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A Review of Effective Technology-Based Writing Interventions: A Componential Analysis

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Abstract: Previous studies have shown the effectiveness of ICT-based writing instructional practices, but they do not show an in-depth analysis of their instructional elements, which could be key to explaining such effectiveness. This study aims to analyze the instructional design of effective ICT-based writing practices according to content and instructional dimensions. An empirical review was performed following the PRISMA statement guidelines with a sample of 22 studies. For the content dimension, learning objectives were coded in terms of target focus, subject-specific knowledge, and learning outcomes. For the instructional dimension, types of learning and instructional activities were coded, identifying their specific elements. Results showed that learning objectives were mostly focused on practice/internalization of high-level processes. Regarding learning activities, ICT was mainly used in practicing/applying, structuring, and observing/noting activities. Regarding instructional activities, application and demonstration principles appeared most frequently in the interventions, with application activities being most frequently performed by ICTs. Product-focused and corrective types of feedback, as well as static and procedural scaffolding types, were the most frequently performed using ICT. In conclusion, this study provides useful information on what writing activities can be performed using ICT and provide the basis for future studies analyzing to what extent these activities contribute to program effectiveness.

Keywords: ICT; psychology and education; technology-based instructional practices; writing instruction; psychological variables and processes

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1. Introduction

Information and Communication Technologies (ICTs) have acquired an important role in society in general and in the educational field in particular, becoming essential tools in all areas of knowledge [1]; including the teaching of writing competence [2,3]. ICTs has been shown to be beneficial in improving student performance and motivation [4], so current international educational legislation advocates its inclusion in classrooms [5]. Likewise, at the global level, the Sustainable Development Goals of the 2030 Agenda emphasize the importance of using ICTs in education to support formal education [6]. Specifically, in the goals of objective four, it is shown that ICTs should be used to develop basic skills such as writing, giving digital literacy the same importance as traditional literacy [6].

In this sense, in the last decades, research has been conducted to learn how to integrate ICTs in the classroom both generally and in traditional writing practices, including standards or norms that help teachers in this task [7–9]. However, there are empirical and theoretical data reflecting that those in charge of carrying out instruction, on many occasions, do not have a clear understanding of how to integrate and employ ICTs in their pedagogical practices, or that they find barriers to their inclusion [10–13]. In this way, the integration of ICTs in the classroom does not only imply making changes in the academic requirements for ICTs to become an instructional medium for teachers and a learning environment for students. It is also necessary to be aware of the characteristics of ICTs applied to the teaching of basic skills, such as writing, to use them effectively [14].

Likewise, to increase knowledge of the use of ICTs in writing, several meta-analyses and reviews have analyzed writing instructional practices carried out with and without the use of ICTs in different types of students, showing their benefits for writing quality [15–17]. Specifically, previous meta-analyses, in which experimental and quasi-experimental interventions were analyzed, showed that writing instruction through ICTs has a larger effect size than those conducted without them on students' textual quality, with significant improvements in their performance, motivation, organization, productivity, mechanics (i.e., readability, clarity, and flow), and content of their texts [17–19]. Regarding the findings found in previous empirical reviews, most have analyzed the effects of ICTs on different writing variables, showing that they improve both high- and low-cognitive-level writing processes, motivation, and performance [13,20–24]. Moreover, in the case of high-level processes, it stands out that the most considered processes are planning and revision; and among the low-level processes, spelling, grammar, and phonological awareness stand out. In addition, studies comparing the effectiveness of an ICT on K-12 students with and without writing difficulties show that its effect is greater on students with learning difficulties versus typically developing students [18,19]. Likewise, all these findings coincide with those found in previous reviews [13,20,21,23,24].

Some of the previous reviews also analyzed the types of ICT used in writing interventions and for what purpose they were used (e.g., learning a foreign language). In relation to the latter, it was observed that ICTs have been used with a higher frequency for learning to write in a second or foreign language, focusing mostly on the textual product compared to the writing process [13,16,21].

The data reported by the previous reviews and meta-analysis performed provide relevant information about the effectiveness of ICTs on different elements of writing but show nothing about the characteristics or instructional support of ICTs, which could be key to explaining that effectiveness. Only Galvin and Greenhow [11] decided to explore what factors contributed to writing improvement in the studies analyzed, which could fill knowledge gaps. However, in this study only social networks were analyzed, leaving aside other types of useful tools for instruction, such as Intelligent Tutoring Systems (ITSs), which have been shown to be effective in improving writing skills [24]. Also, the characteristics of the ICTs used in the interventions were not explained. For example, one factor contributing to success was said to be feedback, but how it was provided and what it looked like (e.g., explanatory or corrective) was not explained.

From our knowledge, previous review studies and meta-analyses do not provide such in-depth analysis of the instructional design followed in writing interventions. For these reasons, the present review study aims to analyze the instructional design of different effective instructional practices for the improvement of students' writing in which an ICT has been used. The analyses were implemented in terms of two dimensions proposed by Rijlaarsdam et al. [25]. On the one hand, there is the content dimension, which includes the intermediate learning objectives of the intervention. On the other hand, there is the instructional dimension, which includes the learning activities to be performed by the learners and the instructional activities to be performed by the instructor, by the researcher, or by the ICT.

At the scientific level, the findings of this review will be useful for researchers to know the details of the intervention. This would allow researchers to identify the specific elements that comprise the ICT-based intervention programs in writing, as well as to show points of interest for designing instructional programs at the educational level based on evidence-based ICT programs. Moreover, this detailed analysis of ICTs will allow for future studies focused on analyzing to what extent each specific element of the intervention influences the effectiveness of writing interventions developed with ICTs through meta-analysis studies, or to design comparative studies that would demonstrate what effect different variables or specific elements produce on intervention effectiveness. Such comparative studies would make it possible to obtain information on which specific elements are fundamental to improve writing proficiency or to know if there is a sequence of learning activities with which the results are better [25].

At the educational level, the findings provided could promote the effective integration of ICTs in the teaching of writing. If teachers acquire a deeper understanding of the features and elements of ICTs applied to the teaching of writing, they can integrate them and use them effectively [14]. It could close the gap between research and classroom practices [26]. The study also contributes to sustainability and the achievement of sustainable development. Through in-depth analysis of the elements of effective writing instructional practices, teachers can identify activities and pedagogical approaches that enhance students' cognitive and communicative skills essential for participation in a sustainable society, which is a requirement for the achievement of Sustainable Development Goal 4 set by UNESCO [6]. Furthermore, according to the Incheon Declaration [6], ICT-supported pedagogical approaches must be promoted today to achieve quality education, and the information provided in this study contributes to the achievement of this goal.

2. Materials and Methods

2.1. Documentary Search Procedure

The initial search was carried out in 2021 through the Web of Science (WOS) and Scopus databases without time limit, using the following keywords: writing, writing instruction, writing intervention, written composition, technology, new technologies, technology-enhanced learning, technologies, technology intervention, technology instruction, technology-based instruction, and digital tools. Then, the articles to be included in the review were selected following three phases (Figure 1), which were based on the indications of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Supplementary Materials) [27].

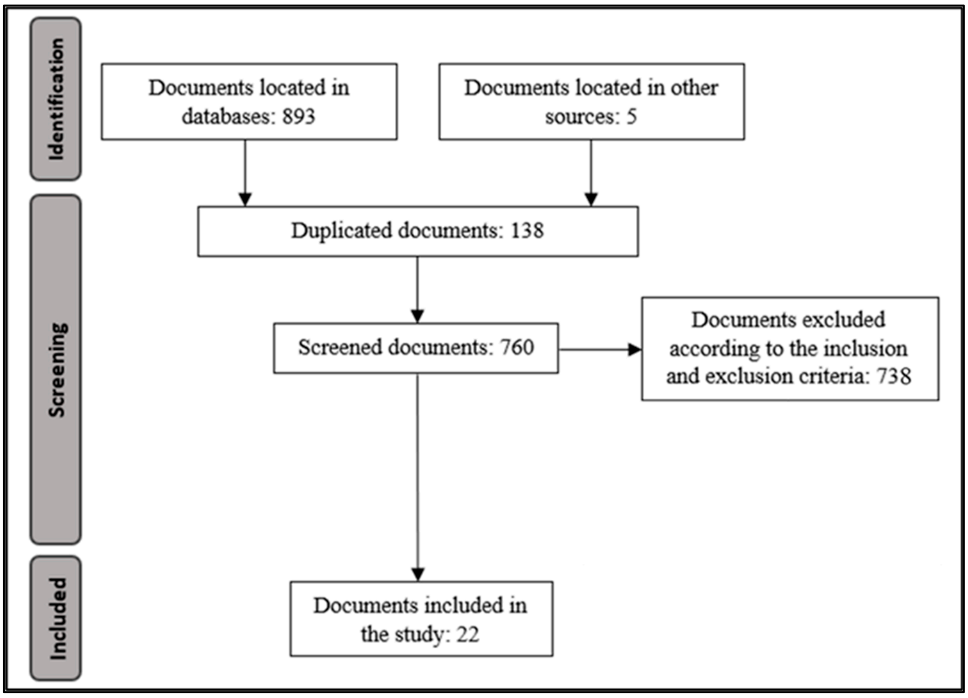

Figure 1. Document search and selection process.

These phases were: (a) search of documents or identification; (b) screening of documents; and (c) final selection. Only articles satisfying the following inclusion criteria were selected: (a) focused on any educational level (childhood education, primary education, secondary education, and higher education); (b) empirical article (e.g., experimental, quasi-experimental designs with control group); (c) written in English or Spanish; and (d) using a digital tool to improve students' writing. Likewise, documents that met the following exclusion criteria were excluded: (a) not written in English or Spanish; and (b) did not provide pre/post-test scores.

During the screening phase, a large number of studies were eliminated mainly due to the following reasons: (a) not being an empirical article with control group; (b) not including pre/post-test data; (c) full article not available or not being sent by the authors when requested; (d) not being related to ICTs use for teaching writing (e.g., there were studies focused on reading); and (e) not providing sufficient information on the intervention, on the activities carried out, or on the ICT used (e.g., not explaining the activities carried out in the intervention or not mentioning or explaining the features of the ICT used). It is noteworthy that in the latter case, we tried to contact the authors by email and sought more information on the ICT tools used. However, there were occasions in which the authors did not respond to the emails and, therefore, since we did not have the necessary information for the analysis, these articles were excluded from the study.

The final sample consisted of 22 empirical articles, in which effective instructional writing practices were performed (see Table A1 in the Appendix A section for a detailed description). These articles appear in the references section marked with an asterisk. Regarding the methodology of the studies, in the vast majority (n = 17) the experimental group carried out instruction using ICTs while the control group did so without the use of ICTs. However, there are certain studies (n = 5) in which both groups use digital tools differing only by the type of tool used (e.g., one group used an Intelligent Tutoring System and the other a word processor). In addition, most of the studies used direct instruction or guided instruction to develop the intervention, while a few used other typologies such as strategic instruction (n = 5) or the response-to-intervention model (n = 1), which have been shown to be effective in improving writing.

2.2. Analysis Procedure

The analysis was carried out considering different elements of the content and instructional dimension of the studies, which are explained below. Moreover, it should be noted that to ensure the reliability of the coding system by which the information on these elements was extracted, the analysis of 50% of the studies was performed by two coders. Specifically, a training phase was carried out beforehand with the coders so that they could familiarize themselves with the system of categories used. After this, the two coders analyzed 50% of the studies separately and the degree of agreement between them was found to vary between 94% and 100% for all variables. Given the high degree of agreement obtained after analyzing half of the studies in the sample, the other half was analyzed only by the first coder, who was the first author of this study.

The elements analyzed for each dimension will be presented in detail below, indicating also the aspects identified for each of them. Specifically, we analyzed the ICT intervention programs in terms of intermediate learning episodes (ILEs), which are bounded by (1) the intermediate learning objectives (ILOs), (2) the learning activities, and (3) the instructional activities. When one of the elements changes, we speak of a new episode. We coded these episodes for these three properties of an episode. We left it open regarding which combinations are possible and if all cells of the matrix can exist, and did not define prototypical episodes beforehand [28].

Next to these three general characteristics of ILEs in writing education, we were specifically interested in which of these ILEs was performed by an ICT, the fourth-dimension characterizing ILEs. This means that we constructed a general framework of instructional learning episodes and a specific framework for ICT contributions. The different elements identified for intermediate learning objectives, learning activities, and instructional activities will be explained in detail below.

2.2.1. Content Dimension

Intermediate Learning Objectives (ILOs)

In this dimension, the ILOs of each article were identified and classified through an inductive process. It should be noted that the ILOs refer to the aims that are intended to be achieved during training and whose attainment will allow the overall objective of the training program to be reached. Consequently, four categories were created: (a) acquire knowledge about high-level cognitive writing processes (HLP); (b) acquire knowledge about the characteristics of one or more writing genres; (c) improve/make more fluent low-level cognitive writing processes (LLP); and (d) internalize and apply the knowledge acquired.

Then, two elements were analyzed. On the one hand, the subject-specific knowledge of the ILOs was identified according to the four categories mentioned above. For high-cognitive-level processes, we distinguished whether planning, drafting, revision, or all three processes together, were worked on. In the case of the writing genre, only one category was established, which was named as the product. Then, five categories were determined for the ILOs related to low-cognitive-level processes, which were spelling, phonological awareness, syntaxis, calligraphy, and low-level processes in general (i.e., when all the processes mentioned are worked on at the same time). Finally, for ILOs focused on internalizing and applying knowledge, the specific knowledge categories were the same as those included in the other three types of ILOs. This is because when students carry out the internalization or practice activities, these will always be directly related to some of the content worked on in the other ILOs.

On the other hand, we identified the learning outcomes, distinguishing between knowledge and skill. In the former case, the outcome is primarily demonstrated in verbal utterances, so that students declare their knowledge or insight, i.e., the internal knowledge representation is declarative. In the latter case, the outcome (skill) is demonstrated in performances, i.e., procedural knowledge.

2.2.2. Instructional Dimension

Learning Activities

The first element analyzed in the instructional dimension was the learning activities, i.e., activities performed by the students at cognitive level to achieve the ILOs. In this analysis, the learning activities were divided into six categories proposed by Rijlaarsdam et al. in 2018 [25] and then we coded according to whether these activities were promoted through the ICTs or not. Table 1 shows a description of the learning activities analyzed with examples of each category.

Table 1. Description of the categories of Learning Activities codified.

Learning Activity	Description	Examples
Observing/Noticing	Paying attention to explanations of learning contents in different formats (e.g., video or text).	Pay attention, read carefully, observe video lessons.
Divergent thinking	Activities focused on generating ideas and activating prior knowledge.	Activation of prior knowledge, brainstorming.
Analyzing	Reprocessing and working on what was previously observed/generated, analyze, and understanding the content to be included in the text.	Analyze examples, identify text elements, synthesize, take notes.
Structuring	Grouping and relating text elements hierarchically, creating patterns based on genre features, chronology, etc.	Categorize, compare, connect, organize information.
Convergent Thinking	Revising, evaluating, or editing texts, both one's own and others.	Assess, revise, edit, check, remove details.
Practicing/Applying	Practicing, applying, or transferring what has been learned in new tasks or contexts, as well as automating or consolidating content.	Automate, memorize, transfer, reiterate, reflect knowledge.

Instructional Activities

The second element of the instructional dimension was the instructional activities, which are the specific activities performed by the teachers, either by themselves or by the ICT itself, to stimulate or trigger learning activities. Specifically, four elements of these instructional activities were analyzed: instructional principles and their specific activities, types of feedback, types of scaffolding, and types of ICT.

First, instructional principles proposed by Merrill [29,30] were identified in each intervention. These principles are common aspects found by Merrill among different effective instructional practices. Likewise, the instructional activities in relation to Merrill's principles were identified. Specifically, a total of 13 categories of activities were considered for the analysis, which were established through an inductive process after reading the method section of the studies, identifying the activities, and analyzing the similarities between these activities. It is noteworthy that both elements are explained in detail in Table 2.

Table 2. Description of the instructional principles and categories of instructional activities codified.

Instructional Principle	Principle Explanation	Instructional Activity	Instructional Activity Explanation
Problem-centered	Explain the aims of the intervention.	Oral presentation	Verbally explain the learning objectives.
		Written presentation	Written explanation of learning objectives.
		Oral and written presentation	Oral and written explanation of learning objectives.
Activation	Activate prior experiences or knowledge.	Brainstorming	Discuss in groups or with the class-group, answer questions, or contribute ideas on the topic of the assignment before starting it.
		Initial writing task	Ask the student to perform a writing task without prior explanations, before starting the intervention, without this serving as a pre-test.
Demonstration	Show students what they should learn instead of just telling them what they are going to learn.	Direct instruction	Explain theory or concepts needed to perform the task in different formats (video, oral explanation, etc.).
		Modeling	Show visually through a model how the task is performed and be able to use think-aloud.
		Provide examples	Provide examples of what the student will have to do (e.g., sample narrative text or sample outline).
		Provide rubrics/checklists	Provide rubrics, checklists, lists, etc. with the elements to consider when performing the task.
Application	Students use their knowledge and skills to solve a problem.	Provide writing spaces	Provide physical or digital templates, sheets, notepads, etc. for writing.
		Provide games to practice	Provide games to practice the contents explained in the intervention.
		Provide help during task	Offer information or aids to students when they are blocked to overcome the task (e.g., dictionary, list of connectors, reminders of the theory, etc.)
Integration	Give students the opportunity to show their work publicly.	Publication	Give the opportunity to show the work publicly.

Second, the types of feedback provided were analyzed, distinguishing six categories based on previous taxonomies [31,32]. On the one hand, four types of feedback were identified according to level: (a) task feedback, which consists of providing feedback on the final execution of the task; (b) process feedback, i.e., providing feedback on the steps to be followed to perform the final product; (c) self-regulatory feedback, which refers to student's self-assessment skills, providing messages through which the student can self-assess what he or she has learned; and (d) personal feedback, which focuses more on encouraging the student than on the content, using messages addressed to the "self" (e.g., you are a great student). On the other hand, a distinction was made between two types of feedback depending on the level of information. The first is corrective feedback, focused on showing the student whether the answer is correct or incorrect without giving more information. The second type of feedback analyzed is elaborative, in which, in addition to indicating the mistakes or correct answers, an explanation is given as to why it is a mistake or a correct answer, i.e., this kind of feedback provides a deeper understanding of the task [33,34].

Third, the types of scaffolding were analyzed based on the taxonomy of Kim and Hannafin [35]. It was decided to follow this classification because these authors relied on online education and the use of new technologies to establish these typologies of scaffolding [36]. Thus, these authors organize the different typologies into two main categories: scaffolding according to interaction and scaffolding according to purpose.

On the one hand, the authors determine that there are two kinds of scaffolding depending on the interaction between the students and the source, which in this case is the ICT. The first type is static scaffolding, which takes place when no interaction between the student and the source is necessary, i.e., the ICT tool includes help sections (e.g., templates or theory reminders) that are always available for the student to consult but are not self-activating. The second type is dynamic scaffolding, which is defined as the existence of interactive communication between the student and the source, which reviews progress, provides feedback, etc. In this case, the aids are automatically activated according to the student's performance by means of interactive messages.

On the other hand, there are four types of scaffolding based on their purpose. The first type is procedural scaffolding, which refers to providing help and information about the features of ICTs, the type of tasks they include, or how they work (e.g., the ICT includes a section explaining how a game works). The second is conceptual scaffolding, which is defined as the verification of the students' understanding of the concepts covered, allowing the identification of erroneous concepts for their clarification (e.g., a multiple-choice quiz on concepts worked on; if the student makes a mistake a message appears explaining the concept). The third type is strategic scaffolding, defined as providing different aids adjusted to the specific needs of the students so that they can solve the problems they face during learning. One example of this scaffolding is that if the student has difficulty joining paragraphs of a text, the ICT offers a list of connectors to join them. The last type is metacognitive scaffolding, which consists of guiding the development of thinking skills in students, including how information is perceived, stored, and received (e.g., the ICT or teacher poses questions for the student to reflect on; for example, does your text meet the characteristics of a narrative text?). Likewise, metacognitive scaffolding includes teaching strategies that help achieve the learning objectives of the intervention [35,36].

Fourth, the types of ICT used in the studies were identified, establishing general categories created from the reading of previous studies [13,16,37,38]. Specifically, six categories were differentiated. The first category includes Automated Writing Evaluation Systems (AWEs), i.e., software that provides formative feedback on student-written texts by pointing out errors, giving scores and/or generating information to remedy errors and improve the text (e.g., Write & Improve of Cambridge, Version 2.0 of 2022). The second category refers to Intelligent Tutoring Systems (ITS), which are software programs that provide instruction, practice games, and individualized feedback by themselves on a specific topic, based on the student's needs (e.g., Summary Street [39]). The third category was named communicative tools, which included all digital tools that only allowed interaction, both synchronously and asynchronously, with other users through different formats such as videos or written messages (e.g., WhatsApp, Version 2.21.1.17). The fourth ICT category included digital writing tools, i.e., those tools that only allow the creation of content in written form, both collaboratively and individually (e.g., OneNote, Version 16.0.14131.20278). The fifth category refers to virtual classes, i.e., digital platforms in which the teacher can create groups with all students to upload content, activities, and feedback (e.g., Moodle, Version 3.11). Finally, the category called digital games includes video games or educational games aimed at practicing and/or improving certain elements of writing, but without offering prior instruction on those elements (e.g., El monstruo come sílabas (The letter-eating monster) [40]).

It is noteworthy that for the analysis of the instructional principles, the instructional activities, types of feedback, and types of scaffolding were co-fixed based on four categories indicating the agent through which they were performed. These categories were: (a) activity not specified; (b) activity performed by the teacher; (c) activity performed by the ICT; and (d) activity performed by the teacher and ICT jointly. This coding allows us to know how often ICTs were used in the intervention and their role in the different variables. In the case of the ICT types, only the presence or absence of each typology was coded.

3. Results

The results are presented according to the dimensions proposed by Rijlaarsdam et al. (2018) [25], because the analyses were performed following these dimensions. First, a general analysis of the ILOs of the 22 studies was made. Second, a more detailed analysis was conducted by ILO categories, analyzing the ILOs as well as the learning activities that were conducted to achieve the ILOs. Finally, the results of the instructional elements are presented in general terms. To facilitate the visualization of some results, summary tables, pie charts, and bar charts are provided.

3.1. Results Analysis of the Intermediate Learning Objectives and Learning Activities

In this section, we will present the results of the general analysis by showing the total number of ILOs and learning activities of the 22 studies and the relationship between ILO categories and learning activities, as well as the use of ICTs in them.

Categories and Sequences of Intermediate Learning Objectives

In total, 222 ILOs were identified, which were divided into four general categories due to their general focus (see Section 2.2.1). As Figure 2 shows, the category with the highest number of ILOs was related to the internalization/application of knowledge (n = 130; 58.5%), of which 110 involved the use of ICTs for its achievement. In contrast, the category of ILOs focused on the acquisition of knowledge of low-level cognitive processes (e.g., grammar and spelling) did not appear in any of the studies, since these types of processes were worked on through practice, i.e., through the category of ILOs related to internalization and application. The categories referring to the acquisition of knowledge about high-level cognitive processes (n = 44; 19.9%) and the characteristics of textual genres (n = 48; 21.6%) presented a similar number of ILOs. On the one hand, of the 44 ILOs focused on high-level cognitive processes, 38 required the use of ICT for their realization. On the other hand, only 15 of the 48 ILOs related to the acquisition of knowledge about the characteristics of textual genres required the use of ICT for their achievement.

After the division into categories, the sequence of ILOs followed in the 22 studies was analyzed, observing a variation of between one and thirty-six ILOs per sequence (M = 10.1; SD = 11.3). The studies that presented a larger number of ILOs (between 29 and 36 ILOs) combined the teaching of higher-level cognitive processes and/or textual genre features with the practice of learning, except for one [41] of them in which only ILOs on content practice, i.e., on learning by doing, were included. However, in all cases in which the intervention had only one ILO, it was related with internalization and application category; that is, they were interventions focused on learning by doing. Specifically, there were five studies in which there was only one ILO, of which one focused on spelling [42] and four on writing complete texts using the processes of planning, drafting, and revision [43–46].

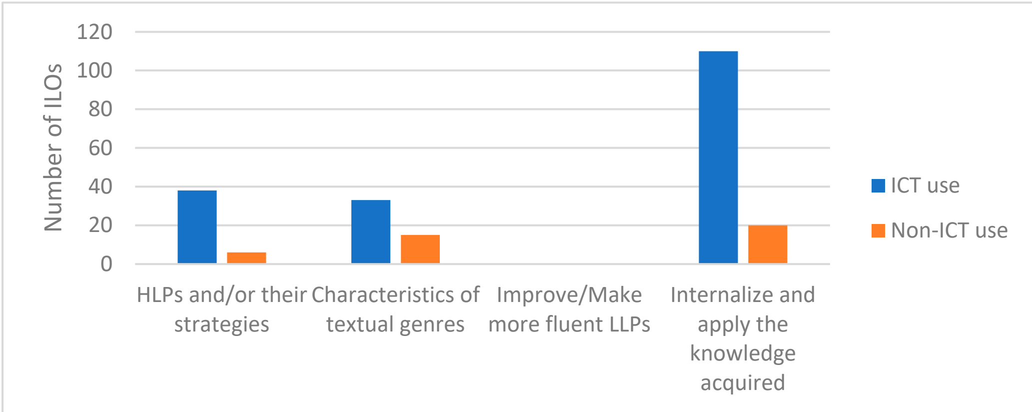

Figure 2. Number of ILOs by category and use of ICTs.

3.2. Results Analysis by Categories of Intermediate Learning Objectives

A more detailed analysis of the different categories of ILOs as the central focus is shown below. First, the subject-specific knowledge (specific content worked on in the interventions) and the learning outcomes of ILOs are presented. Second, the number of learning activities conducted in the studies to achieve the ILOs and how many of them were performed using ICTs are shown (Table 3).

Table 3. General correspondence between ILOs and learning activities.

LA / ILO	Observing		Divergent Thinking		Analyzing		Structuring		Convergent Thinking		Practicing/Applying		Total	
	ICT	NO ICT	ICT	NO ICT	ICT	NO ICT	ICT	NO ICT	ICT	NO ICT	ICT	NO ICT	ICT	NO ICT
HLPs	36	9	0	0	0	0	0	0	2	0	16	0	54	9
Textual genre	12	30	1	0	3	0	0	0	0	3	3	0	19	33
LLPs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Internalize and apply	135	5	86	26	35	14	64	3	59	20	302	29	681	97
TOTAL	183	44	87	26	38	14	64	3	61	23	321	29	893	

3.2.1. Results ILO: Acquire Knowledge about High-Level Processes (HLP)

Nine studies included at least one ILO framed within this category, with a variance of between one and sixteen ILOs per study. Among the nine studies, a total of 44 ILOs were located, being 37 of them performed through ICTs and seven without their use. With respect to the specific high-level process of the ILOs, 9 were focused on working on planning, 7 on drafting, 11 on revision, and 17 on the three processes jointly.

Moreover, regarding learning outcomes, on the one hand, in 17 ILOs, declarative knowledge of the processes mentioned above was promoted; for example, explaining or defining HLP processes. On the other hand, 27 ILOs focused on procedural knowledge of the HLP; that is, they focused on showing students the steps they should follow to carry out the HLP and apply them effectively in writing.

To achieve this type of ILO, three of the six types of learning activities were performed (see Table 3): (a) Observing/Noticing (n = 45), (b) Convergent Thinking (n = 2), and (c) Practicing/Applying (n = 16). The other three categories of learning activities did not appear in this ILO. As can be seen in Table 4, a total of 63 learning activities were coded, ranging from one activity to 32 (M = 7; SD = 9.5) per instructional sequence. Moreover, in four of the studies, ICTs were used for all learning activities performed, while there was only one in which ICTs were used for only half of the activities [47] and four in which they were not used [48–51].

Table 4. Learning activities developed to acquire knowledge about HLP.

Study	LAs Performed with ICTs	LAs Performed without ICTs	Total of LAs
Kim (2018) [47]	3	3	6
Al-Hamad et al. (2019) [48]	0	2	2
Duman & Göcen (2015) [49]	0	1	1
Huang & Renandya (2018) [50]	0	2	2
Rahimi & Yadollahi (2017) [51]	0	1	1
Arroyo et al. (2021) [52]	1	0	1
Goldenberg et al. (2011) [53]	12	0	12
Yamac et al. (2020) [54]	6	0	6
Crossley et al. (2013) [55]	32	0	32

3.2.2. Results ILO: Acquire Knowledge about the Characteristics of One or More Textual Genres

Eight of the 22 studies included at least one ILO related to the acquisition of knowledge of textual genres, which emphasized knowledge of their characteristics, structure, and elements. These studies reported a total of 48 ILOs, varying from 2 to 16 ILOs per study. In addition, regarding the learning outcomes of these ILOs, 31 were identified as focused on declarative knowledge, while the other 17 were focused on procedural knowledge. Likewise, 15 of the 48 ILOs were performed with ICT use and 33 without their use.

For the achievement of these categories of ILOs, five of the six types of learning activities mentioned above were carried out (see Table 3), which meant a total of 52 activities ranging from 3 to 16 activities in the studies (M = 6.5; SD = 5.4). The learning activities that appeared most frequently were those in the Observing/Noticing category (n = 42), whereas those that appeared least frequently were related to the Divergent Thinking category (n = 1). With respect to the other three categories that appeared among the studies, three learning activities were identified in each of them.

Moreover, Table 5 shows that there were three studies [49,56,57] in which ICTs were not used for activities focused on achieving these ILOs. Likewise, in four studies ICTs were employed for all learning activities [52–54,58] and in one they were employed in fewer than half of the activities [59].

Table 5. Learning activities developed to acquire knowledge about one or more textual genres.

Study	LAs Performed with ICTs	LAs Performed without ICTs	Total of LAs
Duman & Göcen (2015) [49]	0	2	2
Hosseinpour et al. (2019) [56]	0	6	6
McKenney & Voogt (2009) [57]	0	16	16
Arroyo et al. (2021) [52]	3	0	3
Goldenberg et al. (2011) [53]	6	0	6
Luna et al. (2020) [58]	2	0	2
Yamac et al. (2020) [54]	2	0	2
Cequeña (2020) [59]	6	9	15

3.2.3. Results ILO: Improve Low-Level Cognitive Writing Processes (LLP)

When analyzing the different ILOs of the writing interventions, none were found to fall into this category. However, this does not mean that there are no studies in which low-level cognitive writing processes are worked on since they are mentioned in some of the studies analyzed [41,42,60]. Specifically, in these studies, these processes were worked on through practice activities. Therefore, the work on these kinds of processes was associated with the category of internalization and application of knowledge, which is explained in the following section.

3.2.4. Results ILO: Internalize and Apply the Knowledge Acquired

All studies (*n* = 22) included at least one ILO related to the internalization and application of what was learned during the intervention, being a total of 130 ILOs and ranging from one ILO to 36 per study. Regarding the analysis conducted on the specific subject on which the ILOs were focused, the results show that: (a) 79 were focused on the practice of high-level writing processes, of which 8 worked on planning, 29 drafting, 16 revision, and 26 the three processes; (b) 29 on practicing contents related to the features of different textual genres; and (c) 22 on the practice of low-level writing processes. In the last case, 2 of the 22 ILOs were focused on phonological awareness, 2 on spelling, and 18 on phonological awareness, spelling, calligraphy, and syntaxis jointly.

Of the 130 ILOs identified, 5 were focused on declarative knowledge, whereas 125 focused on procedural knowledge. Moreover, 119 ILOs were performed with the use of the ICTs in the interventions; meanwhile there were 11 ILOs in which ICTs were not used.

Regarding the learning activities performed to achieve these objectives, a total of 778 learning activities were coded, ranging from 4 to 348 per sequence (*M* = 35.4; *SD* = 69.1) (see Table 3). On the one hand, the activities that appeared most frequently were related to the Practicing/Applying category (*n* = 331), followed by the Observing/Noticing (*n* = 140) and Divergent Thinking (*n* = 112) categories. In contrast, fewer learning activities were identified as related to the Convergent Thinking (*n* = 79), Structuring (*n* = 67), and Analyzing (*n* = 49) categories.

On the other hand, in general the use of ICTs predominates, and they were used in all studies (Table 6). Specifically, there were 12 studies in which ICTs were used to perform all learning activities and 7 in which ICTs were used in more than half of them [41,43,46,53,56,58,61]. However, there was one study [51] in which an ICT was only used in half of learning activities and two in which it was used in fewer than half [44,47].

Table 6. Learning Activities develop to internalize and apply the knowledge acquired.

Study	LAs Performed with ICTs	LAs Performed without ICTs	Total of LAs
Beers et al. (2018) [41]	318	30	348
Elimelech & Aram (2019) [42]	32	0	32
Liu et al. (2012) [43]	6	3	9
Teng (2021) [44]	2	4	6
Tsou (2008) [45]	28	0	28
Vandommele et al. (2017) [46]	13	10	23
Kim (2018) [47]	1	3	4
Al-Hamad et al. (2019) [48]	20	0	20
Duman & Göcen (2015) [49]	21	0	21
Huang & Renandya (2018) [50]	28	0	28
Rahimi & Yadollahi (2017) [51]	16	16	32
Hosseinpour et al. (2019) [56]	30	12	42
McKenney & Voogt (2009) [57]	13	0	13
Arroyo et al. (2021) [52]	10	0	10
Goldenberg et al. (2011) [53]	20	5	25
Luna et al. (2020) [58]	20	5	25
Yamac et al. (2020) [54]	8	0	8
Cequeña (2020) [59]	15	0	15
Carvalhais et al. (2020) [60]	40	0	40
Angelini & García-Carbonell (2019) [61]	6	2	8
Benetos & Bétrancourt (2020) [62]	9	0	9
Crossley et al. (2013) [55]	32	0	32

3.3. Results of General Analysis of Instructional Elements

In this section, five instructional elements are analyzed: the number of studies working on (a) the different instructional principles of Merrill [29,30]; (b) the type of instructional activities carried out per instructional principle; (c) the types of feedback provided according to the Hattie and Timperley [31] and Shute [32] taxonomies; (d) the types of scaffolding provided according to the Kim and Hannafin [35] taxonomy; and (e) the types of ICT used. In addition, the ICT use in the first four instructional elements mentioned are also shown.

3.3.1. Results of Instructional Principles Followed in the Interventions

Only one of the instructional principles appeared in all the studies analyzed. This principle was the application principle, which consists of giving students the opportunity to apply the knowledge being acquired during the intervention. As seen in Figure 3, in all studies an ICT was used in some way to implement this principle. Specifically, in seven studies the principle was developed by the ICT and the teacher jointly (e.g., playing practice games in class with the teacher as well as playing practice games on the computer), while in fifteen studies the principle was performed only by the ICT.

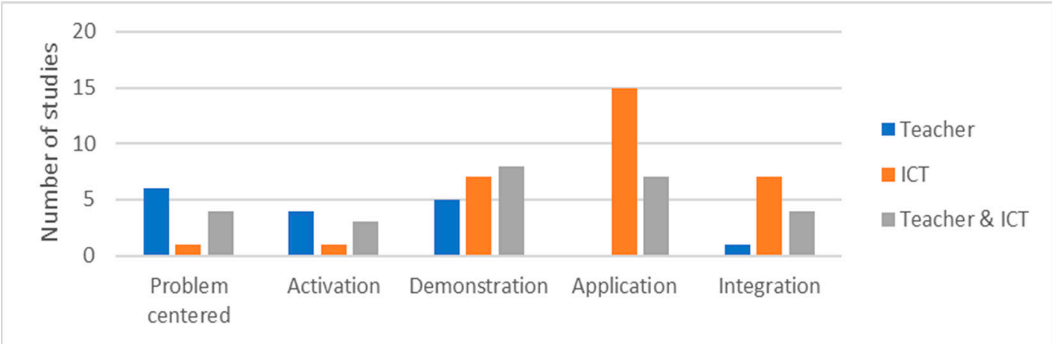

Figure 3. Number of studies that address instructional principles and use of ICTs.

The second most frequent principle in the studies was that of demonstration (n = 20), through which students are shown how to perform the task. Regarding the use or not of ICTs, in five of the studies in which the demonstration appears, it was carried out only by the teacher (e.g., modeling in the classroom), in eight by the teacher and the ICT (e.g., direct instruction in the classroom and modeling through videos), and in seven only by the ICT.

The problem-centered and integration principles appear with a similar frequency (Figure 3), with only one study showing a difference between them. On the one hand, the problem-centered principle related to showing the intervention objectives to the students appears in 11 studies. Specifically, in six studies it is developed only by the teacher, in one only by the ICT, and in four by the teacher and the ICT jointly (e.g., the teacher explains the learning objectives verbally in class, but also sends an email explaining them). On the other hand, the principle of integration whereby students are given the opportunity to show their work publicly appears in 12 studies. In this case, there is only one study in which the principle is developed only by the teacher, while the rest involve the ICT, either jointly with the teacher (n = 4) or independently (n = 7).

Finally, the least frequently developed principle was the one related to the activation of students' prior knowledge or experiences (n = 8). Regarding the agent through which this principle was performed, in four studies the activation principle was developed only by the teacher, in one study only by the ICT, and in three by the teacher and the ICT jointly (e.g., students brainstorm through an online collaborative work platform and subsequently brainstorm again with the teacher in class through a discussion).

3.3.2. Results of Instructional Activities Performed in Relation to Instructional Principles

Figure 4 presents the different instructional activities performed according to the instructional principles of Merrill [29,30], as well as the agent through which the activities were performed. First, with respect to the problem-centered principle, three types of instructional activities were analyzed: (a) oral presentation of learning objectives (n = 6), which was the most frequent in the studies; (b) written presentation of learning objectives (n = 2); and (c) oral and written presentation of learning objectives (n = 3). Regarding the use of ICTs, the results indicate that ICTs were hardly used to carry out these activities. Specifically, in the activity related to the oral presentation of the learning objectives, on five occasions the activity was performed only by the teacher, while there was only one time in which it was performed by the teacher and ICT. The activity of written presentation of the objectives was performed on two occasions, one by the teacher and the other by the teacher and the ICT. The activity of oral and written presentation of the learning objectives was carried out in one study by the ICT and in two by the teacher and the ICT jointly.

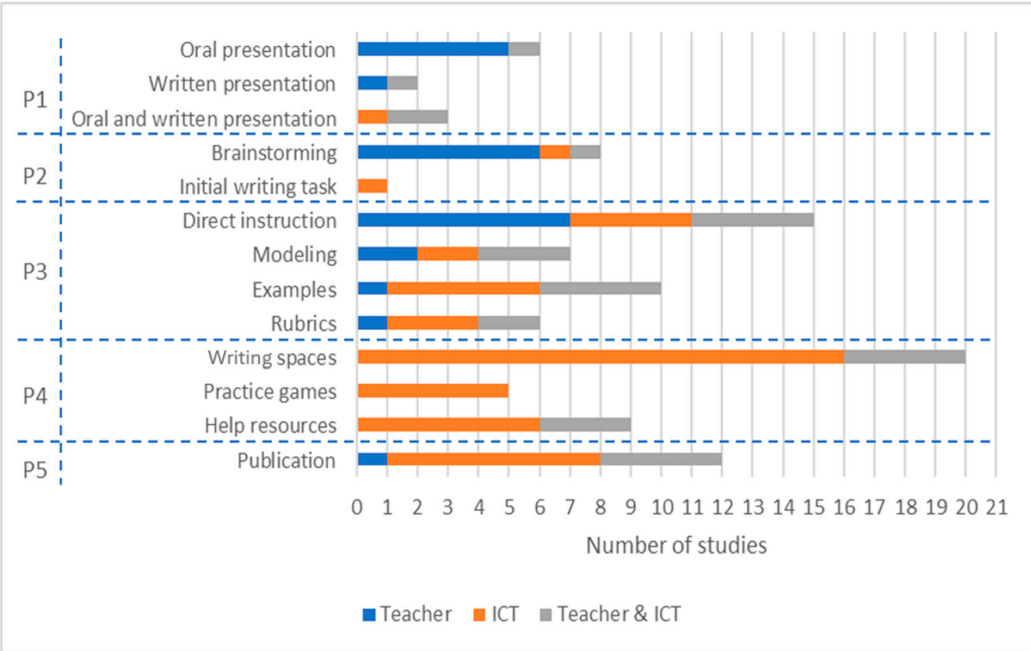

Figure 4. Number of instructional activities related to instructional principles and ICT use.

Second, regarding the activation principle, two instructional activities were identified: (a) brainstorming and (b) performance of pre-test writing tasks. The last one consists of asking the student to perform a writing task before starting the intervention, without giving any explanation about what he/she will learn later, but it is not the pre-test of the intervention.

Of the two activities mentioned, brainstorming was the most frequent, appearing in 8 of the 22 studies. It is noteworthy that this activity in almost all cases was performed without ICT use (n = 6). However, the activity related to the performance of previous writing tasks only appeared in one study [51] in which ICTs were used for its performance.

Third, for the demonstration principle, four instructional activities were identified, of which those appearing most frequently in the studies were direct instruction (n = 15), and providing examples of the task to be performed (n = 10) to students (e.g., if they are learning to write narrative texts an example of a narrative text is shown to the students). Modeling (n = 7) and providing rubrics or checklists (n = 6) were used in fewer studies. Regarding the use of ICTs, it stands out that in the direct instruction activity there are more activities carried out without ICTs, while in the other three activities they are carried out to a greater extent by ICTs or by the teacher and the ICT jointly (Figure 4).

Fourth, three instructional activities were analyzed for the application principle. This principle was developed mainly through instructional activity related to providing different writing spaces to students (e.g., a sheet of paper, a word processor, or a blog). This activity was carried out in 20 of the 22 studies analyzed, with a big difference from the other instructional activities that were analyzed for the application principle: providing practice games (n = 5) and providing help resources during tasks (n = 9). Moreover, in the three instructional activities, the predominant use of ICTs for their implementation is observed since there was no case in which these types of activities were developed only by the teacher.

Finally, for the integration principle only publication activity was analyzed; that is, publicly displaying the work completed by the students. This activity appeared in 12 studies, and it was carried out in one study through the teacher, in seven through ICTs, and in four through the teacher and ICT jointly.

3.3.3. Results of Types of Feedback Provided in the Interventions

In the present study, six feedback categories were analyzed based on previous taxonomies. First, four types of feedback were analyzed according to the levels [31]. Figure 5 shows that of these types of feedback, the one that appears most frequently is the one focused on the textual product (n = 15). Moreover, in 11 of these studies the feedback is provided by the teacher and the ICT jointly (e.g., students write a text in a digital platform and receive automatic feedback provided by the ICT, but also comments from the teacher) and in four it is provided only by the ICT. The other type of feedback that appears most frequently among the studies was the one focused on process (n = 7), which was carried out in six studies through the teacher and the ICT and in one case through the ICT only.

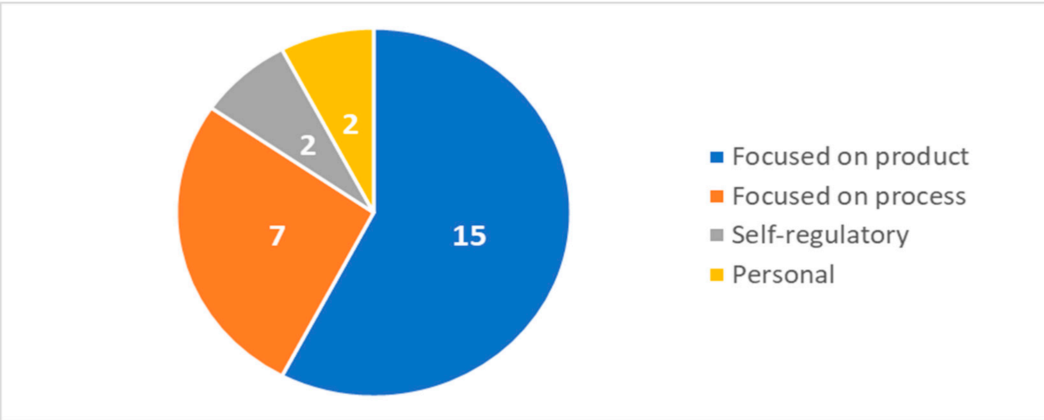

Figure 5. Types of feedback according to the level.

In contrast to the two types of feedback mentioned above, self-regulatory and personal feedback hardly appeared in the studies. On the one hand, self-regulatory feedback focused on students' self-assessment skills appeared in two studies, being provided in one by the ICT and in another by the teacher and the ICT jointly. On the other hand, personal feedback, which consists more in encouraging and motivating the learner than in content, appeared in two other studies, in which it was always provided jointly by the teacher and the ICT (Figure 6).

Second, the results regarding the types of feedback according to the level of information (Figure 6), appeared with a similar frequency in the studies analyzed. On the one hand, with respect to corrective feedback, in which the student is only informed of errors and successes, it should be noted that this was used in 12 studies. In seven of them it was provided by the ICT and in five by the teacher and the ICT together. On the other hand, elaborative feedback, in which errors and successes are indicated and explained, was identified in 10 studies. In nine of these studies, elaborative feedback was provided jointly by the teacher and ICT, while in one case it was provided only by the ICT.

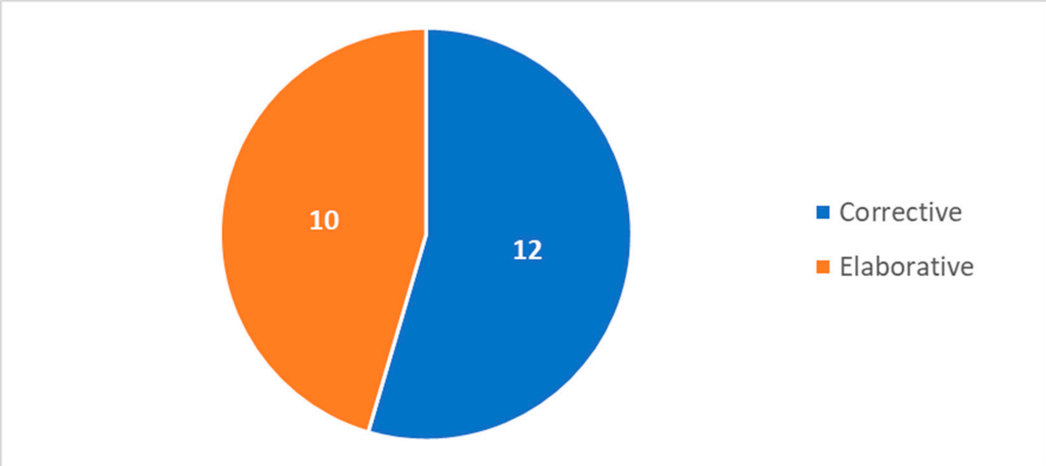

Figure 6. Types of feedback according to the level of information.

3.3.4. Results of Types of Scaffolding Provided in the Interventions

Regarding the types of scaffolding according to the interaction between the subject and the source, the static (*n* = 13) predominated over the dynamic (*n* = 2). Regarding the use or non-use of ICTs to provide the scaffolding, on the one hand, static scaffolding was provided in nine studies through ICT (e.g., the digital tool has a button with help information that the student can open or not) and in four by the teacher and the ICT jointly [44,48,52,58]. On the other hand, as Table 7 shows, dynamic scaffolding was provided by the teacher [53] in one study and by the teacher and the ICT jointly in another [48].

Table 7. Types of scaffolding provided and use of ICTs.

	Static	Dynamic	Procedural	Conceptual	Strategic	Metacognitive	TOTAL
Teacher	0	1	0	0	0	1	2
ICT	9	0	2	1	6	2	20
Teacher and ICT	4	1	11	1	3	1	21
TOTAL	13	2	13	2	9	4	43

With respect to the types of scaffolding by purpose used in the studies, from most to least frequent were procedural (*n* = 13), strategic (*n* = 9), metacognitive (*n* = 4), and conceptual (*n* = 2). Regarding the ICT use, first, of the 13 studies in which procedural scaffolding was used, in 11 it was provided by the teacher and the ICT jointly (e.g., the teacher explains how to use the ICT and the ICT also includes a section explaining the same) and in two only by the ICT [45,53]. Second, conceptual scaffolding was provided in the study of Al-Hamad et al. [48] by the teacher and the ICT jointly and in Yamac et al. [54] only by the ICT. Third, strategic scaffolding was provided in six studies by the ICT only and in the other three by the teacher and the ICT. Finally, metacognitive scaffolding was provided by the teacher in one study [50], by the ICT in two [43,62], and by the teacher and the ICT jointly in another [44].

3.3.5. Results of Types of ICT Used

The results of the analysis of the types of ICT used in the interventions indicate that the most used are digital writing tools (*n* = 10) in which the student can only write (e.g., Word or digital notepads) and virtual classrooms (*n* = 9) such as Moodle or Edmodo. To a lesser extent, communicative tools were used (*n* = 4), such as WhatsApp or email [48,54,59,61]; digital games (*n* = 3) [41,42,60]; and Automated Writing Evaluation Systems or AWEs (*n* = 3) [45,50,55]. Finally, as shown in Table 8, the least used ICTs were ITSs, which were only used in one study.

Table 8. Types of ICT used in the studies analyzed.

Study	AWE	ITS	Communicative Tool	Writing Tools	Virtual Class	Game
Beers et al. (2018) [41]				X		X
Elimelech & Aram (2019) [42]						X
Liu et al. (2012) [43]					X	
Teng (2021) [44]				X		
Tsou (2008) [45]	X				X	
Vandommele et al. (2017) [46]				X		
Kim (2018) [47]				X	X	
Al-Hamad et al. (2019) [48]			X			
Duman & Göcen (2015) [49]				X		
Huang & Renandya (2018) [50]	X					
Rahimi & Yadollahi (2017) [51]				X		
Hosseinpour et al. (2019) [56]					X	
McKenney & Voogt (2009) [57]				X		
Arroyo et al. (2021) [52]					X	
Goldenberg et al. (2011) [53]					X	
Luna et al. (2020) [58]				X	X	
Yamac et al. (2020) [54]			X		X	
Cequeña (2020) [59]			X	X	X	
Carvalhais et al. (2020) [60]						X
Angelini & García-Carbonell (2019) [61]			X			
Benetos & Bétrancourt (2020) [62]				X		
Crossley et al. (2013) [55]	X	X				
TOTAL	**3**	**1**	**4**	**10**	**9**	**3**

4. Discussion and Conclusions

The aim of this study was to analyze the content and instructional dimensions of effective technology-based writing instructional practices for the improvement of students' writing. This research goes beyond previous reviews by performing an in-depth analysis of the instructional design followed in the writing interventions, providing information on the content covered in them, as well as the learning and instructional activities performed. This information is not only useful for improving the effectiveness of writing instructional programs, but can lay the foundation for the development of communication skills that contribute to the achievement of sustainable development by promoting quality education, which is one of the sustainable goals of the 2030 agenda [6].

4.1. Main Findings on the Content Dimension

To understand this dimension, the ILOs of the interventions were analyzed, identifying the specific intermediate learning goals of the interventions, the specific subject knowledge of the objectives, and the learning outcomes of the objectives. The most significant results of each of these elements will be discussed below in that order.

Most of the ILOs were focused on the practice of different types of writing content, which has been highlighted in some international reports [63], reflecting that providing opportunities to practice what has been learned is more effective for learning than other activities such as note-taking. Moreover, Lawrence [64] indicates that this learning methodology is more beneficial for students, as the level of learning is higher compared to more traditional methodologies such as lectures. According to the specific subject worked on in those ILOs, the number of ILOs focusing on the acquisition or practice of knowledge about HLPs and textual genres is higher, as opposed to those focusing on LLPs. This finding is at odds with previous review studies, in which writing practices performed with social media [11] or with different technologies in secondary or higher education students [16] were analyzed. Specifically, in these studies they indicated that most interventions focused on the writing product, and few on HLPs. However, some results were also found in relation to HLP work, as in this study it was also observed that in most cases the planning, drafting, and revision processes were worked on simultaneously. In addition, the study of Al-Wasy [65] indicates that when these three processes are taught together the effect size of the interventions is larger compared to when they are taught separately. This is consistent with the different models of writing which emphasize that all three processes are essential in writing quality texts [66].

Likewise, providing knowledge about textual genres is beneficial for the writing process, as knowing the specific features of the textual typology allows students to organize information optimally during the drafting process [67]. For this reason, the acquisition of knowledge about one or more genres should be a frequent aspect of the studies.

Finally, most of the ILOs (81.5%) were carried out using ICTs and focused more on fostering procedural knowledge than declarative knowledge, which could be related to the fact that most of the ILOs were focused on practice. This result does not coincide with those found in the study by Strobl et al. [16], in which, after analyzing different ICT tools used to support writing instruction, they showed that, through ICT, declarative knowledge was promoted more than procedural knowledge. Likewise, the study mentioned above [16] also indicates that there are occasions in which the two kinds of knowledge are worked on, possibly because the two are interrelated and are essential in the construction of knowledge, one being necessary to understand the other [68,69]. In this sense, in 11 of the studies analyzed, both kinds of knowledge were worked on at the same time.

4.2. Main Findings on the Instructional Dimension

The results found for the components of the instructional dimension are discussed below. First, reference is made to the learning activities. Second, the instructional activities are discussed, considering the different elements analyzed.

4.2.1. Main Findings on the Learning Activities

Roughly speaking, of the six categories of learning activities, the use of Observing/Noticing, Convergent Thinking, and Practicing/Applying activities is common in all ILOs categories analyzed. Moreover, it has been observed that the use of ICTs is possible in all types of learning activities. In this sense, previous studies [70,71] have shown that the use of ICTs in these types of activities is beneficial for learning. On the one hand, it shows that students who followed the teacher's explanation through an ICT show greater commitment to the task to be performed. On the other hand, it shows that the use of ICTs is beneficial for developing the process of textual revision and editing, these activities being framed within the Convergent Thinking category.

Moreover, other studies show that the use of ICTs is beneficial for other types of learning activities, which appear with less frequency among the studies analyzed. For example, some previous studies [13,72] show that the use of ICT in sequencing or structuring activities (Structuring category), analysis and synthesis (Analyzing category) contribute significantly to students' writing improvement. Likewise, Williams and Beam [13] indicate that the use of ICTs in writing activities was beneficial for problem solving and generative thinking. Therefore, it would be desirable to introduce and investigate the role of ICTs in these types of activities.

4.2.2. Main Findings on Instructional Elements

First, although all of Merrill's instructional principles are fulfilled in the studies analyzed, three of them appear less frequently compared to the rest. These principles were activation, problem-centered, and integration. However, the importance of these three principles in the development of knowledge, both through the use and non-use of ICTs, has been demonstrated in previous studies. On the one hand, regarding the activation principle, Al-Mamun et al. [73] defend that when carrying out instruction through an ICT it is convenient to take into consideration the students' previous knowledge and experiences, since this allows a better use of the tool and the scaffolding provided by it. On the other hand, problem-centered and integration principles showed a positive impact on writing skills in previous research [74], which examined the influence of Merrill's principles on Content and Language Integrated Learning courses. Likewise, in relation to the integration principle, another study [75] showed that the application or transfer of knowledge to different contexts is one of the most important factors in achieving deep learning.

Regarding the instructional principles that appeared most frequently (demonstration and application), a study conducted in mathematics seems to indicate that these are related to each other [76]. This is because by demonstrating and/or observing how a particular method is performed (demonstration), there is a greater probability that this method will be applied in different activities and contexts (application).

Second, results show that ICTs can perform instructional tasks both independently and jointly with the teacher, highlighting in this sense the activities related to the principles of demonstration, application, and integration. These results coincide with those found in previous studies, which show that activities such as modeling [66] and publishing [77] have a positive effect on writing. In addition, regarding the agent through which the instructional activities were performed, it seems that certain activities are more frequently performed by the teacher alone (oral presentations and brainstorming) or by the ICT (provision of writing spaces, practice games, and help resources). However, it seems that all except the prewriting tasks and practice games can be developed by the teacher and the ICT jointly. The fact that ICTs can perform instructional tasks on their own or support the teacher reduces the teachers' workload and favors individualized attention to students' needs, since they allow the student to follow his or her own learning pace. Their application in the classroom brings multiple benefits, such as fostering students' autonomous learning, providing immediate and individual feedback, and monitoring students' progress [78,79].

Third, feedback was provided mainly through the teacher and the ICT jointly. The number of studies providing self-regulatory, personal, and process-focused feedback was very small, compared to those using corrective, elaborative, or product-focused feedback. These results coincide with those found in previous studies such as Wang et al. [80], which indicate that despite the usefulness of self-regulatory feedback, it is hardly used in interventions. Therefore, it would be desirable to expand the use of this type of feedback in interventions, as well as that of personal feedback and feedback focused on the process, due to the benefits of its application. On the one hand, personal feedback fosters emotional well-being and helps motivate students to engage in continuous online learning [81,82]. On the other hand, studies such as Graham & Harris [15] indicate that the use of process-focused feedback encourages the improvement of planning, writing, and revision processes, which significantly influence textual quality. Likewise, the proportion of this type of feedback can make ICTs more attractive to teachers, since when selecting an ICT it is one of the elements to which they pay more attention [83].

Fourth, the results show the predominance of static and procedural scaffolding over the rest of the typologies mentioned by Kim and Hannafin [35]. However, studies such as that of Ikawati [84] show that it may be advisable to provide other types of scaffolding such as metacognitive or strategic. Regarding metacognitive scaffolding, James and Okpala [85] indicate that this leads to a significant improvement in literacy performance and that it allows them to acquire strategies which they can turn to according to their comprehension needs, allowing students to verify and clarify their knowledge. In addition, providing strategic scaffolding is beneficial for students to perform increasingly autonomous online learning [36]. In this way, the student becomes the protagonist of the teaching–learning process, which significantly increases student motivation toward the tasks.

Finally, regarding the types of ICT used, a striking fact is that although the effectiveness of tools such as STIs has been shown in studies previously carried out [24], this was the type of tool that was least used in the studies analyzed. This result coincides with those found in the review study conducted by Strobl et al. [16], in which an analysis of different types of ICT and their characteristics was made.

4.3. Limitations and Future Trends

The present study is not exempt from limitations, which are presented below, together with future trends that may remedy them. The first limitation is that the sample is composed of few studies. This was because several studies had to be excluded because of the lack of information on the instructional designs carried out therein and the fact that the authors could not be contacted to request such information. Therefore, one way to remedy this limitation would be to expand the sample to include new studies in which new technologies are used to instruct in writing.

Another limitation is that the study refers to the learning activities carried out in the studies but does not show the instructional sequences and their order. This information could be very useful to know the possible aspects that have contributed to the success of these interventions. Likewise, showing the instructional sequences indicating the moments in which ICTs are used could allow us to know in greater depth the value added by ICTs according to the different instructional conditions. Therefore, another line of future research would be to collect the instructional sequences of the interventions to compare and analyze the differences between the instructional sequences.

Likewise, in future research, a meta-analysis study could be conducted taking into account the effect size of the interventions analyzed and showing statistically the effect of the sequences of learning activities. The results of such a study would show information of interest to researchers because it can show them which specific elements of the interventions may contribute to their effectiveness.

Finally, despite these limitations, the information provided in this study is useful at the scientific and educational levels. On the one hand, the exhaustive analysis of technology-based writing interventions, through a specific reporting system, allows us to know how ICTs can be integrated into the teaching of writing. On the other hand, this exhaustive and detailed analysis, both at the content and instructional levels, is essential for teachers to know in depth how to integrate ICTs for the teaching of writing, thus favoring their professional development in this field. Likewise, knowledge of this theoretical and instructional foundation of the programs will allow teachers to adjust them more effectively according to their objectives, the educational level, or the particularities of the students with whom they work.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16093703/s1, PRISMA 2020 checklist.

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Appendix A

A detailed description of the interventions included in the review study is presented in Table A1 below.

Table A1. Description of the interventions of the studies included in the sample.

Authors and Year	Sample	Aim	Design	Instruction	Experimental Condition	Control Condition	Results
Beers et al. (2018) [41]	53 primary and secondary students	Explore if ICT use contributes to the improvement of transcription processes in struggling writers and if their improvements are comparable with students without difficulties.	Experimental	Response-to-intervention model, including direct instruction and modeling.	Computerized writing lessons	Traditional instruction	Students with difficulties improved their writing quantity making fewer pauses per minute and demonstrated a writing performance similar to students without difficulties.
Elimelech & Aram (2019) [42]	129 childhood education students	Explore the benefits of using auditory and visual support vs. only auditory support or no support in writing quality.	Experimental	Structured and guided instruction	Spelling digital game with auditory and/or visual support	Spelling digital game without support	Auditory and visual and auditory-only groups performed better than the other group in letter knowledge, phonological awareness, spelling, and decoding.
Liu et al. (2012) [43]	67 secondary students	Analyze students' writing performance when using an interactive online writing system.	Quasi-experimental	Conditioned writing and direct instruction	Digital instruction	Traditional instruction	Significant improvements in students' writing performance, argumentation, organization, and structure.
Teng (2021) [44]	120 higher education students	Examine the effects of collaborative writing with an interactive whiteboard on students' writing performance.	Quasi-experimental	Guided instruction with modeling	Collaborative writing through ICT	Collaborative writing without ICT	The use of digital whiteboard significantly improved writing performance, metacognition, and co-regulation compared to teaching without technology.
Tsou (2008) [45]	50 higher education students	Compare the effects of web-based program with traditional instruction on writing.	Quasi-experimental	Guided instruction	Web-mediated instruction	Traditional instruction with and without Word	Experimental group performed better in writing quality, being more significant in content and development, and organization.
Vandommele et al. (2017) [46]	84 secondary students	Analyze the effect of collaborative multimodal instruction in different contexts on writing skills.	Experimental	Direct instruction	Multimodal instruction using ICT	Traditional instruction	Experimental group outperformed control group in text complexity, length, content, lexical content, and communicative efficacy.
Kim (2018) [47]	67 higher education students	Investigate what advantages audiovisual feedback offers in writing and identify its effects on motivation.	Experimental	Direct instruction	Revision and feedback through an ICT	Revision and feedback without an ICT	Audiovisual feedback improves students' writing performance and academic motivation.
Al-Hamad et al. (2019) [48]	98 secondary students	Investigate the effect of WhatsApp instructional program on writing performance.	Quasi-experimental	Direct instruction	WhatsApp-based instruction	Traditional instruction	Experimental group obtained better results in writing performance than control group.

Table A1. *Cont.*

Authors and Year	Sample	Aim	Design	Instruction	Experimental Condition	Control Condition	Results
Duman & Göcen (2015) [49]	76 higher education students	Investigate the effect of digital storytelling method on creative writing skills.	Experimental	Storytelling vs. direct instruction	Digital storytelling method	Instruction through PowerPoint	Digital storytelling improves creative writing skills and contributes to develop thinking fluency and flexibility, organization, wording, sentence structure, and using correct grammar and styles.
Huang & Renandya (2018) [50]	67 higher education students	Explore the impact of integrating Pigai tool (AWE) on revision quality of students' text.	Quasi-experimental	Modeling	Revision and feedback through an ICT	Revision and feedback without an ICT	High perceived usefulness by students for improving written performance and revision skills.
Rahimi & Yadollahi (2017) [51]	42 secondary students	Analyze the effects of online vs. offline digital storytelling on literacy skills.	Experimental	Storytelling with direct instruction	Online instruction	Offline instruction	Literacy skills of the experimental group improved significantly compared to control group.
Hosseinpour et al. (2019) [56]	53 higher education students	Investigate the effects of ICT-based blending learning on writing proficiency.	Quasi-experimental	Blended learning with direct instruction	Collaborative writing through an ICT	Collaborative writing without an ICT	Experimental group outperformed control group in writing proficiency, organization, vocabulary, and writing mechanics.
McKenney & Voogt (2009) [57]	40; 14; 79; 37 childhood education students	Analyze how the PictoPal digital tool can improve students' literacy skills.	Quasi-experimental	Direct instruction	Computer-assisted learning with PictoPal	Traditional instruction and use of another tool	In studies 1, 2, and 3 experimental groups overperformed control group in emergent writing skills. However, in the fourth study control group obtained better results.
Arroyo et al. (2021) [52]	300 higher education students	Assess the learning effect of a web-based multilingual argumentative writing instruction on students' writing quality.	Quasi-experimental	Direct instruction	Web-based instruction	Traditional instruction	Experimental group performed better in writing metacognition, self-efficacy, and rhetorical moves and steps of argumentative text.
Goldenberg et al. (2011) [53]	371 primary students	Compare the effects of an instructional program with an ICT and without an ICT on writing ability and engagement.	Quasi-experimental	Strategic instruction vs. direct instruction	Digital instruction	Traditional instruction	Students with writing difficulties improved their writing skills significantly using an ICT compared to those who did not use an ICT.

Table A1. *Cont.*

Authors and Year	Sample	Aim	Design	Instruction	Experimental Condition	Control Condition	Results
Luna et al. (2020) [58]	68 higher education students	Assess an ICT-based instructional assistance to improve argumentative writing.	Quasi-experimental	Strategic and direct instruction	Online instruction	Traditional instruction	Experimental group outperformed control group in introduction, conclusion, number of against-position arguments, synthesis, and number of words.
Yamac et al. (2020) [54]	96 primary students	Explore the effect of digital writing instruction with tablets on students' writing performance and knowledge.	Quasi-experimental	Strategic vs. direct instruction	Digital instruction	Traditional instruction	Experimental group outperformed control group in quality, number of words, and writing knowledge.
Cequeña (2020) [59]	76 higher education students	Analyze the correlations of self-perception in reading and writing and reading and writing performance in students receiving traditional or web-based interventions.	Quasi-experimental	Direct instruction	Web-mediated instruction	Traditional instruction	Improvements in writing performance. Reading performance positively affects writing performance, and self-perception in reading positively correlates with writing.
Carvalhais et al. (2020) [60]	45 primary students	Tested the effects of GraphoGame Fluent tool on reading, spelling, and phonological awareness.	Experimental	Structured and guided instruction	Computer-assisted learning through games	Traditional instruction	Experimental group significantly improved orthography and phonological awareness.
Angelini & García-Carbonell (2019) [61]	121 higher education students	Examine if simulation-based instruction contributes significantly to students' writing production.	Experimental	Flipped learning instruction vs. direct instruction	Simulations and large-scale web-based simulation	Traditional instruction	Experimental group significantly improved the skills of writing organization and liking ideas compared to control group.
Benetos & Bétrancourt (2020) [62]	23 higher education students	Analyze the effects of a computer-supported writing tool on argumentative writing process.	Quasi-experimental	Strategic instruction	Computer-supported argumentative writing tool	Text editor	Experimental group significantly improved informal reasoning and completion of argumentative writing compared to control group.
Crossley et al. (2013) [55]	64 higher education students	Assess different functions of W-PAL tool using computational indices related to text cohesion.	Quai-experimental	Strategic and self-regulated instruction vs. direct instruction	ITS and AWE	AWE	Both groups improved writing at global and local cohesion levels.

Note: ITS: Intelligent Tutoring System; AWE: Automated Writing Evaluation System.

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