Improving Master's Students' Information Literacy Through Online Instruction

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Abstract
The ability to manage information obtained from the internet for learning purposes represents a difficult task for most students, even in higher education, where this ability takes on major importance for the writing of academic texts. The Information Problem Solving (IPS) model breaks down this ability into five different skills: defining research questions; planning research activities; searching for and locating sources; processing the information found; and organizing and presenting this information. In this study, an IPS training course was designed, implemented, and evaluated in order to train master's students to conduct a literature review task and write their final thesis. Since the university where this course took place is completely virtual, all instruction was offered online. In addition, this pilot course was based on the Four-Component Instructional Design (4C/ID) model, which includes the following components: learning tasks, supportive information, procedural information, and part-task practice. Twenty-five master's students participated in the full two-month course and fifty-five acted as a control group. The findings of this quasi-experimental study indicate that, upon completion, the group of students that had completed the course obtained statistically better results in activities involving the following skills: defining initial questions; planning research and conducting searches on the internet or other sources; and processing the gathered sources and materials. In terms of the ability to organize and present information, no differences were observed between the two groups. Nevertheless, the online course proved to be an excellent tool for improving students' IPS skills.

Keywords: Information Problem Solving (IPS) Skills, Information Literacy, Four-Component Instructional Design (4C/ID) Model, Instruction, Higher Education

Introduction

University students frequently use the internet to find the information they need for their studies. Indeed, libraries have largely been abandoned in favor of massive research databases and academic search engines that provide students with the necessary information to complete their academic tasks. However, most higher education students have yet to master the skills required to find the information they need and put it to good use (Lam & Zhou, 2019). This lack of information skills entails a great deal of effort from teachers, who have to invest a lot of time and resources to bring students up to speed (Lanning & Mallek, 2017). While this kind of training typically falls on the shoulders of information and library management professionals, the information skills required for higher education programs are becoming increasingly specific (Taylor, 2012). Thus, experts from other academic fields are being called upon to impart these skills to students.

These complex cognitive skills are often referred to as information literacy (IL) or information problem solving (IPS) and have already been discussed widely in literature, using a variety of theoretical perspectives and approaches (ACRL, 2016; Brand-Gruwel et al., 2009). IL involves more than a simple internet search. It is a complex process that always leads to a specific objective (Garcia & Badia, 2017). Figure 1 illustrates this process.

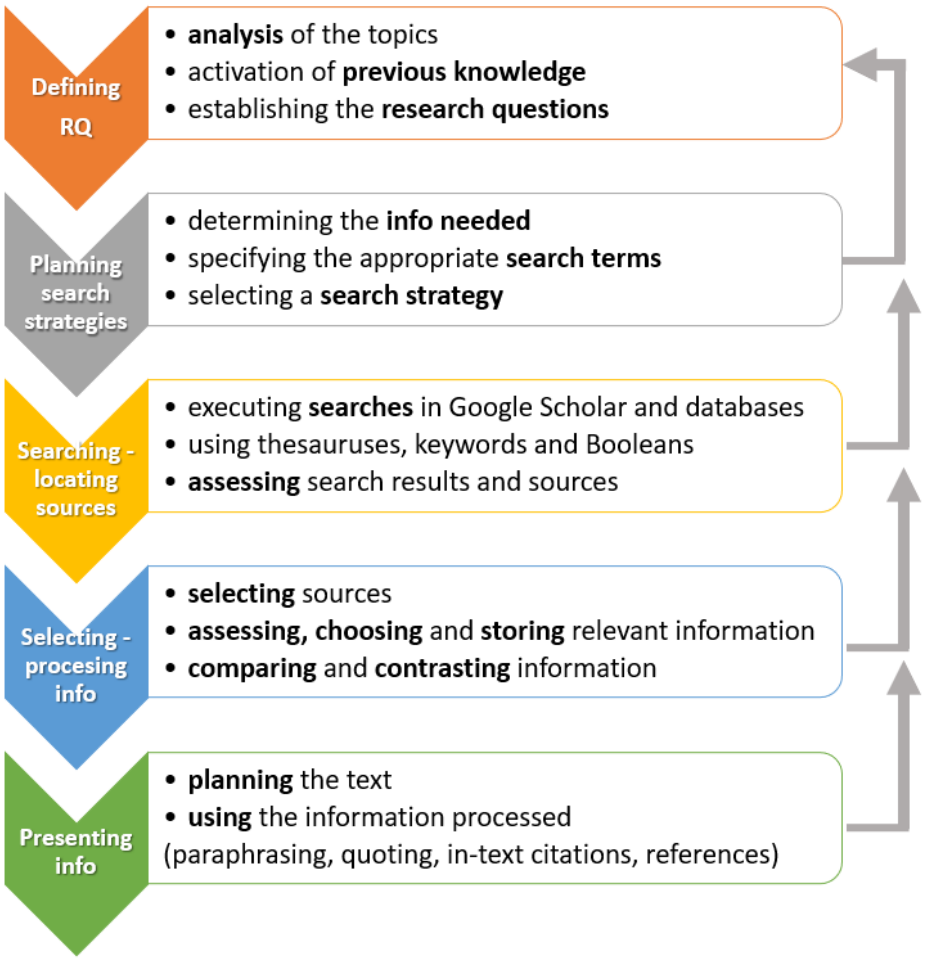

Figure 1: Information problem solving (IPS) skills to review scientific literature (inspired by Brand-Gruwel et al., 2009; adapted from Garcia et al. (2021) and Argelagós et al. (2022).

In this context, the 4C/ID model is a learning method whose primary purpose is to help teach complex skills or competencies (Van Merriënboer et al., 2002). It is a task-centered learning model (Francom, 2016) that moves away from knowledge fragmentation and instead strives to form a seamless integration and connectedness between knowledge, skills, and attitudes (Van Merriënboer & Kirschner, 2018). It is based on four main components, as shown in Figure 2.

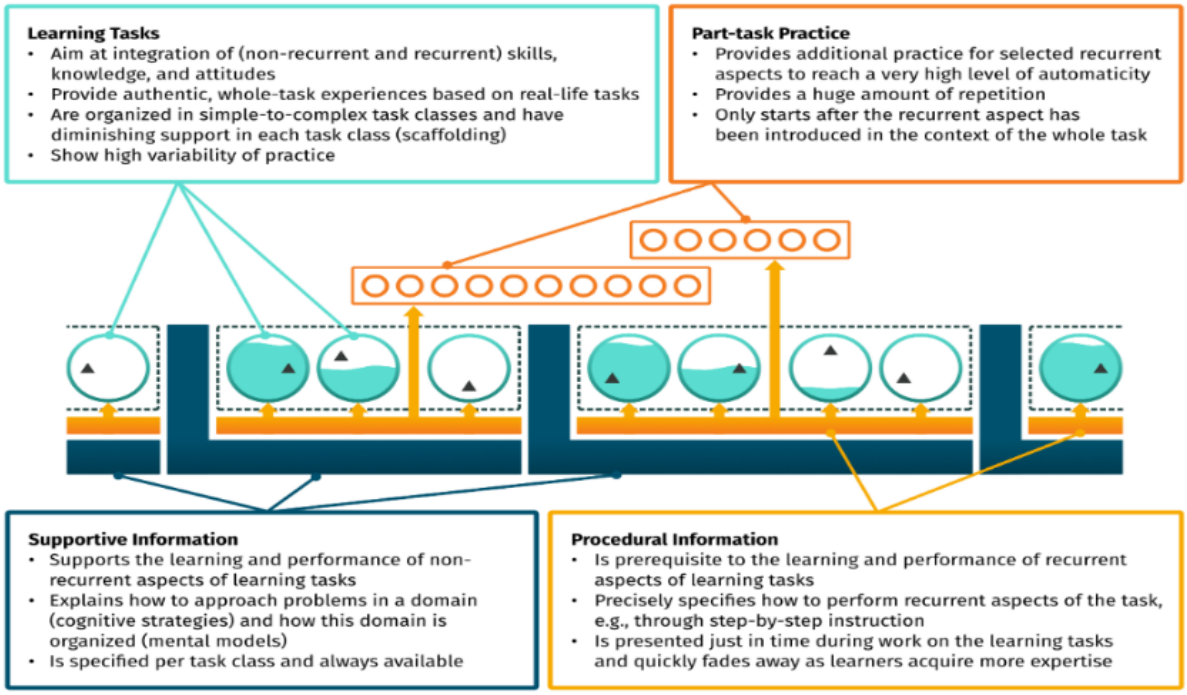

Figure 2: The Four-Component Instructional Design (4C/ID) model.
Extracted from Van Merriënboer and Kirschner (2018).

In this study, an IPS course based on the 4C/ID model was conducted to help master's students improve their skills in using the internet and databases to collect information and write their final thesis. Our hypothesis was that this course would effectively improve participant's IPS skills.

Method

Participants

The participants of this quasi-experimental study were 80 master's students (66 female), mean age 36.86 years (SD = 8.44). The students were divided into two groups: the experimental group consisted of 25 students and the control group consisted of 55 students. The participants were studying for a master's degree in educational sciences at the Universidad Internacional de La Rioja, a fully online university. The students resided in Spain (17%), Colombia (41%), Ecuador (39%), and other countries (3%).

Course and materials

An online course consisting of five different learning tasks was designed to develop the IPS skills needed to conduct an academic literature review in a digital context that culminated in an academic paper. The course had a 60-hour study load. Figure 3 offers an overview of the

learning tasks completed during the course. Each learning task was based on authentic professional topics in the domain of educational sciences. In addition, each task was considered a "whole task," because all five IPS skills (see Figure 1) were needed to complete each of them.

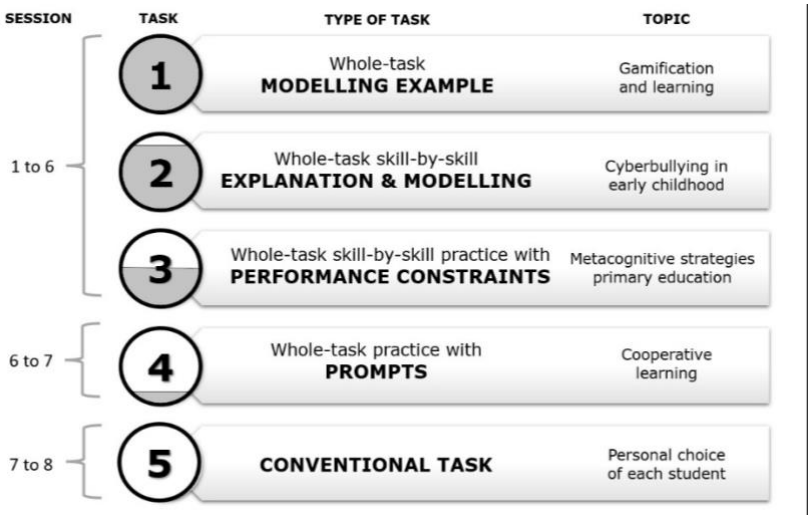

Figure 3: Tasks carried out during the eight sessions of the course; the gray area in each circle shows the level of support given.

The course was divided into three broad phases. The first phase covered the first six sessions, which involved working on three learning tasks. All the sessions were conducted synchronously using the Adobe Connect software tool.

- **Phase 1. Session 1**. **Task 1.** In the first session, the overall task of reviewing literature and writing an academic text was presented. The topic of this task was related to gamification and learning. During the online class, an expert carried out the task from start to finish, including the execution of the five IPS skills (see Figure 1). Throughout the performance of the task, the expert verbalized his actions, thoughts, emotions, and questions, as well as how he managed and resolved the issues encountered. During the first session, the five IPS skills needed to successfully complete the whole task were demonstrated. In addition, a recording of the modeling example was provided, which could be watched by learners as many times as needed after the session, during individual study and consolidation. The modeling example was a whole-learning task, rich in both supportive and, above all, procedural, information. According to Frerejean et al. (2018) the modeling example "presented as a screencast of an expert thinking out loud" (p. 688) is an element that facilitates the teaching of IPS skills.

- **Phase 1. Session 1. Task 2.** At the end of the first session, Task 2 was presented, which was explained skill-by-skill. The subject of Task 2 was cyberbullying in early childhood. This task was a part-task, since it was demonstrated progressively over the course of the sessions. Skill 1—"how to define research questions"—was presented in a detailed and clear way (see Figure 2). Building on this presentation, students were given a homework task for the following session where they were encouraged to develop their understanding of Skill 1. Students were asked to draw on the materials provided for this assignment, which included supportive information, procedural information, and the Skill 1 modeling example.

- **Phase 1. Session 1. Task 3.** As part of their homework task, participants were also expected to independently apply this first skill to the topic of metacognitive strategies in primary education. Task 3 was also conceived as a skill-by-skill activity, and was aimed to help students perform the task in phases. An important issue arose at this stage: Skill 2 could not be mastered if Skill 1 had not already been fully understood and consolidated (performance constraints principle of the 4C/ID model).

- **Phase 1. Session 2. Tasks 1–3.** In Session 2, Skill 1 of Task 3 carried out by the students as homework was discussed, together with any questions or difficulties encountered, and feedback was given so that students could check the task had been completed successfully, and to encourage the assimilation and transfer of knowledge for use in future tasks. After giving feedback on Skill 1, Skill 2 was explained through Task 2, which had been started in the previous session. In this way, Task 2 was used to present a skill, and Task 3 was used to practice it. After each session, each student reviewed and worked through the accompanying materials, which contained supportive and procedural information on the corresponding skill, and the instructions needed to practice it (see Figure 4).

- **Phase 1. Session 3–6. Tasks 1–3.** In this way, the five skills were developed in a progressive manner during the six sessions of the first phase. The range of tasks involved, combined with the opportunity to analyze and practice them, helped students consolidate the routines needed to carry out a task and, more importantly, to transfer what they had learned to tackle new tasks and situations.

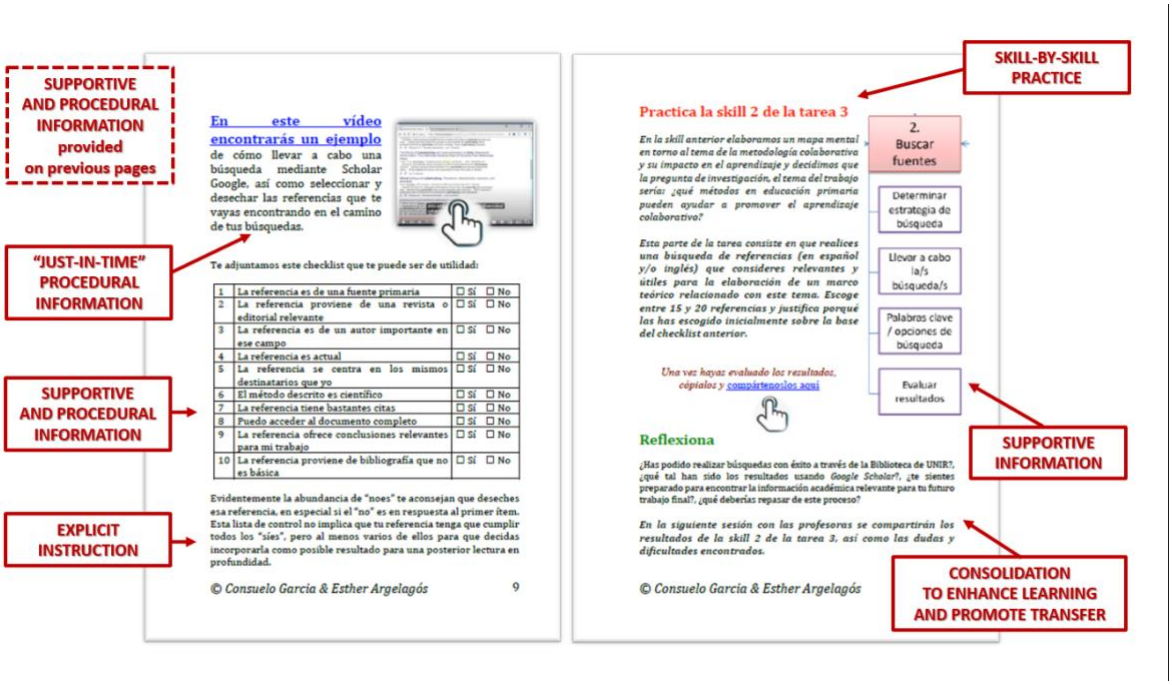

Figure 4: Screenshot of a handout for studying and practicing IPS skills.

- **Phase 2. Sessions 6–7. Task 4.** The second phase included Task 4, which was presented to students at the end of Session 6, once the five skills had been worked on and practiced in a progressive manner. Task 4 required each student to perform a whole task, from start to finish, using a guide, template, and prompts. The topic of this whole task was cooperative learning. The task was practiced again, this time in its

entirety. In the seventh session, any questions and difficulties encountered in Task 4 were shared and feedback was given, again using the supportive and procedural information provided.

- **Phase 3. Sessions 7–8. Task 5.** The third and final phase in this IPS skills training course involved the completion of Task 5. At the end of Session 7, this task was presented as a conventional task without any kind of assistance, allowing the student to select a topic of their choice. After performing this task, in the final session of the course, any questions and difficulties encountered in Task 5 were shared and feedback on the task was given. Once again, the use of the supportive and procedural information was encouraged, centered around task practice, to foster consolidation and transfer of learning.

Design and evaluation method

This study used a non-equivalent control group pre-test post-test design to assess the effectiveness of the course, utilizing two tests to measure instruction effects. To evaluate the IPS skills, the Procedural Information Problem-Solving Knowledge Evaluation in Education (PIKE-E) test was used (Garcia et al., 2020), which is a Spanish adaptation of the PIKE-P (Rosman et al., 2016).

Data collection and analysis

The pre-tests consisted of an online form to collect demographic data, and which included the PIKE-E. The post-test, conducted upon completion of the online course, also included the PIKE-E. Data analysis involved calculating the distribution of scores on the PIKE-E, as well as assessing the effectiveness of the course by means of a mixed analysis of variance (ANOVA) using group (experimental and control) as an intergroup factor, and the pre-test and post-test results of the PIKE-E as an intragroup factor. Statistical Package for the Social Sciences (SPSS; v.18) software was used to perform these analyses.

Results and conclusions

Results indicate that the online course helped the participating students to improve their IPS skills. This improvement was observed as a general factor, that is, for the IPS process as a whole (see Figure 5). In addition, as shown in Figure 6, the students who received online instruction were able to improve all five IPS skills. However, only the two skills related to search actions (that is, “planning search strategies”; and “searching and locating sources”) showed statistical significance ($p < .005$). In the case of the “presenting info” skill, no differences were found. Statistical differences are indicated by asterisks.

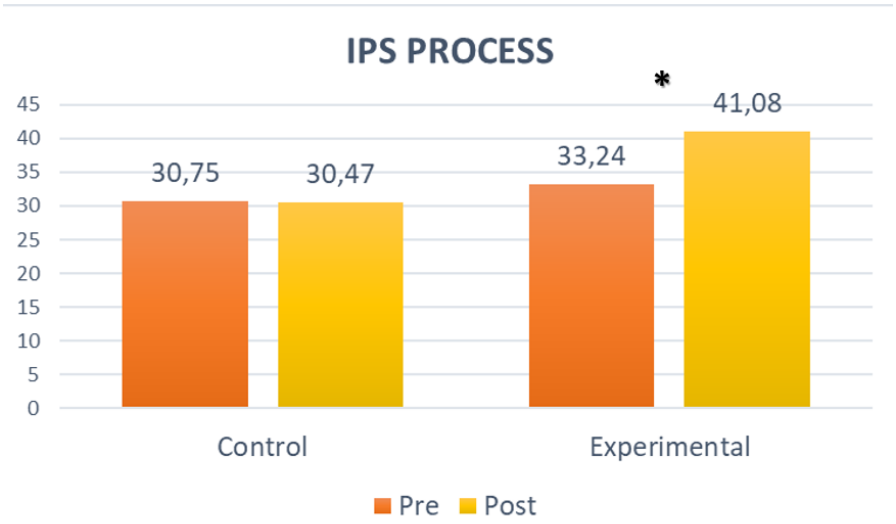

Figure 5: Results of the mixed ANOVA for the IPS process.

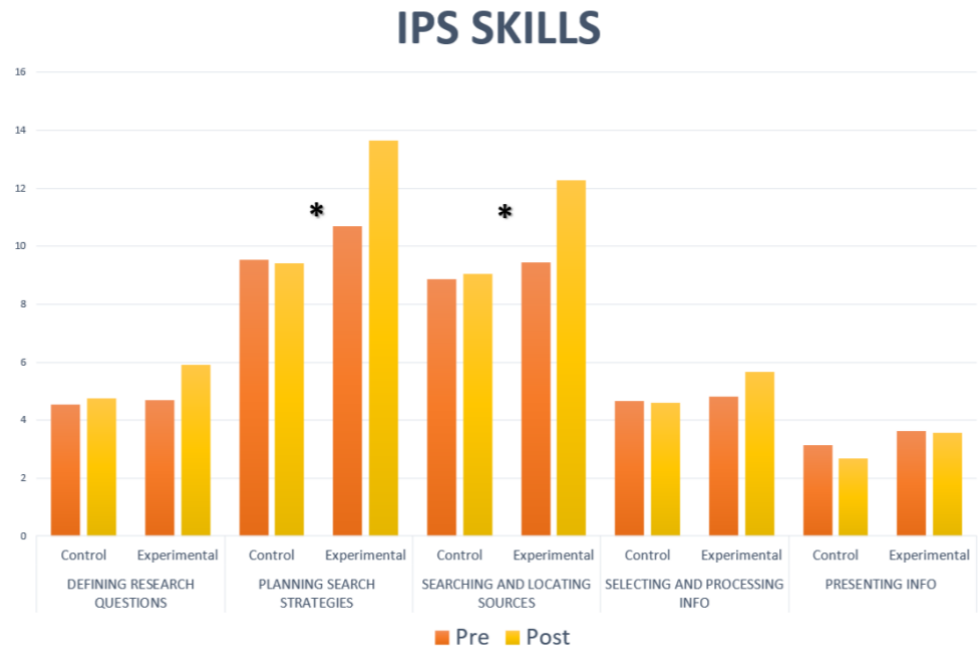

Figure 6: Results of the mixed ANOVA for the IPS skills.

These findings are in line with previous studies that have highlighted the need for instruction to improve IPS skills (Argelagós & Pifarré, 2012; Brand-Gruwel et al. (2009), Frerejean, Velthorst, et al., 2019; Garcia & Badia, 2017; Leichner et al., 2014, Rosman et al., 2018; Squibb & Mikkelsen, 2016), In particular, the 4C/ID model has proven effective in this regard (e.g., Argelagós et al., 2022; Frerejean, Van Merriënboer et al., 2019; Wopereis et al., 2015, 2016).

In terms of the "organizing and presenting information" skill, no differences were observed between the two groups, which prompted us to conduct a more in-depth analysis to highlight potential areas of improvement for the design and implementation of this course. The activities related to the "presenting information" skill are usually as follows: planning the text; utilizing the processed information; and accurately integrating it into the text through paraphrasing, quoting, in-text citations, references, etc. One possible explanation for the lack

of improvement observed is the need to dedicate more time to teaching this skill. In addition, our course did not factor in other specific academic writing abilities that are necessary to produce high-quality work (Cassany; 2015; Castelló, 2014; Castelló et al., 2012; Hyland, 2016; Mitchell et al., 2021; Swales & Feak, 2004).

While this study demonstrates the effectiveness of the course, integrating IPS instruction within an educational and curricular program would offer more opportunities for practice, and over a longer period (Frerejean, Van Merriënboer et al., 2019; Wopereis et al., 2016). Nevertheless, the online course proved to be an excellent tool for improving students' IPS skills.

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