Declaration of Helsinki), which reflects the ethical principles for research involving humans (World Medical Association, 2013). The Ethics Committee of the Principality of Asturias approved the study (reference: CPMP/ICH/135/95).

Additionally, the following procedure ensured that ethical standards were considered. First, one of the authors contacted all of the school principals in a town in northern Spain and informed them of the aims of the study, asking them to participate. Meetings were held with schools that agreed to collaborate, in which the study and the procedure for data collection were explained. Parents were subsequently informed of the aims of the study via letter. They were given an opportunity to express concerns and to ask that their children's data not be included in the study.

The data was collected over two days within regular Spanish language classes. On the first day, students were asked to write a narrative text. In the second day, students were asked to complete the revision task. Both sessions, in all schools and classes, were led by the same person who was a professional member of the research team with a background in psychology and experience in data collection in the educational context. In addition, to ensure proper implementation of the sessions, the instructor was provided with specific training. Audio of the assessment session was recorded to ensure that the session was implemented as intended.

2.4. Statistical analysis

First, the statistical properties of the variables included in the study were examined. The reliability of the measures was calculated using the Kuder Richardson coefficient (KR-20) and the validity of the measurement using confirmatory factor analysis (CFA). Second, in response to the first aim of the study, a Latent Profile Analysis was performed (Lanza et al., 2003). In mixture modeling, indicator variables are used to identify an underlying latent categorical variable. Using Mplus 7.11 (Muthén & Muthén, 1998–2012), six measures of revision were included in the analysis (i.e., 3 (revision subprocesses) * 2 (type of error) to identify *profiles of writing revision subprocesses*. All six scores were standardized prior to analysis.

Given the potential relationship of grade[1] with the six revision variables, it was included as a covariate in the estimation of the latent classes. The model that best described the relationship between the six measures related to the review subprocesses from the set of finite models was determined by adding successive latent classes to the target model (Nylund et al., 2007). As a rule, the best-fitting model uses an optimal number of classes to describe the relationships between the revision variables making it possible to assign each student to the corresponding profile (Galovan et al., 2018). The criteria used to select the best model included the formal adjusted maximum likelihood ratio test from Lo, Mendell and Rubin–the LMRT Test, the Akaike information criterion (AIC), the Schwarz Bayesian information criterion (BIC) and the sample size adjusted BIC (SSA-BIC), as well as the entropy value and the size of each subgroup or class (Galovan et al., 2018; Nylund et al., 2007). Significant *p*-values associated with the LMRT Test indicate significant improvement in model fit compared to the solution with one fewer class. Lower values of AIC, BIC and SSA-BIC indicate better model fit. In order to determine the classification accuracy of the selected model we calculated the posteriori probability and the entropy statistic. This statistic takes values between zero and one, the closer it is to one, the more accurate the classification (values higher than 0.80 indicate good classification quality; Celeux & Soromenho, 1996). Additionally, gender was considered in order to determine the percentage of male and female students in each profile.

To address the second goal of the study, in the same Latent Profile Analysis model with covariation, the AUXILIARY option was used with the "e-setting" to analyze the relationship between the identified profiles and the latent variable (i.e., text quality). Where testing (χ^2) indicated statistically significant differences between classes, or profiles, pairwise comparisons of text quality means were performed.

In addition, ancillary analyses were performed to assess the predictive role of age on text quality within each profile through regression analysis. The criteria established by Cohen (1988) were used to assess the size of the mean differences (small: $d = 0.20$; medium: $d = 0.50$; large: $d = 0.80$). For all analysis, maximum likelihood estimation with robust standard error (MLR) was used. Materials and analysis code for this study are available by emailing the corresponding author.

3. Results

3.1. Descriptive statistics

Table 2 provides descriptive data and Spearman's Rho correlations between the variables included in the study. All correlations were statistically significant at $p < 0.001$. There was a positive relationship between the different revision subprocesses, and between those subprocesses and text quality. All variables exhibited a normal distribution. In any case, the use of MLR ensures consistent estimates.

3.2. Latent profile analysis

3.2.1. Selection of the best model of writing revision subprocesses

Several latent profile models were fitted. We assumed that variances could differ between indicators within each group, with the restriction that they should be equal between groups. Furthermore, independence between indicators, both within and between groups, was imposed as a constraint. As mentioned previously, the grade was included as a covariate in fitting the class models. The results are presented in Table 3.

Model fitting was stopped at the five-class model. Based on the results (see Table 3) and the evaluation criteria, the four-class model was chosen as the best fit because, although the AIC, BIC, and SSABIC fit statistics indicated that the five-class model was better than the four-class model (they had lower values), the LMRT Test for the five-class model was not statistically significant (suggesting that the five-class model was not better than the four-class model, and that the four-class model was more parsimonious than the five-class model). The effectiveness of this model in classifying individuals into classes was good (entropy = 0.868). Moreover, none of the four classes contained fewer than 5 % of the subjects. Finally, as indicated above, the models were fitted with grade as a covariate. When estimating the chosen model (four classes) without this covariate, the data indicated that grade did not significantly affect the results of the model fit. In particular, the assignment of subjects to classes did not change (only 4 of the 834 students moved, from class 3 to class 4).

3.2.2. Description of the four latent profiles model

Table 4 provides relevant information on the four-class model. Fig. 2 depicts the levels of the six revision subprocesses in each of the four identified profiles. All six variables were standardized ($M = 0$; $SD = 1$).

Four profiles of students were identified. We generally refer to these profiles as "*Writing Revision Profiles*". In practice, this implies minimal intra-group and maximal inter-group differences. The percentage of students in each profile was very similar (between 22 % and 28 %) and the probability of actually belonging to the group to which they were assigned was also very high (class 1: 0.95; class 2: 0.93; class 3: 0.94; class 4: 0.95). In terms of describing the identified profiles, 195 of the 834 students were assigned to class 1 (23.38 %). They shared scant use of the three revision subprocesses at both mechanical and substantive

[1] The grade variable was considered in all analyses except for the ancillary analyses where age was considered in response to the reviewer's suggestion.

Table 2
Descriptive Statistics and Spearman's Rho Correlation Matrix.

	1	2	3	4	5	6	7	8
1. GL	–							
2. MDe	0.180	–						
3. MDi	0.184	0.960	–					
4. MC	0.305	0.329	0.367	–				
5. SDe	0.215	0.346	0.372	0.349	–			
6. SDi	0.208	0.385	0.424	0.388	0.920	–		
7. SC	0.321	0.320	0.365	0.650	0.487	0.529	–	
8. WQ	0.405	0.370	0.378	0.413	0.356	0.385	0.486	–
M	5.02	3.14	3.01	4.61	3.23	2.65	3.79	97.51
SD	0.80	1.32	1.37	1.62	1.88	1.91	1.89	16.54
Asym.	−0.04	−0.24	−0.25	−1.28	−0.17	0.09	−0.67	0.14
Kurt.	−1.43	−0.34	−0.46	0.87	−1.08	−1.15	−0.84	−0.92

Note: $N = 834$. GL (grade level: 4th to 6th), MDe (mechanical detection), MDi (mechanical diagnosis), MC (mechanical correction), SDe (substantive detection), SDi (substantive diagnosis), SC (substantive correction), WQ (writing quality). All correlations are statistically significant at $p < 0.001$.

Table 3
Fit Statistics for the Models of Writing Revision Strategies.

	Two Classes	Three Classes	Four Classes	Five Classes
AIC	12564.047	12036.328	11774.266	11495.051
BIC	12658.572	12168.663	11944.410	11703.005
SSABIC	12595.059	12079.744	11830.087	11563.276
Entropy	0.875	0.884	0.868	0.862
LMRT Test	1640.204***	533.799***	571.745**	289.829^{ns}
$n < 5$ %	0	0	0	0

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, *ns* = not significant; AIC = Akaike Information Criterion; BIC = Schwarz Bayesian Information Criterion; SSA-BIC = BIC adjusted for the sample size; LMRT-Test = adjusted Lo-Mendell-Rubin maximum likelihood ratio Test.

levels; we called this profile of students "Poor Reviewers", characterized by a low level of revision actions. This group has significantly more boys than girls (117 boys [60 %], 78 girls [40 %]; $Z = 3.95$, $p < 0.001$). In contrast, 28.30 % were assigned to class 4. These students shared frequent use of all the mechanical and substantive revision subprocesses (especially those for detecting and diagnosing errors), leading us to call them "Good Reviewers". Most of this group were girls (97 boys [41.1 %], 139 girls [58.9 %]; $Z = -3.87$, $p < 0.001$).

Students in the remaining two classes were characterized by an acceptable level of revision, although they demonstrated a clear tendency towards one type. More specifically, students assigned to class 2 (26.26 %) preferentially used mechanical revision subprocesses, whereas students assigned to class 3 (33.06 %) indicated a preferential focus on substantive revision. For this reason, we called students in class 2 "Mechanical Reviewers" and those in class 3 "Substantive Reviewers". In both groups there were no statistically significant differences between the numbers of girls and boys: mechanical reviewers (100 boys [45.7 %], 119 girls [54.3 %]; $Z = -1.82$, $p > 0.05$) and substantive reviewers (87 boys [47.3 %], 97 girls [52.7 %]; $Z = -1.04$, $p > 0.05$).

The data regarding the relationship between the profiles and students' grades indicate significant differences in terms of grade membership within each profile: poor reviewers [100 (51.3 %) 4th, 65 (33.3 %) 5th, 30 (15.4 %) 6th)], mechanical reviewers [65 (29.7 %) 4th, 93 (42.5 %) 5th, 61 (27.8 %) 6th)], substantive reviewers [35 (19 %) 4th, 65 (35.3 %) 5th, 84 (45.7 %) 6th)], and good reviewers [57 (24.2 %) 4th, 79 (33.5 %) 5th, 100 (42.3 %) 6th)]. In summary, these data suggest that the higher the student's grade, the larger the percentage who focus on substantive revision and the smaller the percentage who focus on mechanical revision ($rho = 0.258$, $p < 0.001$).

3.3. Writing revision profiles (WRP) and writing quality (WQ)

To address the second goal of the study, the extent of the association between WRP and WQ was calculated. The results are provided in Table 5 (descriptive statistics) and Table 6 (differences between pairs of profiles).

The data show statistically significant differences between the four WRPs, both in multivariate terms (overall test)—with a large effect size ($d > 0.80$)—and at the level of pairwise comparisons—with large or very large differences when comparing poor reviewers with any of the other three groups (especially those using substantive strategies), moderate differences (Good Reviewers vs. Mechanical Reviewers), or small differences (Substantive Reviewers vs. Mechanical Reviewers and Substantive Reviewers vs. Good Reviewers). As Tables 5 (means) and 6 (mean differences) show, the lowest writing quality was from the poor reviewer profile, followed by the mechanical reviewer profile, irrespective of the grade. Students who frequently used both types of subprocesses (good reviewer profile) demonstrated the highest quality of writing.

The analysis of the patterns in the use of revision subprocesses reveals their relative contribution to text quality. Implementation of mechanical detection and diagnosis subprocesses was associated with lower-quality texts (mechanical reviewers), though better than not using them at all (poor reviewers). The use of substantive processes, whether associated with all mechanical revision subprocesses (good reviewers) or only the correction of such errors (substantive reviewers), was related to writing higher-quality texts than the other two revision profiles, with students who used all processes achieving the highest scores in text quality.

3.4. Ancillary analysis

Table 7 provides the descriptive statistics (means and standard deviations) for each group or profile, corresponding to the quality of writing according to the age of the students. The results of the regression analysis indicated a linear, significant relationship between age and writing quality: poor reviewers ($b = 0.339$, $t = 4.973$, $p < 0.001$, $R^2 = 0.115$), mechanical reviewers ($b = 0.199$, $t = 2.974$, $p < 0.01$, $R^2 = 0.035$), substantive reviewers ($b = 0.296$, $t = 4.171$, $p < 0.001$, $R^2 = 0.083$), and good reviewers ($b = 0.286$, $t = 4.559$, $p < 0.001$, $R^2 = 0.078$). In the four profiles the relationship was linear, positive and statistically significant (the older the student, the better the writing).

4. Discussion

The first goal of this study was to capture the underlying distinct patterns or profiles displayed by upper-primary students based on the different revision subprocesses. Our second aim was to explore the relationship between the specific latent profiles and the quality of students' text compositions. We also performed complementary analyses to study the relation between age and writing quality within each of the profiles. The following conclusions can be drawn from the results.

Examining the revision performance of 834 upper-primary students,

Table 4
Statistics of the Four Revision Writing Profiles.

	Estimates	S.E.	*t*	*p*	LO5%	UP5%
Class 1: *Poor Reviewers* (n = 195; 23.38 %)						
MDeS	−1.196	0.087	−13.697	<0.0001	−1.340	−1.052
SDeS	−1.012	0.068	−14.785	<0.0001	−1.124	−0.899
MDiS	−1.253	0.080	−15.733	<0.0001	−1.384	−1.122
SDiS	−1.036	0.053	−19.412	<0.0001	−1.123	−0.948
MCS	−0.671	0.097	−6.906	<0.0001	−0.831	−0.511
SCS	−0.841	0.086	−9.767	<0.0001	−0.983	−0.700
Class 2: *Mechanical Reviewers* (n = 219; 26.26 %)				<0.0001		
MDeS	0.370	0.090	4.092	<0.0001	0.221	0.518
SDeS	−0.652	0.084	−7.727	<0.0001	−0.791	−0.513
MDiS	0.356	0.096	3.728	<0.0001	0.199	0.513
SDiS	−0.668	0.086	−7.796	<0.0001	−0.808	−0.527
MCS	−0.117	0.144	−0.811	0.4170	−0.354	0.120
SCS	−0.255	0.148	−1.722	0.0850	−0.498	−0.011
Class 3: *Substantive Reviewers* (n = 184; 22.06 %)						
MDeS	−0.450	0.068	−6.590	<0.0001	−0.562	−0.338
SDeS	0.779	0.074	10.511	<0.0001	0.657	0.0901
MDiS	−0.392	0.065	−6.075	<0.0001	−0.498	−0.286
SDiS	0.772	0.078	9.923	<0.0001	0.644	0.900
MCS	0.288	0.074	3.889	<0.0001	0.166	0.410
SCS	0.477	0.070	6.770	<0.0001	0.361	0.593
Class 4: *Good Reviewers* (n = 236; 28.30 %)						
MDeS	0.981	0.045	21.677	<0.0001	0.907	1.056
SDeS	0.815	0.077	10.529	<0.0001	0.687	0.942
MDiS	0.995	0.045	22.339	<0.0001	0.921	1.068
SDiS	0.854	0.082	10.437	<0.0001	0.719	0.989
MCS	0.427	0.060	7.061	<0.0001	0.327	0.526
SCS	0.544	0.058	9.406	<0.0001	0.449	0.639

Note: n (%) are the size of the classes and percentages. LO5% and UP5% are the confidence intervals. MDeS (mechanical detection subprocesses), SDeS (substantial detection subprocesses), MDiS (mechanical diagnosis subprocesses), SDiS (substantial diagnosis subprocesses), MCS (mechanical correction subprocesses), SCS (substantial correction subprocesses).

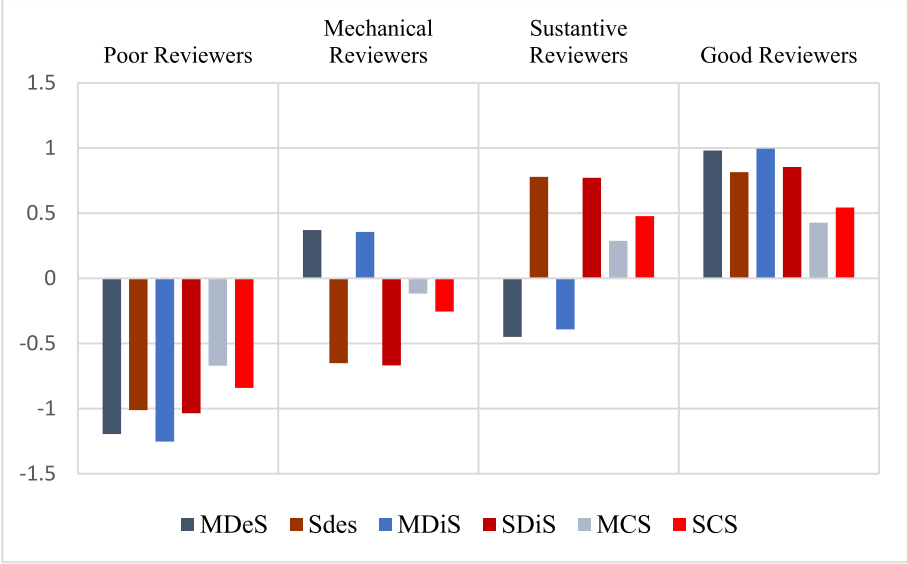

Fig. 2. *Graphical Representation of the Writing Revision Profiles (WRP).* Note: MDeS (Mechanical Detection Subprocesses), SDeS (Substantial Detection Subprocesses), MDiS (Mechanical Diagnosis Strategies), SDiS (Substantial Diagnosis Strategies), MCS (Mechanical Correction Strategies), SCS (Substantial Correction Strategies).

our results indicated four relatively evenly-distributed reviewer profiles in the last years of primary education. We found that revising behavior in this educational stage is not a unitary construct but instead can be described by heterogeneous patterns in the use of revision subprocesses. This is consistent with previous studies where different writing profiles have been found according to different writing-related variables in upper-primary students (e.g., Troia et al., 2022), although none of them considered revision.

We classified our sample of students into four subgroups; poor, mechanical, substantive, and good reviewers. Poor and mechanical reviewers demonstrated below average performance in most or all of the revision variables considered. Poor reviewers exhibited significantly

Table 5
Means and Standard Errors.

	Poor Reviewers	Mechanical Reviewers	Substantive Reviewers	Good Reviewers
Writing Quality				
Mean	85.408	96.996	101.006	105.068
S.E.	1.025	1.041	1.196	1.059

Table 6
Relationship between Writing Revision Profiles (WRP) and Outcome Variables (Text Quality).

	WRP	χ^2	*p*	Cohen's *d*
Text Quality	Overall Test	146.861	<0.0001	0.925
	PR vs SR	96.763	<0.0001	1.171
	PR vs MR	60.797	<0.0001	0.874
	PR vs GR	177.524	<0.0001	1.877
	SR vs MR	6.092	0.0140	0.247
	SR vs GR	6.230	0.0130	0.245
	MR vs GR	29.095	0.0001	0.523

Note: PR (Poor Reviewers), SR (Substantive Reviewers), MR (Mechanical Reviewers), GR (Good Reviewers).

Table 7
Descriptive statistics for each revision profile, corresponding to the quality of writing according to the age of the students.

Profile	Age	*M*	*SD*	N
Poor Reviewers				
	9	79.922	12.734	51
	10	84.738	12.346	82
	11	90.545	13.835	44
	12	95.233	15.313	15
Mechanical Reviewers				
	9	92.203	12.873	37
	10	95.429	14.286	78
	11	100.250	14.825	72
	12	99.967	14.359	30
Substantive Reviewers				
	9	97.429	17.853	14
	10	96.175	15.535	63
	11	102.716	13.082	67
	12	108.833	14.177	39
Good Reviewers				
	9	97.672	12.549	29
	10	100.560	17.037	75
	11	107.711	15.574	76
	12	110.295	13.867	56

weaker performance in all the revising subprocesses for mechanical and substantive revisions, whereas mechanical reviewers showed the same pattern except for mechanical detection and diagnosis. Substantive reviewers, on the other hand, demonstrated good performance in all substantive subprocesses and mechanical correction, with below average levels for mechanical detection and diagnosis. Finally, good reviewers had the highest scores in all the revision subprocesses, at both mechanical and substantive levels. According to the results, it seems that what differentiates the profiles is the use students make of all revision subprocesses (Poor and Good reviewers) or the textual level they focus their revisions on (Mechanical and Substantive reviewers). We found no differential profiles in terms of the use of the different revision subprocesses, which could indicate that these subprocesses develop homogeneously in this educational stage. This result is surprising as research has shown that students differ in the use of the different revision subprocesses, and writers seem to have more problems with error detection than with error correction (Hacker et al., 1994; Limpo et al., 2014). In fact, in all the *Writing Revision Profiles,* the scores for correction were lower than those for detection and diagnosis. This means that, in the context of the present study, students had more difficulties with correction than with detection and diagnosis, which is not consistent with previous studies (e.g., Limpo et al., 2014).

This might be explained by the complex nature of the detection and diagnosis subprocesses. For example, students might have experienced serious difficulties detecting and diagnosing errors in the text, which could have affected their confidence in their revision skills and thus their performance in the correction phase. Self-efficacy is an important predictor of writing performance (Graham et al., 2018) and specifically of revision (Chen & Zhang, 2019). On the other hand, it could be that the characteristics of the revision task, both in terms of the difficulty of the errors included and the time available to complete the task, could have affected the students' performance. This is, however, unlikely, considering that the errors were included considering the typical mistakes that usually appear in student compositions in this age group. Similarly, all students completed the revision task, in each of its phases, within the time limits that were set. This would be consistent with studies which have shown that primary school students spend an average time of one minute revising their texts (López et al., 2019).

The existence of heterogeneous revising profiles has implications for educational practice because it suggests that teachers need to design and implement instructional practices and interventions that match their students' needs. Good reviewers would be considered responsive to instruction and thus simply require ongoing, developmentally appropriate teaching. The situation would be similar for substantive reviewers, given that these students have good revision skills at the substantive level, although they would need instruction in perceptual and analytical skills related to detection and diagnosis of mechanical errors. Students in this group might exhibit lower skills in these two subprocesses than in correction for various reasons. Firstly, students may have higher scores for correction than detection and diagnosis because these two subprocesses might be more complex for them (Limpo et al., 2014), even at the mechanical level. Also, students might underestimate mechanical aspects and overlook them during the detection and diagnosis phase, or it may be that focusing on substantive aspects reduce the resources available for mechanical revision (McCutchen, 2011). In fact, the revision of substantive aspects is a cognitively demanding process for students and consumes a significant portion of their attentional resources (Roussel & Boivin, 2021). However, given that mechanical detection and diagnosis play an important role, students would need to be taught to consider these processes.

In contrast, near to 50 % of the students were classified as poor or mechanical reviewers, who demonstrated below-average performance in revision. This suggests that instruction tailored to these students should focus primarily on promoting all the revision subprocesses. With improved revision skills and knowledge about evaluation criteria that would result from targeted instruction, these students may be expected to be more successful in revising (e.g., Graham et al., 2021; López et al., 2021). In fact, several studies have explored the impact of revision instruction and the results have generally been positive (for *meta*-analyses see Graham et al., 2012). It is also important to consider that problems with revision may be due to different issues such as lacking knowledge of appropriate evaluation criteria or a limited conception of revision as proofreading, lack of audience awareness, deficient reading strategies or problems with self-regulation (MacArthur, 2012). It would therefore be interesting to analyze the causes of revision problems to adapt interventions to these students' needs (e.g., Braaksma et al., 2018).

Additionally, examining the effects of other factors on the reviewing profiles can provide insight about influential non-cognitive factors in revising. It is well documented that individual characteristics affect writing achievement (e.g., Jones, 2011). In the present study we found that girls exhibited a significantly higher probability of being classified as good reviewers, and boys as a poor reviewers. To our knowledge,

there are no previous studies that have analyzed these gender differences considering revision profiles. However, our results are consistent with previous studies which have found that boys have more difficulties using high-level writing processes such as planning and revising (De Smedt et al., 2018; Berninger et al., 1992) and that girls in the last years of primary school demonstrate better writing skills than boys (e.g., Reilly et al., 2019 for a *meta*-analysis).

In addition, we found clear differences in the writing revision profiles according to grade. The results showed that the highest percentage of pupils in fourth grade belonged to the group of poor reviewers, in fifth grade to the group of mechanical reviewers and in sixth grade to the group of substantive or good reviewers. This may have to do with the development of writing skills. According to the studies by Berninger et al. (1992), post-translation revision (i.e., revision after writing) emerges between 4th and 6th grade. Given that in 4th grade this skill is at a very early stage, it makes sense for most students to fall into the group of poor reviewers, exhibiting problems with all revision subprocesses at the mechanical and substantive level. As schooling progresses, students' revision skills seem to improve (Limpo et al., 2014) and in fifth grade, most of the students are in the mechanical reviewers profile, which means that their revision skills are better than fourth-graders', despite focusing exclusively on mechanical aspects. This might be explained by the scant knowledge students at this age seem to have about substantive aspects (Wilson & Wen, 2022) or their conception of revision as a proofreading task (MacArthur, 2012; 2016). Finally, in sixth grade most students are in the substantive or good reviewers groups, which is consistent with previous studies finding that in this grade students revision skills affect text organization and semantics (Allal et al., 2004).

In addition, the relationships between text quality and revision profiles were explored. The results show that the text quality of poor reviewers was significantly worse than the other three groups, followed by mechanical reviewers. Substantive reviewers wrote higher quality texts than poor or mechanical revisers, and good reviewers wrote better texts than the other three profiles. Although previous studies have shown that revision skills do not predict the quality of students' texts in the last years of primary education (Berninger et al., 1992; Limpo et al., 2014), given the results of our study, revision skills do seem to play an important role in students' writing processes. Students who do not use the revision subprocesses write lower-quality texts. The fact that students whose revision focused on mechanical aspects wrote higher quality texts than those who did not use the different revision subprocesses is an interesting result, given that mechanical revision has not generally been shown to be related to text quality (Limpo et al., 2014). However, mechanical revision also seems to play an important role. This would be consistent with studies showing that texts containing mechanical errors such as grammatical or spelling issues are evaluated as having lower overall quality based on these mistakes (e.g., Boland & Queen, 2016). In addition, raters have been shown to be more sensitive to mechanical than to content errors (Johnson et al., 2017).

The fact that writers in the substantive reviewer profile wrote better texts than the poor or mechanical reviewer profiles is also consistent with previous research (Graham et al., 2021; Limpo et al., 2014). Importantly, however, this result has been found in older writers (i.e., secondary school students), with no such relationship found in primary school students (Berninger et al., 1992; Limpo et al., 2014). This may be because the rating scales for text quality in previous studies might have been less sensitive than those used in this study. For example, Limpo et al. (2014) used a 7-point rating scale, while we considered a larger variance (i.e., the raters had the option to assign a score from 60 possible points, choosing between scores ranging from 70 to 130). This might have allowed a more detailed assessment of the quality of students' compositions, enabling the relationship between the revision of substantive aspects and textual quality to be established. Finally, given the benefits of mechanical and substantive revision, it makes sense that students matching the profile of good reviewers would write the best texts.

Finally, analysis of the relationship between age and text quality within each profile showed that the older the students in each profile, the better their texts. This might be explained by the fact that, as previous studies have shown (Limpo et al., 2014), students' revision skills improve as they progress through the educational system. This, rather than being a matter of maturation, could be explained by the approach typically taken in writing skills instruction, which focuses on the automatization of mechanical aspects at the beginning of schooling (Arrimada et al., 2019) and leaves specific high-level skills instruction, specifically revision to later years. Despite this, comparing students of the same age in each profile shows how the quality varies depending on the profile the students fall into. Students in each grade achieve lower quality scores if they fit the poor reviewers profile compared to those who the good reviewers profile. Future studies with more measurement timepoints (longitudinal studies) may shed light on relationships between age, revision and text quality.

4.1. Limitations

The results of the present study should be considered in light of its limitations. First, it is important to remember that the students revised texts created by the researchers. Although this was important for assessing students' revision skills independently of text quality, research has shown that students seem to have more problems revising their own texts than others' texts (Midgette et al., 2008). Therefore, this study would need to be replicated in future research by assessing students' revisions of their own texts. In addition, the characteristics of the task used need to be considered, such as the time or the information provided in each phase. Future studies should analyze the influence of these variables as well as the relationship between revising someone else's text under certain circumstances and revising their own texts.

Secondly, revision is a highly complex process influenced by many variables. Although in this study the measures were intentionally chosen, this does not provide information on all revision-related variables. Therefore, future replications may include measures such as working memory capacity (Bohn-Gettler & Kendeou, 2014), motivation (Camacho et al., 2023), knowledge (MacArthur, 2012, 2016), executive functions (Valcan et al., 2024) or even error-tolerance (Aben et al., 2022). It would also be useful to include students' reading skills and its potential relationship with revision processes (Graham et al., 2021) or students' use of different strategies during revision (Arias-Gundín et al., 2021). Such information would be important for designing instructional programs appropriate to the students' needs. Similarly, latent profiles should also be assessed by considering different textual genres which may require different writing and revision processes (Beauvais et al., 2011). Finally, it would be interesting to assess the relationship between students' revision skills at the mechanical and substantive level and the quality of their texts by considering these two dimensions (Wu & Schunn, 2022).

It is also necessary to mention the limited reliability of the measures used. Future studies should consider other measures to overcome this issue, although the measures used in this study have been used in previous studies with good results (e.g., Limpo et al., 2014; López et al., 2021).

Finally, the study only looked at typically developing students. Given that previous studies have shown that students with learning difficulties demonstrate specific problems with revision (Graham et al., 2021), future studies should assess the profiles in these students.

4.2. Educational implications

Although the results show that revision skills improve during schooling, 50 % of the students overall were in poor or mechanical reviewers groups, exhibiting significant problems with revision and producing the poorest quality texts. These results are not necessarily only

related to students maturing, they may also be related to students not receiving instruction allowing them to acquire revision skills in a way that positively influences the quality of their texts. These results emphasize the need to consider instruction in revision skills from very early on through effective instructional practices (e.g., De la Paz & Sherman, 2013). In this regard, one of the most effective instructional approaches for improving writing proficiency in general (e.g., Harris et al., 2023; Palermo & Thomson, 2018), as well as revision skills specifically (De la Paz & Sherman, 2013; López et al., 2021), is strategy instruction. Therefore, this type of instruction in the classroom needs to be promoted (Koster et al., 2017; McKeown et al., 2023).

Finally, in line with previous research (De Smedt et al., 2018; Reilly et al., 2019), it has been shown that boys have greater difficulties with writing than girls. This highlights the need for special encouragement of writing skills in these students, as these skills are a fundamental tool in their achievement of academic, social, and work-related goals.

CRediT authorship contribution statement

Olga Arias-Gundín: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Celestino Rodríguez:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Formal analysis, Conceptualization. **José Carlos Núñez:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis, Data curation, Conceptualization. **Gert Rijlaarsdam:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Formal analysis, Data curation, Conceptualization. **Paula López:** Writing – review & editing, Writing – original draft, Investigation, Data curation, Conceptualization.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cedpsych.2025.102353.

Data availability

Data will be made available on request.

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