Universitat Oberta de Catalunya

Improvement of secondary education students' Information Problem Solving skills using an Inquiry Web-based Learning environment

Information and Knowledge Society Doctoral Programme

Doctoral Thesis - 2020

Marta Gómez Domingo

under the supervision of Dr. Antoni Badia Garganté

When you make the finding yourself – even if you’re the last person on Earth to see the light – you'll never forget it.

Carl Sagan

Acknowledgments

I would like to communicate my sincerest gratitude to my advisor Dr. Antoni Badia Garganté, for the continuous support of my Ph.D study and connected research, for his patience, inspiration, and breadth of knowledge. His guidance has helped me during the whole elaboration process of this thesis. I could not have imagined having a better advisor and mentor for my Ph.D study.

Besides my advisor, I would like to express my gratitude to the rest of my thesis committee: Dr. Lorena Becerril Balín and Dr. Consuelo García Tamarit, for their encouraging me on my work, but also for the rigorous questioning which incentivized me to improve my research from various perspectives.

My honest thanks also goes to the teachers and students of the IES Manacor and IES Pau Casesnoves, who gave me the opportunity to join their educational teams with trust in my work, and who provided me with access to the classrooms and technologies of their high schools. Without their support it would not have been possible to achieve the pursuits of the current research study. In addition, I would like to show my thankfulness to the CEPA Francesc de Borja Moll school management team, who gave me the time I needed to collect my research thesis's data, while I was also working as a teacher.

Certainly, I would also like to thank my family: my grandparents, my parents, and my sister for supporting me morally throughout the elaboration of this thesis and in the decisions that I make in my life, without their help I would not have gotten here.

Last but not least, I would like to thank you, Miquel, because you have always encouraged me in what I do and you have never stopped believing in me. Your love and support have been crucial to make the completion of this thesis possible.

Thanks to all of you for your support, without your encouragement I would not have been able to face my challenges and succeed.

Index

Index of Figures

Index of Tables

1. Introduction

In today's global and computerized world, technological advances have become popular worldwide with a broad range of users from all around the globe (Timmers, Walraven, & Veldkamp, 2015). The current information and knowledge society that surrounds our lives has brought on a situation where information is crucial. As a result, people are expected to be able to manage the overload of information successfully (Becerril & Badia, 2013). In order to answer the needs that the current situation requires, we must begin by teaching Informational Competency. In accordance to this fact, the Organization for Economic Co-operation and Development (OECD[1]) and the Organic Law for Improvement of Quality in Education 8/2013 of ninth of December (LOMCE[2]) establishes the importance of developing the Key Competences in the schools.

Because information and knowledge are increasing fast no one can learn everything about every subject, because what might seem right at the moment could be demonstrated to be wrong tomorrow. Consequently, teaching students ideas and facts without teaching them how to use the content learnt in real-life situations is no longer sufficient. Students should be taught flexible skills that they can use in different conditions of life. Schools from all over the planet need to introduce innovative methods of teaching and learning that reproduce the changing world (Rotherham & Willingham, 2010). This is why it is important to incorporate teaching strategies that attract, engage, and enhance students' learning styles and abilities; so that they can become skilled, engaged, and committed citizens in today's society.

---

[1] The Organization for Economic Co-operation and Development is an intergovernmental economic organization with 35 member countries, founded in 1960 to stimulate economic progress and world trade. It is a forum of countries describing themselves as committed to democracy and the market economy, providing a platform to compare policy experiences, seeking answers to common problems, identify good practices and coordinate domestic and international policies of its members.

[2] Education in Spain is regulated by the *Ley Orgánica para la Mejora de la Calidad Educativa* (LOMCE, Organic Law of Education) that expands upon Article 27 of the Spanish Constitution of 1978. Education is compulsory and free for all children aged between 6 and 16 years, and is supported by the national government together with the governments of each of the country's 17 autonomous communities.

Accordingly, the purpose of the entire educational system should be to prepare students for success in their future lives, ensuring that each student can fluently and successfully develop information competency.

It is now essential for people to know how to recognize what information is necessary, find the precise information in the right site, organize and synthesize the information found, and communicate their outcomes. All these skills, knowledge, and attitudes which are needed to be able to seek information efficiently can be defined as IPS (Brand-Gruwel, Wopereis, & Vermetten, 2005).

This state of affairs is challenging since it is known that numerous studies have documented people of different ages having many difficulties developing information literacy. Bearing in mind these problems, it is progressively more recognized that explicit information literacy instruction is required to reach a satisfactory level of expertise (Lazonder & Rouet, 2008).

Responding to these demands, the purpose of the present research will be to expand further on academic knowledge available about students' information literacy development.

The current information and knowledge society requires skilled citizens to interact more effectively and efficiently. For that reason, active pedagogical methods are increasingly being carried out in the educational system focusing their attention on a curricular development based on competences rather than on only teaching content (Griffin, McGaw, & Care, 2012). Considering the situation described, it is assured that research that contributes to expanding the present knowledge on the development of different competences is more than welcome. Therefore, the present research study provides new significant information on how informational literacy could be successfully embedded in curricular development.

In educational practices several studies have detailed how different competences have to be taught at school in order to guarantee students learning. However, little attention has been paid to deeply understanding how informational literacy can be inclusively developed by different types of students that require different things. Hence, thanks to the present research, an insight on how to adapt the sequence of IPS to individual differences of students would provide a significant step on developing inclusive education.

In this period of constant change, teachers have been required to adapt themselves to a new situation that requires regularly learning different emergent pedagogical methods for effective teaching. As a result, it is necessary to provide teachers with relevant information that allows them to improve their teaching performance of informational literacy in schools. For that reason, the present research seeks to help education professionals solve questions that can emerge in their daily practice as well as facilitate a new experience where IPS is developed.

The situation previously described clearly defines the necessity of further research focused on how students develop information literacy. Currently in this research field it is well known which skills and processes participate in developing IPS. Nevertheless, not much is known about how these skills are performed by different collectives such as, in the case of the present research, secondary education students.

It becomes important to mention that, because information literacy is a process that cannot be taught separately from the learning curriculum, several studies have focused their attention on embedding it in different subjects. This process of seeking information is closely related to the process of teaching science following the inquiry approach. Therefore the current investigation facilitates knowledge about learning situation where both concepts are developed simultaneously.

In conclusion, if the above mentioned gaps that currently exist surrounding IPS development are taken into account, it is clearly essential for the present research to be developed in order to provide an answer to the educational community’s needs.

1.1. Structure

The twelve chapters of the present thesis wish to transmit in an organized manner the different steps that have been pursued to achieve the aims of the current research study.

To start with, the first and present chapter includes the acknowledgements, introduction and structure sections which help the readers to prepare themselves for the field of study that it is going to be developed.

Afterward, the second chapter emerges with the theoretical framework including a detailed revision of the existing literature that has surrounded IPS processes until now. In pursuit of this purpose, the third chapter aims to present the different teaching and learning models that have been used in science education, while simultaneously introducing the demonstrated usefulness of the Inquiry Web-Based Learning (IWBL) model. To conclude with the theoretical background that supports the current research study, the fourth chapter is used to summarize the concluding remarks extracted from the literature revision on the field of study.

Once the theoretical background has been presented, the empirical framework begins in chapter five with the research design. This chapter provides information about the research aim and objectives, the context of study, the participants, the data collection and procedure, the instruments and measures, and the data analysis.

With the purpose of presenting a structured account of the findings derived from different analyses developed from the data collected, chapter six exposes and discusses the results obtained.

In chapter seven, the conclusions of the investigation include a general picture of the chief features of the research study, considering both the theoretical and the empirical framework, in this way offering the most relevant findings achieved in this study. In addition, chapter eight deals with the limitations of the study and chapter nine with the future research lines, both chapters present the current study's strengths and weaknesses. Since the current research study grounds its roots in the educational context, it becomes crucial to highlight the educational implications that the results may have, for this reason, they are presented in chapter ten.

To close the research study, the compilation of all the bibliography that has been used to elaborate the theoretical framework is carefully presented in chapter eleven, as well as the annexes that include information dealing with the different materials employed to perform the different processes that concern this investigation are presented in chapter twelve.

THEORETICAL FRAMEWORK

2. Main Aspects That Characterize the Information Problem Solving (IPS) Process

As previously stated, the current information and knowledge society has put people in a situation where information has a crucial role and people are expected to successfully manage the information overload (Becerril & Badia, 2015). Therefore, for several years, IPS has been a relevant focus of research around the world (Behrens, 1994). Consequently, this chapter aims to focus its attention on the different characteristics, in terms of cognitive processes involved in, that, until now have conformed to the IPS process by synthesizing the main paths taken on each IPS dimension and the remaining unknowns.

In accordance with this chapter's purpose, the information is structured to offer a precise and detailed overview of the different dimensions that shape the IPS process, in order to guide the reader through an exhaustive revision about what has been done in each dimension, up to the present day.

A brief revision of early models of seeking information over the globe is presented until the IPS model while using the internet emerges. After that, the IPS process and the skills involved in students' IPS development are carefully described, to continue dealing with the different uses of the detailed skills according to the requirements of the task.

Then, since numerous studies have documented that people from different age groups have a lot of difficulties developing IPS, the main problems found in each skill will be carefully highlighted. Teaching skills to ensure students succeed when developing IPS seems a challenging task. Therefore the last explored dimension will describe the main characteristics of effective teaching and learning methods based on IPS skills acquisition.

Last but not least, the factors that may impact students' IPS skills development will be carefully analyzed in order to identify how some students' individual differences can shape the IPS process.

To conclude, the chapter ends by presenting a synthesis on what has been explored and the gaps in IPS that have been scarcely developed until nowadays.

2.1. Early Models of Seeking Information

A detailed revision of research studies that focus attention on the process of seeking information has shown that for numerous years, the process of searching for information has been a focus of research around the world (Bruce, 2011). To be more precise, the late 1980's was a period when numerous librarians and educators were debating the significance of information skills. From then until now, various models have been proposed at the national and the international levels to carefully describe the processes used by people who are pursuing information as well as to emphasize the integration of this process within the curriculum. However, the majority of publications with regard to the field of seeking information have come mainly from the United States (Virkus, 2003).

The process of seeking information, which was named information literacy by American researchers, is quite extensively analyzed and discussed in this country. In 1989 the United States established the National Forum on Information Literacy where different collectives supported collaboration to promote principles for appropriate information literacy development in students. These principles mainly focused the attention on encouraging students to access information competently and successfully, to evaluate critically the information found, and to use precisely the information selected to properly share the information with others.

Since then, several models of information literacy have been proposed by American researchers through the years. Each suggested model tried to indicate the different steps that the students must follow in order to solve, in a logical and sequenced way, an information problem as well as the different abilities that must be acquired in each step.

Of the different models that emerged in North America during the 1980s and 1990s, the four most outstanding models were: the research process model (Stripling & Pitts, 1988), the Big6-model (Eisenberg & Berkowitz, 1990) , the search process model (Kuhlthau, 1988) and the pathways to knowledge (Pappas & Tepe, 1995).

However, as can be seen on Table 1, the four outstanding models and other American models that emerged during the same decades have a similar pattern. They divide the process in different steps that can be grouped into six stages that express the logical cycle of a study and allow us to find similarities between them.

Table 1
Comparison of American Information Literacy models

Stripling and Pitts (1988)	Kuhlthau (1988)	Lamb (1990)	Joyce and Tallman (1990)	Eisenberg and Berkowitz (1990)	Pappas and Tepe (1995)	Yucht (1997)	Jukes, Dosat and Matheson (1997)	INFOhio (1998)	McKenzie (2000)
Research Model	Information Seeking	8W's	I-Search	Big6 Information Problem Solving	Pathways to knowledge	FLIP It	5 As	Dialogue Model	Research cycle
1. Choose a broad topic. 2. Get an overview of the topic. 3. Narrow down the topic. 4. Develop the statement.	1. Initiation. 2. Selection. 3. Formulation of focus.	1. Watching. 2. Wondering.	1. Selecting a topic.	1. Task definition.	1. Appreciation.	1. Focus.	1. Asking.	1. Define. 2. Initiate.	1. Questioning. 2. Planning.
5. Formulate questions. 6. Plan research.	4. Exploration.	3. Webbing.	2. Finding information.	2. Information seeking strategies.	2. Presearch.	2. Links.	2. Accessing.	3. Assess. 4. Locate.	3. Gathering.
7. Find, analyze and evaluate information.	5. Collection.	4. Wiggling.		3. Location and access.	3. Search.	3. Input.	3. Analyzing.	5. Organize.	4. Sorting & Sifting.
8. Evaluate evidence.		5. Weaving. 6. Wrapping.	3. Using information.	4. Use of information.	4. Interpretation.		4. Applying.	6. Guide.	5. Synthesizing.
9. Establish conclusions. 10. Create and present a product.	6. Presentation.	7. Waving.	4. Developing a final product.	5. Synthesis.	5. Communication.	4. Pay off.		7. Use.	7. Reporting.
(Reflection point)	7. Assessment.	8. Wishing.		6. Evaluation.	6. Evaluation.	5. IT!	5. Assessing.	8. Evaluate.	6. Evaluating.

Adapted from Lamb (2001).

The early American search-process model suggested by Stripling and Pitts (1988) was a ten step search-process model which was defined as a thinking frame for research. This ten step process is particularly interesting because it emphasizes a thinking framework that can be appropriate at any age level and with any curricular subject. During the process, each step simultaneously developed different abilities that enabled the acquisition of a rich experience in the field of writing research papers. Moreover, the students had numerous reflection points which let them make judgments about their progress.

Not much later, Kuhlthau (1988) suggested one of the models with higher impact in the field of information literacy since it is based on research. This model, named Information Search Process (ISP), broke away from the idea that students can only perform data collection processes. Instead students' cognitive, emotional, and physical dimensions were taken into account, because they could have a greater impact on the understanding and development of knowledge. The dimensions that could influence the students' information interpretation could also lead them to behaviors that would become obstacles in further steps of seeking information. For this reason, this model supported the idea that students should be guided in order to reduce their feelings of insecurity and uncertainty in the search process.

The 8W's model developed by Lamb in the early 1990s, but presented by Lamb, Smith, and Johnson (1997) was similar to the work of Eisenberg and Berkowitz (1990) and Kuhlthau (1988). However, participation was motivated through a fun word game with the initial letters of each stage of the model. For instance, the first step "Watching" asked students to explore and become observers of the environment presented. Then, "Wondering" had students focus on brainstorming options, discussing ideas, identifying problems, and developing questions. "Webbing" was the third step of the model and directed students to locate, search for, and connect ideas and information, showing them that one piece of information could lead to new questions and areas of interests. After, "Wiggling" consisted of evaluation, which was observed to be the toughest phase for students because they were uncertain about what they had found and where they were going. Once the students had evaluated, “Weaving” emerged to ask them to synthesize what they had found by organizing ideas, creating models, and formulating plans. Closely related to the fifth step, “Wrapping” included creating and packaging ideas and solutions. The seventh step, “Waving” encouraged students to communicate ideas to others through presenting, publishing, and sharing. Finally, the last step, “Wishing” consisted of assessing, evaluating and reflecting on the process and the product, which led the students to think about how the research went and to think about possibilities for the future.

The same year, Marilyn Joyce and Julie Tallman presented a four step research model named I-Search that was based on Macrorie’s 1988 book entitled, *The I-Search Paper*. This model proposed an alternative to the traditional research role by allowing students to select topics of personal interest and consequently develop meaningful research projects (Joyce & Tallman, 1997). Therefore, the first step to be followed was named “Select a topic”, which required students to explore their interests, discuss ideas, and browse resources. Once this step was completed, students moved on to “Find information”, which consisted of generating questions and exploring resources. Once information was found, they had to “Use information” that demanded students take notes and analyze the materials found. This analysis allowed students to achieve the last step called “Develop the final product” which encouraged pupils to communicate and share experiences of the process. Moreover, this model also highlighted the relevance of metacognitive thinking, since students were requested to carry on a register of their procedures, feelings, and thoughts while they developed the procedure.

Otherwise, the Big 6 model was the most popular model for information literacy during the early years. Developed by Eisenberg and Berkowitz (1990) the model emphasized the importance of developing transferable, higher level thinking skills that were linked to the general school curriculum. Therefore, the model suggested an information literacy curriculum oriented for primary and secondary education students. Even though the model only comprises six stages, certain primary teachers found the model too extensive for their early pupils. Consequently, teachers developed adapted varieties to achieve the necessities in their classes. Later, Eisenberg and Berkowitz developed a version called the Super 3 for very young learners which included three steps: plan, do, and review. Furthermore, several adjustments of the model have been made in order to address diverse learning situations that have emerged over the years. This has fostered the model relevance and its applicability on IPS.

One of the mid-nineties American models that dealt with information literacy was the Pathways to Knowledge model proposed by Pappas and Tepe (1995). This six step model was particularly interesting because the authors described the process as a nonlinear process for finding, using, and evaluating information. In addition, the model designed for children and young adults encouraged students to continuously explore and reassess as they process information which coincides with current relevant research studies (Monereo & Badia, 2012). Hence, the different steps of: “Appreciation”, “Presearch”, “Search”, “Interpretation”, “Communication” and “Evaluation” could be developed without a specific order depending on what the tasks demands.

A few years later, Yucht (1997) stated that what students often needed was an IPS strategy because they knew how to proceed but they did not know how to begin each step in a process. Therefore, the author and a team of seventh grade students developed a four step model, named FLIP It. This model was originally based on the organization of the different tasks that students developed in a research process. From the grouping of several procedures performed by the students, four steps were found: “Define specific problem”, “Identify and locate likely resources", "Gather information" and "Present findings". Then, the author asked her students to create a four-letter acronym word to easily remember the information strategy they had elaborated, which led them to: "Focus on the topic", "Locate the appropriate resources", "Investigate the information" and finally "Produce the results of the findings", giving birth to FLIP.

However, then they decided to add "It" for "Intelligent Thinking" in order to consider a phase of reflection and evaluation of the process taken. In addition, the FLIP It model was cohesive with Pappas and Tepe (1995), because this process could also be moved in any direction needed, which allowed students to move both backwards and forwards depending on their needs.

Jukes, Dosat and Matheson (1997) defined a five step model named the 5 As, in which each step of the process started with the letter A. For instance the first step was "Asking" which required students to ask themselves the answers to key questions. The second step was "Accessing" which drove students to consult relevant information in the field of the research. Once the information was consulted it had to be analyzed, which gave way to the third step of the process, "Analyzing". After the information had been analyzed it was time for "Applying", a step that encouraged students to apply the information found to the task given. Finally, the step that concluded the process was "Assessing" which considered the assessment of the final result as well as the assessment of the whole, developed process.

A year later, the DIALOGUE model suggested by the Information Network for Ohio schools (1998) also presented eight steps to be followed in an information research procedure with a mnemonic device word. For instance, the letter D required students to define the need of information and the letter E demanded students evaluate the results. The model aimed to be a support structure to foster the development of research, problem-solving, and metaconginvite skills through the collaboration of the classroom teacher and the teacher-librarian.

The main American model for information literacy was the Research Cycle model suggested by Jamie McKenzie (2000). It emphasized the significance of considering students as information producers rather than merely information searchers. Therefore, the model places stress on questioning, rejecting many of the models that focused their attention on topical research. His model demands that pupils make decisions, give answers, and show autonomous judgment by moving repetitively through the subsequent steps in the research cycle: “Questioning”, “Planning”, “Gathering”, “Sorting and Sifting”, “Synthesizing”, “Evaluating”, and “Reporting”. The last step mentioned was developed after several repetitions of the cycle. Hence, a relevant characteristic of this model is its focus on actively revising and rethinking the research queries during the process.

In 1998, thanks to the great improvements that emerged after the broad range of research studies developed in the field of information literacy, the Institute for Information Literacy was born, leading the United States Department of Education to include, in 2000, information literacy in its national education technology plan. However, despite the huge amount of models proposed by American researchers during the 1980s and 1990s, references to information literacy publications in Europe are scarce and fragmented. In fact, the greater number of research studies have come from the United Kingdom, which leads to the idea that this lack of research on information literacy may be induced by the language barrier, since there is a presence of publications in local languages such as: Finnish, French, German, Norwegian, Spanish and other languages, but not in English in other European countries during the mentioned decades (Virkus, 2003).

One of the most important contributions in Europe was the one of Irving (1985) who stated that the research process was a vital part of our daily lives and for that reason it had to be directly linked to permanent learning. For instance, when we are ill, we look for medical information or when we do not want to have dinner at home, we search information about different restaurants. Moreover, with her nine step information skills model, Irving stressed the importance of a resource-based learning approach that emphasized the significance of addressing individual differences in teaching and learning style and the relevance of students, teachers, and librarians collaborating toward this joint goal.

Several years after the aforementioned models of information literacy appeared, a group of researchers in the European Union initiated a succession of studies that looked at students' IPS development and metacognition on the web. These studies, which were mainly based on a revised version of the Big 6 model, illustrated the importance of metacognitive skills in the IPS process on the web.

2.2. IPS Model While Using the Internet

With the appearance of the World-Wide Web, the IPS process had undergone several changes (Brand-Gruwel, Wopereis, & Walraven, 2009). Solving an informational problem using the internet undoubtedly differs from solving it using a library database as was done in the past. Therefore, the older models of the IPS process do not fit with the new educational-social context. The internet has its own characteristics, the volume of information is huge, the information does not appear following an established pattern and there is no filter of information. These features have promoted an adjustment of how the whole process of IPS is developed (Timmers et al., 2015). In light of the network society's current situation, several models that describe and analyze the problem solving process based on information from the Web have been proposed (Gerjets & Hellenthal-Schorr, 2008).

However, the model of Brand-Gruwel, Wopereis and Vermetten (2005) accurately defines the skills required to solve an informational problem when the Internet is used, and has been the most widely considered in IPS process research by different authors and perspectives until now (Bråten, Strømsø, & Salmerón, 2011).

As can be seen in an updated and verified version of the model suggested by Brand-Gruwel et al. (2005), Figure 1 has been developed with consideration for different cognitive processes defined by the central cognitive skills as well as the regulatory and conditional skills both involved in the process of IPS process while using the internet.

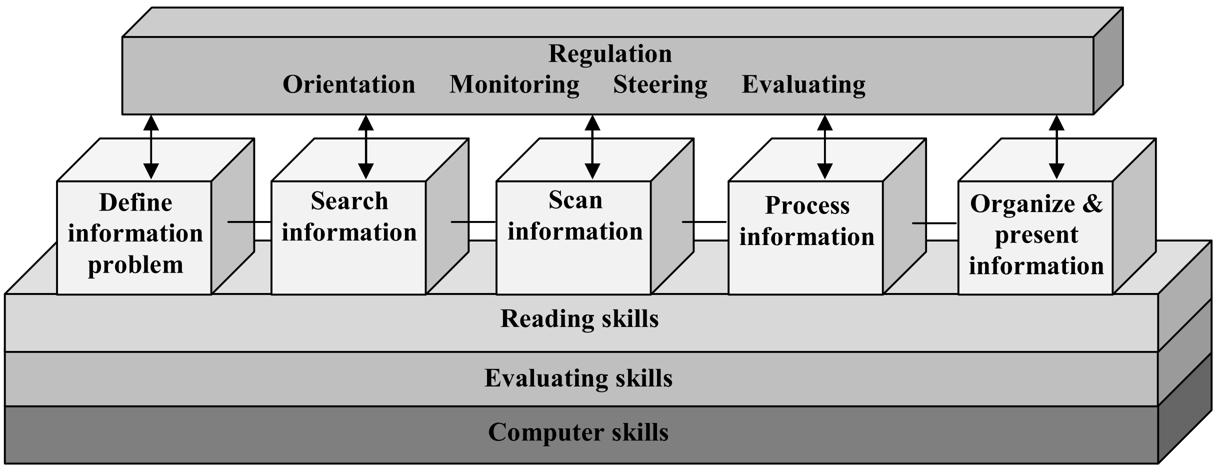


Figure 1. Model of IPS while using Internet
Source: Brand-Gruwel et al. (2009).

In the following sections, the model presented and the cognitive processes involved with it will be explained in detail, considering the central skills and sub-skills as well as the regulatory and conditional aspects.

According to the IPS-I-model, students need to hone the following central skills when developing IPS using the Internet: "Define the information problem", "Search information", "Scan information", "Process information", and "Organize and present information".

The first stage of an IPS process has the intention of defining the information problem. At this stage it becomes crucial to acquire a precise vision of the problem to be solved. In order to ensure this, it is essential that students develop several sub skills, such as: "Read the problem to be solved", "Formulate questions regarding what needs to be done", "Activate previous knowledge on the topic", "Outline problem requests", and "Designate required information".

Secondly, the main objective in that phase is to find the information needed to solve the task presented. The process of searching for information will demand that students develop certain sub skills, such as: "Select an appropriate search strategy", "Define the search keywords" and "Judge search results".

Once a web site has been opened, it is time to develop the third stage of the IPS process, which is mainly focused on scanning the information found, and then deciding what information will be useful in answering the initial task. Four different sub skills contribute to this aim: "Read information found", "Judge the consistency of the information", "Select relevant information", and "Elaborate on content".

After choosing the relevant information to solve the IPS task, a deep processing of the selected information is required. Hence, the fourth stage of the IPS process is focused on reaching a profound comprehension in order to integrate the different pieces of information found with significant previous knowledge (Wopereis, Brand-Gruwel, & Vermetten, 2008). At that stage several sub skills are also developed, such as: "Read information found", "Judge the processed information", "Choose appropriate information" and "Elaborate on content". Elaboration is a central part of the constituent skill and it is articulated by analyzing, selecting, and structuring information (Brand-Gruwel et al., 2009).

Finally, the outcomes of the whole search process have to be synthesized in order to give an appropriate answer to the initial problem-solving task. Therefore, the stage of organizing and presenting information arises to make the product as was initially required. Moreover, this stage involves the performance of some sub skills, such as: "Frame the problem", "Structure selected information", "Plan the product", and "Create the product".

Final products can have different formats, such as an info graphic, which requires additional domain of computer skills, or a more modest written text like an essay on the topic.

Despite the differences in the central skills and sub-skills, when the IPS task is presented, the students need to create a strategy in order to solve the information problem. Therefore, throughout the whole process of IPS the usage of regulatory aspects becomes fundamental. According to Brand-Gruwel, Wopereis and Walraven (2009), students have to monitor, steer, and evaluate whether the proposed strategy is still the right one, or decide if modifications in tactic are required.

Orientation towards a task is focused on the analysis of the task as well as how it performs. Throughout the orientation of the task, the whole situation is measured including the features of the task presented, the context where it will be developed, and the main characteristics that the final product requires. An estimate of the time needed for task fulfillment is also examined in order to know how much time will be devoted to each particular activity. Previous knowledge on the topic or the problem stated is examined along with competency.

Steering includes the decisions made after having carried out the orientation activity. These decisions will guide what activities have to be performed, establishing direction for achieving the activities. Steering occurs on a macro level (which includes the general planning) and on a micro level (which includes what to do next).

Monitoring the process means supervising the task performance that is being implemented. This activity is considered to be less profound than an orientation towards a task.

Evaluating aims to assess the process and the product. When this evaluation is executed during task performance it is called formative evaluation. Cases where both process and product are evaluated at the end of the IPS process are called summative evaluation. Summative evaluation is relevant for fine-tuning future performance.

The regulatory activities mentioned must be executed at a level sufficient to solve information problems effectively. However, to do so, students are also expected to have the adequate reading, evaluating, and computer skills, which are described in the model as the conditional skills (Brand-Gruwel et al., 2009). Some of the aforementioned conditional skills, such as reading skills and computer skills, will be deeply analyzed in the following chapter of the present dissertation.

The updated version of the model presented by (Brand-Gruwel et al., 2005) provides an accurate overview of the central skills required to solve an informational problem when the internet is used to solve it. As has been described, the model suggests that these skills have to be developed as different steps to be followed during the process of IPS; with the help of certain regulatory aspects that have to be taken into account in order to adjust and enrich the whole process. Consequently, IPS has been seen for several years as a sequence of certain skills to be developed in a structured way in order to solve the problem given (Brand-Gruwel et al., 2009).

However, other research studies differ from the idea that the skills mentioned have to be developed in a sequenced manner. Instead, they suggest that these skills can be used by the students according to the diverse necessities of the assignment and according to the requirements that the task demands (Badia & Becerril, 2015; Becerril & Badia, 2015; Monereo & Badia, 2012; Şendurur & Yildirim, 2015).

Researchers who agree that the skills presented and regulatory activities derived from the IPS-I-model are not developed instinctively by the students support the view that these processes must be learned and improved by the students with the help of efficient instruction on IPS (Puustinen & Rouet, 2009).

According to Monereo and Badia (2012), being able to produce a strategic resolution to an IPS task involves developing each skill with a high level of expertise in self-regulation, and staying consistent with the characteristics of the task's requirements to solve the informational problem.

Additional support for this comes from Becerril and Badia (2013), who developed a research investigation focused on studying information literacy in peer learning among secondary school students. This study exposed how the kind of task impacted the process of building common knowledge when solving an IPS task. Their results showed that the process of building common knowledge was stimulated by different interactive processes in which the task demanded that students select and establish conceptual relationships, and also that IPS processes had larger incidences of building common knowledge in tasks that required students to interpret information.

In order to label the previous findings, Naumann (2015) presented the concept of task-adaptive navigation, which means that navigation behavior is responsive to task demands, as information is accessed and processed as required by the task. This concept emerged after analyzing data from the Digital Reading Assessment test of 17 countries obtained thanks to the Program for International Student Assessment (PISA[3]) in 2009. The results found supported the proposed model of online reading engagement, which mentions that task-adaptative navigation behavior predicts digital reading task performance, which was demonstrated by significant interactions between navigation behavior and navigation demands.

The concept derived from task-adaptative navigation behavior has been recently supported by Walhout, Oomen, Jarodzka and Brand-Gruwel (2017) who pursued the study of

---

[3] Every three years, PISA which is the Programme for International Student Assessment from OECD, measures how well is 15-year-old students' level from all over the world in the main areas of reading, mathematics and science. The results obtained from the tests allow determining if students are prepared for real-life situations in their adult world.

influence of task complexity on search query formulation, evaluation of search results, and task performance. The results derived from their research study demonstrated that an increase in task complexity gives way to more search queries and keywords used, more time to make search queries, and more search results taken into account on the search engine results page. These results lead them to conclude that growth in the task difficulty directly influences the task performance as well as the search behavior itself.

Şendurur and Yildirim (2015), who pursued an investigation of the whole search process of 13-year old students, also demonstrated that search patterns can change according to the types of task. More precisely, the results from their research stated that the amount of pages visited, the manner in which keywords were used, and the level of task accomplishment changed significantly across task type. Moreover, if attention is focused solely on the information scanning skill, five types of information scanning were defined which depended on the task at hand: (a) one-shot, (b) forward linear, (c) backward linear, (d) mixed, and (e) non-linear.

The first scan type defined was one-shot scan and included students that visited only one web page, without judging the connection of the content with their aim. If students were not able to find the information they were searching for, they did not continue with the search. The second and third scan types were considered linear but with different directions. The forward linear scan type started with high-ranked pages and continued to the lower ranks, in contrast the backward linear scan type started first with low-ranked pages and then continued to higher ranks. The fourth type, mixed scans demonstrated a different pattern, including both features of forward and backward linear scanning in one search session. The last scan type was named non-linear, which was the type of scanning that did not follow a linear pattern.

Boutet, Lemieux, Goulet, and Collin (2017) reinforced previous findings with the results from their research, which was based on investigating whether prior knowledge of the task's requirements influenced eye movements elicited during configural and featural face processing tasks. The results of their experiment suggest that faces elicit different scanning patterns depending on task demands. When participants were unaware of the nature of the information relevant to the task at hand, face processing was dominated by attention in the eyes. When participants were aware that relational information was relevant, scanning was dominated by fixations towards the centre of the face. These results lead them to conclude that faces do not elicit a single pattern of eye movements, but that different scanning strategies can be deployed depending on task's demands.

The above-mentioned findings, derived from several research investigations in this field of study, drive us to conclude that the learning sequence while developing IPS could be used in a flexible way. Especially considering that, depending on the demands of the tasks presented, some skills will have more or less relevance on the resolution process. Nevertheless, as studies that focus their attention on finding possible relations among students' IPS skills performance and the different tasks type are scarce, it becomes important to increase the number of studies that gather information about how both variables may be related in order to improve students' development of IPS tasks.

2.3. Types of Research Investigations Surrounding IPS-I-Model in Education

In the last two decades, investigation of the IPS process using the internet has produced a huge amount of knowledge. Numerous investigators in library, information, and educational sciences have studied methods and abilities related to information use (Argelagós & Pifarré, 2016; Julien & Barker, 2009; Probert, 2009; Raes, Schellens, De Wever, & Vanderhoven, 2012; Şendurur & Yildirim, 2015; Timmers, Walraven, & Veldkamp, 2015). Due to large number of studies in various disciplines that surround the IPS process when using Internet in Education, several paths have been opened with the intention to better analyze the processes performed by information seekers.

Despite its variability, the investigations that have dealt with this subject can be classified into three large main groups according to their focus of study, as can be seen in Table 2.

Table 2
Main types of research investigations surrounding IPS-I-Model in education

Types of research investigations	Sub-types of each path
1. Problems students face when developing the IPS process.	1.1. Problems when performing the central skills of the IPS process.
	1.1.1. Define information.
	1.1.2. Search information.
	1.1.3. Scan information.
	1.1.4. Process information.
	1.1.5. Organize and present information.
	1.2. Problems when developing regulatory activities of the IPS process.
	1.2.1. Orientation.
	1.2.2. Monitoring.
	1.2.3. Steering.
	1.2.4. Evaluating.
	1.3. Problems regarding the conditional skills of the IPS process.
	1.3.1. Reading skills.
	1.3.2. Evaluating skills.
	1.3.3. Computer skills.
2. Effective teaching and learning methods focused on IPS skills acquisition.	2.1. Organized knowledge base.
	2.2. Embedded in other domains.
	2.3. Supported by scaffolds.
3. Factors that influence IPS process.	3.1. Contextual factors.
	3.2. Individual factors.
	3.3. Resource factors

The research that is located in the first group focuses on the problems that students face when developing IPS tasks. In the second group, investigations are related by a common problem, which is successfully teaching IPS skills to assure students' success when developing IPS. This second field of study deals with the characteristics of effective teaching and learning methods focused on IPS skills acquisition. The third field of study, in accordance with the interests of this research work, deals with the main research contributions that analyze how several factors may have effects on both the results and the search process of IPS, which will be deeply explored in the next chapter of the present research.

In order to draw an overview of the state of affairs, literature on the search for information in the educational field of the three groups cited above will be reviewed.

2.3.1. Problems students face.

As previously declared, with the arrival of the Internet, hypermedia systems have become a leading tool that facilitates the access of information to a large variety of users. Because hypermedia helps learners accessing educational content, hypermedia has been recognized to have a huge potential when providing information to learners. However, the non-linear nature of hypertext environments, in addition to other specific features, can generate certain difficulties during the IPS process, converting the resolutions of informational problems in hypermedia environments into a more complex and challenging task for our students (Walraven, Brand-Gruwel, & Boshuizen, 2008).

In this line of research, when students face problem solving activities several issues can appear. Consequently, an important field of study has been centered on detecting issues that students face while developing IPS skills in the Internet. Several authors agree that many students often use superficial strategies for seeking and treating information and cannot solve informational problems effectively (Badilla Quintana, Pujol, & Romani, 2012; Head & Eisenberg, 2010; Monroe-Gulick & Petr, 2012). For this reason, this section wishes to elaborate a summarized revision of which difficulties have been highlighted when developing the constituent skills of the IPS-I-model previously presented. The results derived from this revision have been summarized on Table 3.

Table 3

Summary of problems secondary education students face while developing IPS Skills

Authors	Define the information problem	Search information	Scan information	Process information	Organize and present information
Probert (2009)	-	-	-	Students do not store relevant information but modify text from the site and add it to the product.	Students simply 'copy and paste' their answers when using digital information in their tasks.
Walraven et al. (2010)	Students have problems with "activating prior knowledge", "clarifying task requirements" and "determining needed info".	-	Students often do not evaluate results, information and sources.	Students rarely take the time to read the information in-depth.	-
Badilla Quintana et al. (2012)	-	Students do not know which search terms to use.	-	-	-
Monroe-Gulick and Petr (2012)	Students generally show deficiencies with regard to defining the information problem.	-	Students trust the information found, even if information does not fit with prior knowledge.	-	-
Raes et al. (2012)	-	-	-	-	Students include whole fragments of information extracted from the internet in their answers.
Şendurur and Yildirim (2015)	-	Students' use of correct keywords does not always make the right results.	-	-	-
Chevalier, Dommes and Marquié (2015)	-	Students present difficulties reformulating requests, navigating and browsing websites.	-	-	-
Argelagós and Pifarré (2016)	Students' lack of reflection regarding the actions to be taken to solve the digital task contributes to the difficulty of defining the information problem.	Students have problems selecting reliable and useful results.	-	-	-
Salmerón, Naumann, García and Fajardo (2017)	-	-	Students have difficulties assessing hyperlink relevance from a webpage.	-	-

Firstly, the skill responsible for defining the information problem is hardly included in IPS research despite it being a key stage to succeed in the whole process (Walraven et al., 2008). When students are required to define the information problem, students are also asked to elaborate a mental representation of the problem to be solved, internalize the search problem statement, and extract or infer useful keywords to formulate a query (Sanchiz, Chin, et al., 2017).

However, students from various ages generally present deficiencies with regard to defining the information problem (Monroe-Gulick & Petr, 2012). Apparently a lack of reflection regarding the actions that must be taken to solve the digital task contributes to the difficulty of defining the information problem (Argelagós & Pifarré, 2016b).

Correspondingly, Walraven, Brand-Gruwel and Boshuizen (2010) highlighted that students tend to have important problems with the subsequent tasks "activating prior knowledge", "clarifying task requirements", and "determining needed info". This fact is alarming since the constituent skill of defining the information problem is mainly sustained by the mentioned sub-skills, among others.

Second, searching for information has been the main skill analyzed in IPS research studies. Therefore, a broad field of study has been conducted regarding the difficulties that the students may encounter when performing this constituent skill.

The development of this skill involves planning actions to complete the search objective. Once the strategy that will be followed has been defined, students have to analyze and evaluate the search results emerged by comparing them with the objective of their research. If the results do not match the students' information requirement, students may decide to reformulate the question they produced and change the keywords used to produce a new question. However, developing this process of searching for information might not be an easy process for a significant number of students. No matter how advanced their technical skills, the related literature claims that students face certain difficulties while searching for information (Bar-Ilan & Belous, 2007).

One of the main difficulties demonstrated by this process is that students do not always know which search terms to use (Badilla Quintana et al., 2012). According to Şendurur and Yildirim (2015), even if meaningful keywords are entered, there can be irrelevant clicks, superfluous content, long search durations, and so forth. This fact leads us to conclude that appropriate keywords do not always produce relevant results. Moreover, apart from the numerous difficulties exhibited by the students when typing appropriate search terms, they also have several problems when selecting reliably useful results from a search engine (Argelagós & Pifarré, 2016b; Brand-Gruwel et al., 2009).

The difficulties mentioned would seem a more frequent problem to novice readers, and selecting menu items or text passages posed difficult problems even to experienced readers (Rouet, Ros, Goumi, Macedo-Rouet, & Dinet, 2011). After deciding the relevance of the findings emerged, if the information is not cohesive with the purpose of the research, the initial question or keywords have to be reformulated. This procedure is complicated due to the numerous difficulties present when reformulating requests, navigating the web, and browsing websites (Chevalier et al., 2015). The skills to find reliable information do not develop spontaneously; they require instruction (Walraven et al., 2008). Surprisingly, instruction on these IPS skills receives relatively little attention in education (Walhout et al., 2017).

Third, once the appropriate webpage is located, the hard task of scanning the information found arises. The aim at this stage is to evaluate search results, information, and sources to properly select the information that will help students to elaborate on the content and give an answer to the initial tasks' requirements. However, it seems that the assessment of hyperlink relevance in a search engine results page is a difficult mission for students, which is suggested to be caused by the lack of previous knowledge on the research topic (Salmerón et al., 2017).

The selection of information seems to be based on the information one expects to find, and not by considering important aspects such as validity, authority, and actualization of the information found. Hence, teenagers exhibit relevant problems with distinguishing the reliable information from the questionable and due to this run into serious problems when selecting the useful information for the task fulfillment (Lazonder & Rouet, 2008). Therefore, students use information that properly fits with the tasks' requirements despite the fact that the origin of the information used is commercial or not focused on scientific purposes. In fact students confirm that they trust the information they find, even if this information does not agree with their own experience (Monroe-Gulick & Petr, 2012).

Even though processing information is not an easy task for students, few researches in the field of IPS have focused their attention on going deeper into how this skill is developed by the students, in order to discover the main problems that students might face. Focusing our attention on the latest findings in the field, as with the previous skill analyzed, students hardly ever take the time to read the information found in a profound way (Wallace, Kupperman, Krajcik, & Soloway, 2000), which leads them to miss relevant information that could be employed to give a better answer to the initial question. Moreover, pupils have a tendency to review the processed information by seeking the exact words they expected to find to give an answer (Large & Beheshti, 2000). Likewise, students do not collect relevant information, they simply transform the text from the site and insert it into their final product (Probert, 2009).

Finally, it is important to highlight that present information has not been described enough in previous studies to point out numerous problems that students might encounter. However, when the final skill of the process has to be developed, students also fall into using the common, but inefficient, strategy of "copy and pasting" from digital information found to write answers for their assignments (Probert, 2009).

Raes, Schellens, De Wever and Vanderhoven (2012) also observed the frequent usage of this strategy in high school students who included whole fragments of information extracted from the internet in their answers. However, the way the information must be organized and presented in itself seems to be a complex cognitive skill. Therefore, increasing the number of present studies focusing on students' writing skills will perhaps proportionate a deeper understanding of the difficulties students face with this skill (Walraven et al., 2008).

As numerous research studies have displayed, during the resolution of IPS tasks it becomes quite easy for the students to lose orientation and therefore not know how the information found fits into the big picture and which hyperlinked path to follow. Moreover, several authors agree that many students often use superficial strategies for seeking and treating information and cannot solve informational problems effectively (Brand-Gruwel et al., 2009; Head & Eisenberg, 2010; Monroe-Gulick & Petr, 2012; Pujol, Quintana, Romaní, & Gibson, 2009). Additionally, it is important to highlight that numerous studies have been developed in order to detect the main problems that students face while developing the first constituent skills ("Define the information problem" and "search information").

However, less attention has been paid to the rest of the constituent skills ("Scan information", "Process information" and "Organize and present information"). Taking into account the previous mentioned studies, it is undeniable that an effective IPS instruction needs to be designed when students learn IPS skills. For this reason, more studies are needed in order to overcome the possible problems that could appear in the rest of the constituent skills.

2.3.2. Effective instructional principles.

As previously stated, IPS has been a field of study for several years, but with the internet's arrival into society, the process has changed and research focused on teaching strategies to improve students' problem-solving skills on the web has increased in the last decade. Consequently, an extensive body of research has highlighted different instructional principles that allow us to define an effective instruction of IPS skills. Therefore, in this section the effective instructional principles derived from research in the field of study is reviewed. The result of the developed review is the summary presented in Table 4 which leads to the synthesis of the main findings on effectively teaching IPS skills.

Table 4.
Synthesis of recent findings on teaching effectively IPS skills

Authors	Organized by a knowledge base	Embedded in other domains	Supported by technological scaffolding
Gerjets and Hellenthal-Schorr (2008)	An organized knowledge base helps students to relate the contents and strategies learned.	-	Adaptable and temporary supports avoid to students feeling overwhelmed by the different activities they have to perform when developing IPS tasks.
Kuiper et al. (2008)	Providing explicit instruction becomes a key part of the learning process.	Thanks to embedding the teaching of Web skills within content matter skills become meaningful for students.	-
Stadtler and Bromme's (2008)	Students need to understand what the IPS skills are and when they should be used.	-	Offering students an adaptable and temporary support system during the initial phase of the learning process is positive.
Walraven et al. (2010)	Students have to be stimulated to pay explicit attention to the various steps that have to be taken in an IPS process.	Students need to realize how steps can be used flexibly in different situations by abstraction and metacognition.	-
Argelagós and Pifarré (2012)	-	IPS skills should be taught through situated problem solving.	Scaffolding helps to accomplish all the steps needed to successfully solve a problem.
Raes et al. (2012)	-	Connected instruction that promotes IPS within inquiry activities is effective for teaching the highly interrelated constituent skills and sub-skills involved in IPS.	The scaffold should provide enough information so that the learner makes progress on his or her own.
Manson et al. (2014)	-	-	Scaffolds trigger students to activate key cognitive processes to solve the learning task.
Hutchison and Colwell (2014)	-	Digital tools provide new learning opportunities and contexts that must be used to foster the knowledge acquired in other domains.	-
Brand-Gruwel, Jarodzka, van Dijk, de Groot and Kirschner (2015)	-	Learners should not be taught Web skills through isolated assignments or worksheets.	-
Van Merriënboer and Kirschner (2018)	-	Training of IPS skills should be intertwined with the teaching of domain specific skills taught in the context of one or more domains.	-
Frerejean et al. (2019)	Successful problem solving depends on the existence of structured knowledge, the mastery of a set of skills and a critical attitude.	IPS practice in domain-specific instruction can potentially be effective for the development of abstract knowledge structures and cognitive strategies necessary for IPS.	Learning tasks should have diminishing support in each task class.

The first instructional principle, derived from several previous studies, defines an effective instruction of IPS skills and provides students with an organized knowledge base.

When students have to learn how to subtract, they are presented a method to follow in order to successfully solve the math operation given. Then, students are encouraged to face different subtraction problems following the procedure that contains an organized knowledge base. Once they have solved different problems several times, it is assumed that they have internalized the different steps to follow when solving a subtraction equation, which means that students will be able to solve similar problems presented in their daily lives, even outside the academic context. For that reason, when students are asked to solve an IPS task they have to be given an organized knowledge base that helps them to comprehend the different steps that have to be followed to assure they succeed. A proper way of providing students with an organized knowledge base is presenting them with a useful and comprehensible model for pupils to follow. If they understand what has to be done in each phase of the process and why is it relevant, they will be able make better decisions in each step of the process, which will lead them to be effective when solving IPS tasks in any context of their lives.

Concurrently, certain previous studies agree that students should be stimulated to pay explicit attention to the various steps to be taken in a problem solving process, in order to acquire an organized knowledge base which will help them to relate the contents and strategies learned with concrete experiences and with representations in other domains (Gerjets & Hellenthal-Schorr, 2008; Kuiper, Volman, & Terwel, 2008; Stadtler & Bromme, 2008; Walraven et al., 2010).

Conversely, the constructivist approach of de Vries, van der Meij, and Lazonder (2008), who developed a review of five different studies that tried to overcome IPS skill deficiencies via different types of instructional and environmental support, suggested that students should not be taught web skills through isolated assignments or worksheets.

Nevertheless the review performed demonstrates that most students appeared to remain inconsistent web users and did not act upon their knowledge of web searching, reading and evaluating skills.

In the investigation where two educational programs to foster IPS skills in secondary education students were designed and evaluated, Walraven et al. (2010) demonstrated that students have to be stimulated to pay explicit attention to the various steps in a problem solving process and to the way these steps can be used flexibly in different situations by abstraction and metacognition.

With older students, Stadtler and Bromme (2008) developed a research study to evaluate how a metacognitive computer tool named *met.a.ware* supported laypersons' Internet research for medical information by means of metacognitive prompting and ontological classification. The results revealed that *met.a.ware* was an effective tool that supported laypersons' internet research by helping students to understand what the IPS skills are and when they should be used.

Recently, Frerejean, Velthorst, van Strien, Kirschner, and Brand-Gruwel (2019) presented a study that investigated the effects that an IPS instruction had on future primary education teachers' IPS skills. The IPS instruction designed was mainly characterized by: (1) Learning tasks based on authentic real-life situations, (2) Supporting information to develop cognitive models and strategies, (3) Procedural information which provided gradual instruction when learners executed procedural aspects of the skill and (4) Part-task practice which allowed repeated practice for the skills used. The results revealed that the instruction received succeeded in developing cognitive strategies for solving an information problem, although improvements were not consistent in all features of the IPS skill.

Providing students with an organized knowledge base means presenting them with a useful IPS method that allows them to understand the different steps of the process and how the specific skills should be used in a critical way to successfully solve an IPS task.

On the other hand, the second instructional principle, derived from different earlier studies, defines that an effective instruction of IPS skills deals with embedding IPS processes' instruction in other domains. Perin (2011) focused on reviewing the success of contextualized instruction and concluded that the existing studies propose that when instruction is embedded within a significant context based on representations in other specific domains, it has the potential to increase students' motivation towards learning and grow greater commitment.

Aversely, isolated instruction of IPS in standalone sessions outside of a domain context has been shown to be less effective (Tricot & Sweller, 2014). In the concrete context of IPS, various authors suggest that if the organized knowledge base presented before is connected with concrete experiences and representations in other domains, the learning outcomes will be more durable, flexible and global (Argelagós & Pifarré, 2012; Britt & Aglinskas, 2002; Walraven et al., 2010).

For instance, when Spink, Danby, Mallan and Butler (2010), explored the development of young children's web search and information literacy skills when instruction was embedded in the curriculum, they showed that young students employed complex web searches, such as: keyword searching and browsing, question formulation, significant judgments, and consecutive searches.

In primary education, Kuiper et al. (2008) assessed how an educational program based on teaching web skills in the context of a content knowledge domain, influenced 10-years old students' performance and knowledge. The results demonstrated that students benefit from instruction on search and evaluation skills embedded in learning tasks focused on healthy food, because students' content knowledge and web skills improved. However, researchers also highlight that the majority of the students were still not capable web users because they did not act using their knowledge of web searching, reading, and evaluating skills.

In secondary education, Britt and Aglinskas (2002) examined students' proficiency when developing the literacy skills that dealt with sourcing, contextualization, and corroboration. To do so, they designed the Sourcer's Apprentice, which was described as a computer-based tutorial and practice environment for teaching students the abovementioned skills while learning through history texts. The results revealed that students who had used the Sourcer's Apprentice improved their abilities when performing the three literacy skills. Moreover, the essays written by these students also presented more references and information derived from primary and secondary sources than the control group.

Argelagós and Pifarré (2012) also confirmed that the teenagers in secondary education that received an IPS instruction embedded in the science curriculum had positive results when developing IPS skills. More precisely, researchers developed an investigation which focused their attention on defining which effects that a long-term, embedded, structured, and supported instruction had in secondary education students. The results determined that participants demonstrated more skilled when developing the contintuent skill of "defining the problem", and greate marks on task performance than the participants who belonged to the control group.

Consistently in previous research studies at different levels of education, it is been shown that when IPS skills are embedded in the scholarly curriculum of existing subjects, students will realize how different steps can be used flexibly in different situations by abstraction and metacognition (Walraven et al., 2010). Likewise, Francom (2018) proposes that IPS skills training should be taught simultaneously with other domain specific skills, in this way, giving a contextualization to the training.

In the same vein, Raes et al. (2012) investigated how diverse forms of scaffolding influenced students who were learning science through a web-based collaborative inquiry project. They mentioned that embedding IPS in an inquiry based learning (IBL) environment that provided multiple forms of scaffolding was effective for teaching the highly interrelated constituent skills and sub-skills involved in IPS, which leads us to the next instructional principle.

The last instructional principle, derived from numerous preceding studies, defines an effective instruction of IPS skills as having to support the IPS processes instruction by technological scaffolding. As IPS skills require significant effort to learn, students can easily become overwhelmed by the amount of different activities they have to perform (Lazonder, 2001). However, several studies have mentioned that scaffold instruction aims to avoid this problem by offering students an adaptable and temporary support system during the initial phase of the learning process (Gerjets & Hellenthal-Schorr, 2008; Huang, Liu, Chen, Kinshuk, & Wen, 2014; Pifarré, Cobos, & Argelagós, 2014; Raes et al., 2012; Stadtler & Bromme, 2008). In addition, scaffolds the activation of key cognitive processes to solve the learning task (Mason, Junyent, & Tornatora, 2014).

Consequently, technological scaffolding has achieved recognition as an important instructional scaffolding method, and its usage has increased in the field of computer-based learning environments (Morris et al., 2010). These technological scaffolding measures, defined as prompts, stimulate cognitive and metacognitive activities throughout the learning process and can vary from hints, suggestions, reminders, sentence openers, and questions, among others (Raes et al., 2012).

Recent investigations have shown an overall improvement of the students' performance when developing IPS tasks supported by prompts, which means that technological scaffolding enhances knowledge acquisition and metacognitive awareness with respect to IPS skills.

For instance, Argelagós and Pifarré (2012) revealed that the use of a methodical instruction embedded into the curricular content and supported by concrete scaffolding had a positive influence on the students' ability to define the problem. This was especially true in the two information search sub skills of "search terms" and "selection of results", as well as in the proper fulfillment of the task. The same year, Raes et al. (2012) demonstrated that students significantly improved metacognitive consciousness and knowledge achievement in sciences thanks to the use of two types of scaffolding. The first one being instructional scaffolding provided by the teacher that consisted of verbal messages, with instructions adapted to the students' needs. The second one was the same as the aforementioned scaffolding with additional technological scaffolding which was comprised of queries and propositions that emerged on the computer screen as fixed messages related to each task.

Concurrently, Yeh, Hsu, Chuang and Hwang (2014) developed a research study to help secondary education students improve the main IPS strategies with the support of an instructor's scaffolding in an IPS course designed in an Online Information Management interface. It was observed that continuous encouragement and scaffolding hints were likely the main reason for the insignificant level of participants' improvement on "disorientation" and "problem solving" skills, since they decrease the opportunities for users to experience difficulties on their own, and deal with the frustrations of independent online searching.

In coherence with what previous studies have suggested, Walhout et al. (2015) examined how a hypertext learning environment, characterized by offering navigation support with both a tag-cloud or conventional hierarchical menu, could influence students' task performance with regard to the students' gender. The results obtained demonstrated that navigational support and gender were not associated with differences in task performance, which lead them to conclude that tag-clouds support navigation and can facilitate learning from hypertext. Since it has been shown that scaffolding helps students to accomplish all the steps needed to successfully solve a problem, it becomes relevant to provide students with technological scaffolding in order to guide them through the whole learning process of information problem resolution.

In summary, an effective IPS instruction must take into account three different instructional principles in order to effectively teach IPS skills. First, students should be stimulated to acquire an organized knowledge of IPS processes in order to correctly identify the different steps of the process, and how the specific skills should be used in a critical way to solve an IPS task. Second, students should be taught IPS skills embedded in other domains such as the scholarly curriculum; in this way students will realize how different steps can be used flexibly in different situations through abstraction and metacognition, and give a contextualization to the training. Third, students should be supported during the IPS process through technological scaffolds in order to be guided through the whole learning process of information problem resolution, so that the learner will be able to make progress on his or her own.

However, in formal education, more attention should be paid to equipping students with the necessary tools to efficiently face efficiently the different processes of solving information problems. Hence, instructional designs that consider the three principles extracted are needed to foster the appropriate development of students' IPS skills when responding to different types of demands. Therefore, the instructional design used in the present research study will be based on the three principles before mentioned.

2.3.3. Different factors that influence the process.

From an integrative point of view, three different factors that affect the cognitive process of solving an informational problem through the use of digital information can be defined. As shown in Figure 2, these three factors include contextual factors, information resource factors and individual factors (Lazonder & Rouet, 2008).

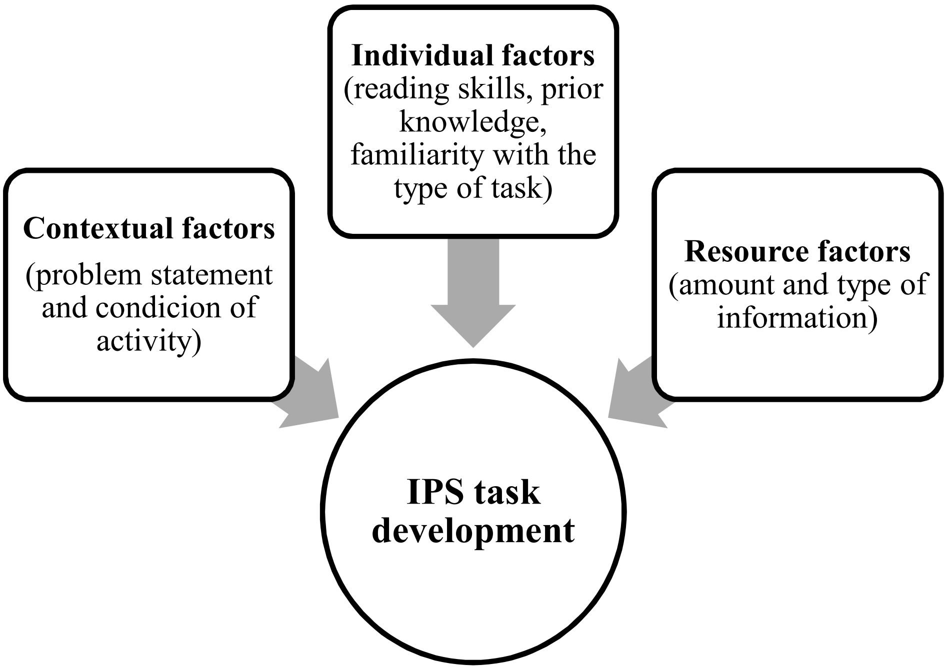


Figure 2. Factors that influence IPS development
Adapted from Lazonder and Rouet (2008).

First, contextual factors include the relevant characteristics of the situation that are pre-existent to the IPS activity, such as: place, time, equipment, people, and messages. In an educational environment, the context of the task often includes the instructions and advice given by the person responsible for leading the educational situation, which is frequently taken by the teacher. The instructions facilitated frequently take the form of a topic like "Illnesses and Health" or a problem statement such as, "A friend of yours has to travel to Brazil but he is afraid of being exposed to the Zika virus, help him write a list of different tips to follow when travelling to Brazil in order to prevent him from getting infected".

Both examples offered have been extracted from the didactic sequence designed and developed in the present research. Walraven, Brand-Gruwel and Boshuizen (2008) highlighted that in order to avoid certain difficulties that students might have during the development of an IPS task, it becomes vital to make realistic and motivating tasks for the students. Moreover, the statements have to be simple enough to be manageable, because if the statements are too complex to be understood the students will be faced with an additional difficulty (Lazonder & Rouet, 2008).

Second, the factors that refer to information resources can differ depending on the way in which information is presented. Consequently, information can be presented as a list of different previously selected web pages previously selected or as the whole web. At this point a critical factor is the available interface, or tools, with which the students must select and evaluate appropriate sources. In fact, it has been demonstrated that studying electronic documents can be related to feelings of disorientation and cognitive overload in students (Macedo-Rouet, Rouet, Epstein, & Fayard, 2003). Therefore, it becomes crucial to take into account the quality of content representation devices in the electronic information systems, which seem to be critical in reducing these types of problems for the students (Lazonder & Rouet, 2008).

Third, individual factors that comprise general skills such as the students' level of reading, the use of written language to communicate, the level of previous knowledge, familiarity with the type of task, and information resources that define the IPS task that students are working on.

In the latest research studies, various factors have been suggested to be directly related with the students' level of expertise in the resolution of an IPS task. However, less attention has been paid to the individual factors that may perhaps influence the development of a specific skill such as scanning information or processing information. Hence, recent empirical research studies have been analyzed to elaborate a revision of the central factors that might influence the development of a certain skill.

On one hand, students' reading skills have been highlighted as an individual central factor that influences the development of certain skills. Students' reading ability is a complex factor that has recently proven to experience many changes as has happened with searching processes as well. With the arrival of electronic information technologies, the collection of digital documents has increased, changing the way documents are read. This state of affairs has established a current reading transition from print texts to digital texts in which books are being over taken by a growing number of digital reading devices, such as: computers, laptops, e-books, tablet devices, and smart phones among others (Mangen, Walgermo, & Brønnick, 2013).

Reading and comprehending digital texts, which are mainly characterized by a nonlinear hypertext structure, might be mystifying for students because digital texts involve a more self-directed selection of text pieces compared to linear reading (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

Since the time spent by the students reading digital texts has strongly increased, the manner in which students read has changed, giving rise to the so-called "screen-reading behavior". The screen-based reading behavior has been mainly characterized by a increase in the time devoted to browsing and scanning, keyword identifying, non-linear reading, and reading more selectively, while less time is devoted to detailed reading (Liu, 2005).

Consequently many questions have been raised, such as if the digital texts involve different understanding skills or different understanding processes than print texts, as well as how students read, understand, and interact with digital texts. In order to bridge the gap between what's known about digital reading comprehension and what education professionals would like to know, several research studies within the last decade have attempted to investigate how student's reading behavior has changed in the digital environment where we live and how the student's reading behavior is related to information literacy processes (Li, Tseng, & Chen, 2016; Mangen et al., 2013; Naumann, 2015).

Preceding studies have focused their attention on how students' reading abilities have shaped the way they scan and process printed texts with the purpose of answering questions. Evidence suggests that students with poorer reading abilities tend to be less efficient when answering specific questions (Vidal-Abarca, Mañá, & Gil, 2010).

Due to this, studies that relate scanning and processing information processes with reading level have also been performed. Salmerón, Naumann, García, and Fajardo (2017), for example, wondered how reading skills influenced the way students scanned and processed hypertext while answering a specific question. On one hand, the results from their study showed that highly skilled readers scanned quicker and revisited segments of the hypertext that did not contain relevant information less often, especially in integrated questions. On the other hand, the results also indicated that there was no evidence for a positive relation between reading skills and processing information of relevant sections.

Likewise, Hahnel et al., (2016) studied how high school students scanned a text while giving answer to different questions by using a Wikipedia text, and how their reading ability and the question type interacted with this process. When focusing on their results related to reading ability, researchers suggest that students who are skilled in reading linear texts are estimated to understand and relate significant concepts presented on nodes in the hypertext, and to review specific pieces of information if they perceive gaps in their comprehension.

Still, less skilled students may have difficulties finding important pieces of information from web pages, connecting key ideas among different sentences, or making inferences based on the associations between text information, previous knowledge, and their reading objective. For that reason, less skilled students will probably choose pages less effectively than competent readers will, bringing them to a more restricted hypertext comprehension. Moreover, the results also indicate that comprehending significant information to accomplish the task could be associated with extended times. However, if students become aware of unconnected information, they might stop reading information thereby presenting shorter reading information times. Therefore, the authors suggest that the duration of students' access to hypertext could facilitate the understanding of how students use their time, and therefore facilitate a different vision into the students' cognitive processes.

Potocki, Ros, Vibert and Rouet (2017) established significant relations among students' knowledge of reading strategies by examining how students' searching strategies were when reading a text to solve a specific task. The results demonstrated that significant individual differences were observed in the development of students' strategies. For instance, some students systematically fixated on headers to find information related to the questions given, which showed the presence of selective reading strategies, such as the skimming technique, whereas others did not. These differences were not significantly related to the participants' decoding or comprehension skills but rather to their knowledge of reading strategies.

Recently, Şendurur and Yildirim (2015) investigated the entire search process of seventh grade students and demonstrated that students with better reading abilities had a shorter scan time than students with less reading abilities because they made use of a more efficient and selective reading strategy which allowed them to directly locate the relevant information to solve the question given.

Furthermore, thanks to the data collected during tasks' development, different patterns of reading were recognized: (a) distracted, (b) linear, and (c) skimming readers. The first reading style, "Distracted reading style", occurred each time users found advertisements or other irrelevant images. The second reading style, "Linear reading style", emerged when the keywords were very precise and detailed. Students who started with linear reading stopped, scrolled, and skimmed if they found unconnected information. The last reading style, "Skimming reading style" mostly benefited from headings, common keywords, or phrases.

The students with this style read one or two phrases as a maximum and in general from the principal lines. Researchers also observed that if the information was consistent with achieving the aim of the task, then the style changed to linear reading.

From the precise revision of current empirical research studies encompassing students' reading, scanning and information processing skills, we can conclude that students who are more efficient using reading strategies seem to have fewer difficulties finding useful information on the hypertext to solve an IPS than less skilled students. Indeed, it seems that to succeed in the IPS required skill of hypertext reading, it is crucial to regulate scanning and processing information skills.

However, the regulation of scanning and processing information skills is a problematic assignment that involves properly identifying significant text sections to complete the learning task while scanning a hypertext by means of analyzing appropriate signs, such as the introduction to a fragment or section headings, and to immediately process those sections (Salmerón et al., 2017). Hence, it becomes undeniable that further examination is required with regard to how students' scanning patterns and processing information in hypertexts might be related to their reading skills.

Likewise, students' information and communication technology skills have also been highlighted to be an individual, central factor that influences the development of certain skills. Nowadays, there is no wonder that in the field of education, information and communication technologies are becoming an irreplaceable tool used by students to develop their academic activities. However, in order to succeed in the information society, students need skills that allow them to effectively handle digital technology and communication tools or networks, which give way to Information and Communication Technologies (ICT) skills. According to Lau and Yuen (2014) ICT skills include the fundamental skills and actions of accessing, managing, integrating, evaluating, and creating information.

In coherence with the previous point developed, Coiro (2011) showed that reading skills and ICT skills were crucial prerequisites for an effective digital reading. The results of the empirical research showed that skilled readers with ICT skills were better at locating, evaluating, and synthesizing the information from the hypertexts than students who had problems with linear texts or who lack basic ICT skills. These students had several difficulties in locating and relating relevant information from different hypertexts.

In addition, earlier empirical research stated that students with powerful basic computer skills were able to find, access, and locate information in digital environments, indirectly supporting their comprehension of digital text (Goldhammer et al., 2014; Hahnel et al., 2016; Naumann, 2015). Accordingly, Rohatgi, Scherer, and Hatlevik (2016) wondered which was the role of ICT self-efficacy in students' computer and information literacy achievement, the results of their research showed that self-efficacy in basic ICT skills was positively related to computer and information literacy achievement.

However, research studies that focus their attention on the possible relation among students' ICT skills and their IPS task development are scarce.

Therefore finding answers to questions like how ICT skills support locating and scanning relevant information and processing digital texts should be the main purpose in further research studies (Hahnel, Goldhammer, Naumann, & Kröhne, 2016). Hence, in the present research study, the attention will be focused on how ICT skills are related to students' performance of scanning and processing information skills.

The last individual central factor that influences the development of certain highlighted skills is the students' previous domain knowledge. With regard to different levels of previous knowledge, numerous studies claim that this factor can play an important role in IPS processes (Raes et al., 2012). In fact, many studies have brought to light the close relationship between students' previous knowledge and their decisions on selecting a particular hyperlink or piece of information (Rouet, Ros, Goumi, Macedo-Rouet, & Dinet, 2011).

With focus on previous domain knowledge and the level of expertise in search skills, a study done by Wood et al. (2016) examined how both variables influenced when using the Internet to find information. The results revealed that the combination of high search expertise and high previous domain knowledge produced the most effective searches. In one respect, participants with higher search expertise accessed more precise and credible sites and, in another, participants with higher previous domain knowledge accessed sites more thoroughly. Likewise, Brand-Gruwel and Stadtler (2011) carried out different studies on how students of different ages selected information on multiple hypertext documents. The search outcomes showed that previous domain knowledge had an impact on students' evaluation behavior, in the sense that students with low previous knowledge trusted less reliable sources and did not distinguish between relevant and irrelevant criteria when judging the reliability of sources.

In the same vein, other studies have indicated that students who have less previous knowledge may be more limited in effectively performing different problem solving processes. Consequently, this leads us to suggest that these students need a support to scaffold or model the information gathering process (Kim & Hannafin, 2011).

In pursuit of that question, Bulu and Pedersen (2012) explored how students with diverse previous domain knowledge benefited from different scaffolds. The results revealed that students with low previous domain knowledge took benefit from the different scaffolds provided, while for students with higher previous domain knowledge, scaffolds did not give a significant advantage to solve the IPS task. Hence, it seems that it can be anticipated that students with high previous domain knowledge on the task topic will proceed differently than the students with low previous domain knowledge during each phase of the IPS task.

Taub, Azevedo, Bouchet, and Khosravifar (2014) wondered if students' level of previous knowledge could predict the usage of cognitive and metacognitive self-regulated learning strategies when developing IPS processes in hypermedia-learning environments. From this research, the authors found significant differences in the use of self-regulated learning strategies among students with diverse levels of previous knowledge. More specifically, the main differences were found in the use of each metacognitive strategy, but not in each cognitive strategy.

More recently, in order to find answers on how previous knowledge and other variables could influence the resolution of IPS tasks, Sanchiz, Chevalierf and Amadieu (2017) focused their research on how previous domain knowledge helped older adults to handle navigational and search strategies required by the task. The results showed that the more previous knowledge participants had, the faster they were processing the first search engine page but, on the contrary, the effect of previous knowledge was not significant on the mean time spent on all the search engine result pages. However, researchers revealed that participants, who had higher previous knowledge also had less tendency to use keywords, extracted from the search problem statements in their initial search and the following scanning of information.

Similarly, in a related study (Sanchiz, Chin, et al., 2017) attention was fixated on the influence of age, previous knowledge and cognitive skills on performance, query production, and navigation strategies while solving information problems. Authors concluded that older adults' previous knowledge may have helped them to create higher comprehensible mental representations of the problem, and allowed them to process the concepts involved; improving by this way the precision of the expected search. Indeed, previous domain knowledge has been demonstrated to influence how students select and evaluate the information, if students have more previous domain knowledge their selections belong to more consistent sources (Brand-Gruwel, Kammerer, van Meeuwen, & van Gog, 2017).

Supporting the above statements, recent research studies have mentioned that a limitation of their research is that it does not consider students' previous knowledge as a variable that could influence their findings (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

The findings from the empirical research studies demonstrate that the number of studies that focus their attention on how previous domain knowledge could influence the way different IPS processes are developed has recently increased. However, few researchers have gathered information on how two of the main IPS skills (scanning and processing information) may be influenced by students' previous domain knowledge. There is now a clear gap in IPS empirical research that has to be filled by performing studies that can tell us how students' previous domain knowledge could influence scanning and processing information skills.

Therefore, if we want our students to be proficient when scanning and processing information on hypertexts, it becomes necessary to support them with previous knowledge of the content that they will be working on. It seems that participants with higher previous domain knowledge perform better when searching for information (Brand-Gruwel et al., 2017; Sanchiz, Chevalier, et al., 2017; Wood et al., 2016).

Last but not least, it becomes appropriate to mention that although students' gender has not been considered an individual factor that comprises general skills, the current research study will take into consideration the possible existing differences between the two genders in relation to the various individual students' variables described before as students' initial scientific knowledge, students' reading skills and students' ICT skills.

Available literature on the topic suggests that there might be certain differences among both genders in relation to certain individual characteristics.

Regarding science success, O'Reilly and McNamara (2007) examined how well cognitive abilities predicted high school students' science achievement as measured by traditional content-based tests. The content-based science achievement was calculated considering students' comprehension of a science problem, science course mark, and state science test punctuation. The results demonstrated that cognitive variables predicted the three measures of science achievement mentioned before, but the results also highlighted that there were considerable gender distinctions. Regarding the differences that emerged from gender, the authors observed that male students scored higher on scientific knowledge and on reading comprehension. To be more specific, in terms of the format of questions and differences by gender on content-based assessments, males were shown to score higher on both multiple choice and open-ended questions than females.

In the same vein, Halpern et al. (2007) wanted to determine the reasons for gender differences in science and mathematics careers. After developing an exhaustive research study based on the best available scientific evidence, they concluded that to be successful in math and science careers numerous kinds of cognitive abilities were needed. Females were found to have a tendency to do extremely well in verbal skills, while males did better than females on most measures of visuospatial skills. Consequently, because succeeding in science and math involves the capacity to communicate successfully and understand abstract ideas, females' advantage in verbal skills becomes useful in all educational domains, whereas males' advantage in visuospatial skills seems to help them in developing better standardized exams in mathematics and science. However, authors concluded that early experience, educational policy, biological factors, and cultural context influence the amount of women and men who pursue higher studies in science and math and that these effects work together in complex ways, which may perhaps indicate that there are no single responses to the multifaceted questions about gender differences in science and mathematics.

Supporting the conclusion obtained from previous authors, other recent research studies, which focused on gender differences and academic achievement, found female students to be better than male students in scientific and technological knowledge achievement despite the fact that the self-concept of their knowledge on the field of study was lower than male students (Sáinz & Martínez-Cantos, 2016; Schoon & Ng-Knight, 2017).

2.4. Synthesis

Over the last few decades, using electronic information technologies for seeking information, entertainment, and communication has become an essential part of students' everyday lives as they employ electronic information technologies for both entertainment and learning (Hahnel, Goldhammer, Naumann, & Kröhne, 2016) .

Due to the global and technological world of today, old IPS models are no longer enough to describe the process for seeking information. For this reason, the IPS on the Internet model presented by Brand-Gruwel et al. (2009) becomes a powerful background to describe the procedures that students experience during internet use for educational activities.

As presented in the current chapter, the IPS on the Internet model describes five key procedures (definition, search, scan, process, and present information). The five processes are directed by diverse regulatory activities and are qualified by different conditional skills. However, recent research studies have questioned the way in which the aforementioned skills are used according to the requirements of the task; they suggest that different IPS skills can be deployed depending on task demands. Consequently, the three broad avenues have opened according to these investigations and their focus of study.

The first group of research studies has focused their attention on determining the main problems that students face when seeking information. From a revision of the main problems highlighted by different researchers, the skills which present more problems when have to be developed by the students are defining information and searching for information (Argelagós & Pifarré, 2016b; Chevalier et al., 2015; Monroe-Gulick & Petr, 2012; Sanchiz, Chin, et al., 2017; Şendurur & Yildirim, 2015; Walhout et al., 2017; Walraven et al., 2008; Walraven et al., 2010). However, few research studies have paid attention to the problems that the rest of the constituents skills of scanning, processing and organizing and presenting information (Probert, 2009; Walraven et al., 2008; Raes et al., 2012). Consequently the students may also present important problems that have yet to be precisely identified.

The second group of investigations has focused on finding efficient instructive methods that enhance students' IPS skills (Argelagós & Pifarré, 2012; Frerejean et al., 2016; Raes et al., 2012). From an extensive revision of empirical research studies that have demonstrated useful instruction procedures for teaching IPS skills, three main principles can be extracted. These principles will allow us to define an effective instruction for IPS skills improvement in the present research study (organized knowledge base, learning embedded with representations in other domains, supported by providing scaffolds).

The third relevant group of research studies in the IPS field deals with different factors that may influence the IPS process. They are: contextual factors, resource factors, and individual factors (Lazonder & Rouet, 2008). Because the present research wants to design an instructional methodology to improve students' IPS skills development with regard to students' individual differences, the final part of the chapter deals with the main individual differences that may influence the development of students' IPS skills. From a detailed review of empirical research studies on individual factors that shape the method of scanning and processing skills, certain studies have demonstrated that reading skills, ICT skills and students' previous knowledge may have specific impacts on students' IPS skills development (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

As has been demonstrated in the aforementioned lines, the IPS as a general process is a mature field of study, since numerous research studies regarding the process of seeking information have shown to have a deep knowledge on the topic, such as the opened paths previously described.

However, after having gone in depth with the principal open paths of research that can be derived from the process of IPS while using the Internet, it is worth mentioning that there are still gaps in specific features of the process. For instance, it is still unknown how this IPS process is affected or modified by specific characteristics of the IPS process itself or the educational context, for example, the epistemology of specific curricular content (such as science), the educational level of the students and their previous abilities, or the use of a certain educational technology that can be traced in a particular technological environment of learning.

Therefore, the next chapter will describe how, the IPS process while using the Internet can be embedded in the curricular content of science through IBL approach.

3. IBL to Acquire Science Curricular Contents and Improve IPS Skills

The current chapter aims to present why an instruction grounded in the IBL model is a proper methodology to embed IPS skills development while the curricular contents of science are learnt by secondary education students.

To begin, the chapter starts with a revision of the different teaching and learning models that have been used through the years to teach students scientific content. Thanks to the review that goes over traditional models and current models of teaching and learning science, the evolution of the different models is presented and hence, makes obvious the reason why IBL absolutely works with IPS.

Additionally, because the use of computers and the Internet has produced innovative chances for students to learn, the usage of IBL environments in the teaching and learning processes of science has demonstrated promising results. Therefore, a detailed review of the latest IWBL science environments has been developed in order to select the environment that better fits the requirements established in the previous chapter and thus embed IPS skills in IBL didactic sequence.

Finally, recent research studies which have demonstrated outstanding benefits from embedding IPS skills instruction in science curricular content through using IWBL model are reviewed. This revision will allow us to consider the benefits and drawbacks that researchers encountered in order to solve possible future weaknesses of the study developed.

3.1. The Transformation of the Teaching and Learning Models of Science before IBL

As it stated in the previous chapter, today's global and computerized world has quickly changed our society. Since people are expected to manage the emerging information and communication technologies, schools have a need to transform the way students learn how to respond to the demands of today's society. The information technology society requires new skills, new knowledge, and new forms of learning to provide students with the abilities and competencies that will help them achieve success in an uncertain, constantly changing environment (Kuhlthau, Maniotes, & Caspari, 2015).

Over the years, several models of teaching and learning have been suggested to provide the most appropriate educational framework in order to help students learn. Joyce, Weil and Calhoun (2011) described more than twenty models of teaching and learning based on ideas offered by important education theorists. However, our focus will be on the small group of these models that seem suitable to science instruction (Wenning, 2011).

Therefore, briefly described below are some of the educational models that have had or still have relevance in the process of teaching and learning science, such as: the transmission model, the discovery model, the meaningful reception model, the conceptual change model, and the inquiry based learning model.

Transmission model in science teaching and learning process. For years, the transmission model has been the dominant model through which teachers disseminate factual knowledge to students using lectures and textbooks. This model of teaching and learning is also characterized by using low technology devices, often relying on the use of textbooks and workbooks instead of computers. From this traditional model, scientific knowledge is seen as a package of finished, objective, absolute, and true knowledge that must faithfully be transmitted by the teacher to the students (Campanario & Moya, 1999).

Hence, it is purported that students do not need to be active in the teaching-learning process. Students are considered a blank sheet of paper on which contents are written, which means that the student learns the scientific contents that the scientists know and appropriates for their self the same knowledge. In addition, because it does not include student preferences or give students opportunities to adopt an active role, direct instruction is extremely teacher-centered.

The teachers that implement this model are focused on what they do in their teaching, since they assume that students have little or no prior knowledge of the subject they are teaching, and they do little more than transmit knowledge to allow the students to have a good quality set of notes (Trigwell, Prosser, & Waterhouse, 1999). Consequently, the teacher is the dispenser of knowledge, the arbitrator of truth, and the final evaluator of learning. Moreover, according to Pozo (1999), the teacher becomes the science's narrator, whose main function is to rigorously expose the results of the scientific activity. By this way, the role of the teacher is to orally transmit the fixed contents that the students must memorize to later pass a standardized test of the knowledge provided.

Despite the fact that this model has been used for a long time and there are specific instances that demonstrate it is usefulness, such as working examples, explicit explanation, and test corrections (Alfieri, Brooks, Aldrich, & Tenenbaum, 2011), few studies support this model as a generally valid form of the teaching and learning of science since numerous disadvantages have been mentioned by several research studies (Dean & Kuhn, 2007). For instance according to Kubicek (2005) when students do not construct their own knowledge, the knowledge acquired by memorization will not be a lifelong lesson and consequently will be forgotten in a short period of time. Moreover, due to the students' roles as the passive receivers of knowledge, their levels of motivation throughout learning drastically decrease.

This method also does not promote the students' critical and reflective attitude (Hanrahan, 1998).

Discovery model in science teaching and learning process. In response to the various difficulties presented in the transmission model, the discovery model was presented by Brunner in the 60's. In this model the scientific knowledge is in the everyday reality that surrounds the students' lives (Nielsen, 2011). For this reason the students can spontaneously access science. From this educational point of view, procedures and attitudes gain relevance and the scientific contents lose importance. Science is still a package of knowledge but one which is nearer to the student than before, thus the students can find the information needed for their own development in and outside the school.

The way of learning described by this model converts the students into active learners that obtain new knowledge by having contact with their reality. As a result, the student is no longer a simple receiver of knowledge but starts developing their own critical attitude. This fact increases the student's level of motivation on learning science and the scientific field is nearer to the students' life, which promotes a contextualized learning (Dean & Kuhn, 2007).

At this point, the role of the teacher is no longer the figure that possesses the knowledge to be transmitted. The teacher becomes a resource full of knowledge to be used by the student if it is necessary during the students' process of comprehension of the surrounding reality. However, a critical aspect of discovery learning is that it must be teacher assisted; without teacher assistance, discovery learning can also result in students becoming confused and frustrated (Kirschner, Sweller, & Clark, 2006). Therefore, different authors have suggested that efficiently teaching with discovery techniques requires that teachers become guides of the students' knowledge to help them through the teaching and learning process. For instance, Alfieri et al. (2011) propose that teachers should provide examples of how to complete the tasks to show students the right path to follow or, if students feel lost, they have to explain their own ideas and teachers should assess the accuracy of the idea and provide feedback.

From this model several advantages emerge as compared to the traditional model. For instance, early research demonstrated that the usage of the discovery model had positive effects on retention of information at six weeks after instruction, versus that of transmission model instruction (Ray, 1961). On the same line, Dorier and García (2013) state that the main purpose of discovery model learning is to encourage learners' investigation and cooperation with teachers and classmates to acquire knowledge. The knowledge is acquired by being actively involved in the learning process, which will become crucial for students to develop life-long learning and increase motivation.

By contrast, some authors state that the discovery model offers the students too much autonomy, which means that teachers cannot plan or direct the learning process if they want to attend to the students' interests (Kirschner et al., 2006). Moreover, the contents have a secondary value and the students are expected to acquire them by themselves, which negatively affects the acquisition of specific scientific knowledge (Campanario & Moya, 1999; Settlage, 2011). Concurrently, Mayer (2004) emphasizes that unassisted discovery learning tasks do not help learners discover problem-solving rules, conservation strategies, or programming concepts. However, he recognizes that despite that the pure discovery learning lacks structure in nature and hence will not be beneficial for the students' learning, guided discovery may be beneficial.

Meaningful reception model in science teaching and learning process. After different and serious discussions about the science teaching and learning processes and as a response to previous criticisms of older models, from the perspective of meaningful learning, the meaningful reception model in science learning was unveiled by Ausubel in the 80s, who also stated that the teaching and learning process is efficient and durable when learning is associated with students' existent previous cognitive structures also named previous knowledge.

Hence, science learning is produced when the students' mental schemes are structured and restructured as a result of the relationship between the students' previous knowledge and what another person, such as the teacher, gives as new information by an established formal instruction. Coherently, instructional materials are thought to incorporate new knowledge with earlier existing information by using associations and comparisons of new and old ideas.

According to that way of understanding the science teaching and learning process, the student has a cognitive structure, with previous ideas and concepts, which will be progressively filled in by new scientific concepts. Therefore, the student's role is to process and understand the information presented by the teacher by constructing a network of concepts in order to add the new knowledge to the previous concepts acquired.

With the purpose of facilitating new learning, the teacher is assigned the role of the teaching and learning process guide, for which they have to use the students' previous knowledge to successfully connect them with the new concepts that the students must learn.

However, as has been presented in previous models, the model of meaningful reception learning has also been criticized. Despite the main importance in this model is of the student cognitive internal structure, the concepts are also transmitted as closed blocks of knowledge that have to be properly organized to guarantee the students' learning (Gil, 1986; Pozo, 1999). Moreover, the student is, as happened in older models, the passive receiver of the knowledge because he or she internalizes the concepts provided by the teacher.

Conceptual change model in science teaching and learning process. From the weaknesses of the previous model, the conceptual change model emerges during the 80s (Posner, Strike, Hewson, & Gertzog, 1982). This model is based on the idea that the knowledge is not static because it can change with the pass of the time. Coherent with this statement, during knowledge acquisition is when the old concepts have to be faced to new information that may be incongruent with the one previously learned. This will allow students to modify their knowledge and thus they will be constantly learning.

Hence the teacher is responsible for creating cognitive conflicts within the students' minds. In these contradictory situations to be faced by the students, students' previous knowledge will play a crucial role. When this confrontation of knowledge occurs, the incongruous concepts emerged are named preconceptions or beliefs (Kuhn, 2001). Preconceptions will be modified with the passing of the time thanks to the students' personal experiences and environment, teachers' explanations and instructional materials (Novak, 2002). For this modification to take place, the students must have an active role in the reorganization of their knowledge, whereas teacher has to be aware of students' conceptions, in order to teach in ways that facilitate students' conceptual change (Hewson, 1992).

Moreover, according to Hewson (1992), the curriculum must contain not just particular theories, but also the foundations for their approval. If teachers cannot justify curriculum content to students, teachers must not teach it. The intention of the conceptual change teaching of science is not to oblige students to give up their concepts that differ from the teacher's or scientist's ideas but rather, to assist students in forming the habit of challenging one idea with another.

However, from the conceptual change model specific weaknesses have been highlighted. The most outstanding weakness is the surprising close similarity that may have to the old transmission model. If students are exposed to situations where it is considered that their knowledge is erroneous and that it is always the teacher who has the authority to expose the theories accepted by the scientific community, students may reject the science learning process.

3.2. IBL Model in Science Teaching and Learning Process

Based on the strong points of the different models presented above, as well as on the efforts of science education researchers, numerous science teachers will undoubtedly agree that there are emergent features that all science teaching and learning models should contain. According to Hassard and Dias (2013), the science process of teaching and learning should be active, experiential, constructivist, address prior knowledge, and include cooperative and collaborative work among students. Taking into account what has been said, the IBL model of science teaching and learning emerges from the combination of the characteristics previously mentioned, and even more.

The inquiry based learning model is a pedagogical method which encourages teachers to allow students to get in touch with authentic situations, and to explore and solve problems that are similar to real life (Li & Lim, 2008).

Based on student investigation and hands-on projects, IBL is a teaching model that defines a teacher as a supportive figure who provides guidance for students throughout their learning process, rather than a sole authority figure. The teacher's aim mainly consists of proposing students real problems from their environment to be solved thanks to the work that students do in the classroom. As a result, the learners are active participants full of previous knowledge who, by means of exploration, investigation, and observation, can take the initiative in the learning process and become involved in more rigorous social interactions. They can also gain higher level thinking which allows them to give an answer to different real questions emerged (Shih, Chuang, & Hwang, 2010). Answering these questions will allow students to acquire new knowledge after having activated and restructured their previous knowledge (Mayer, 2004). Moreover, IBL is seen as a model for solving problems and involves the application of several IPS skills (Pedaste & Sarapuu, 2006).

In summary, the educational models have had a main emphasis on memorizing and organizing facts, until the beginning of the 20th century. Luckily, during the discovery learning movement of the 1960s, constructive learning theories emerged as a response to traditional forms of instruction in which students were required to memorize information given (Osborne, 2007).

Thanks to the constructivists learning theories learning is seen as a dynamic, constructive process in which students are logic makers who aim to construct coherent and organized knowledge (Mayer, 2004). In view of that, current approaches based on constructivist theories succeed in placing the students at the center of the learning process and promote students construction of knowledge through the development of general skills of inquiry, communication, critical thinking and problem solving (Argelagós, 2012).

With the intention of successfully implementing the IBL model in a teaching and learning situation, various proposals have been presented through the years that have been based on the organization of the activity in phases with different purposes.

Pedaste et al. (2015) pursued to define the different general phases of the IBL model. To achieve this purpose the descriptions and the definitions of inquiry phases presented in 32 articles were analyzed. Researchers concluded that IBL model includes five general inquiry phases: orientation, conceptualization, investigation, conclusion and discussion.

Orientation underlines the importance of stimulating students' interest and curiosity in relation to the problem. Through this phase the learning issue is presented by the environment, given by the teacher or defined by the learner (Scanlon, Anastopoulou, Kerawalla, & Mulholland, 2011). The central outcome of this first phase is a problem statement clearly defined after having recognized the main factors of the field of study.

Conceptualization is the phase in which certain concepts that belong to the stated problem have to be comprehended. The sub-phases of the conceptualization phase are questioning and hypothesis generation. Questioning consists of generating research questions about the field of study, while hypothesis generation aims to design possible hypothesis to be investigated.

Investigation is a process where curiosity arises in order to answer the defined research questions or hypotheses (Scanlon et al., 2011). Investigation is divided into three sub-phases: exploration, experimentation, and data interpretation. Exploration is an organized way of developing an investigation with the purpose of finding a relation between the factors involved. Experimentation focuses on designing and applying a strategic plan for the research with a detailed timeline. At this point, signs for testing a hypothesis will be collected. Both sub-phases mentioned encompass the plan and application of the research activities. The final sub-phase is an interpretation of the data in order to allow the students the establishment of relations among different factors involved.

Conclusion is the phase where the main findings of a study are identified. At this point, the students review the original research questions or hypothesis and consider whether these are answered or supported by the results of the research. The result of the conclusion phase is a conclusion about the findings of IBL, answering the research questions or hypotheses.

Discussion is the final phase of the IBL process and contains the sub-phases of communication and reflection. Communication is a process where students present and communicate the findings and conclusions of their research which allows them to obtain feedback and comments from others (Bruce & Casey, 2012). Reflection is defined as the process of reflecting on anything in the learner's mind about the whole process of IBL.

Teachers should introduce the IBL model of teaching and learning at the lower grades and gradually increase the level of the demand in order to successfully develop students' inquiry skills, however it does not always happen in this manner (Banchi & Bell, 2008).

Sometimes, students at upper grades are erroneously demanded to perform high levels of inquiry for which they may not be prepared and fail in their attempt. This is why the IBL model should be gradually introduced in the teaching and learning process in order to make the students feel secure with their learning process. Banchi and Bell (2008) suggested that there are four levels of IBL in science education: confirmation inquiry, structured inquiry, guided inquiry and open inquiry (See Figure 3).

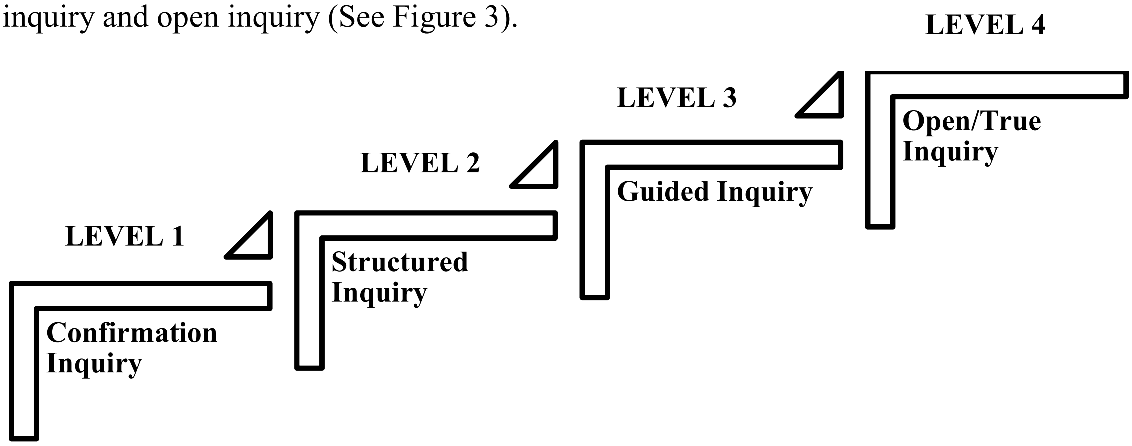


Figure 3. Levels of Inquiry learning
Adapted from Banchi and Bell (2008).

Level 1 or, *Confirmation Inquiry*, starts when the teacher teaches particular concepts and then facilitates to students different questions and procedures to guide students to develop an activity where the results are already known.

Level 2 or, *Structured Inquiry*, starts when the teacher provides an initial question and a plan of the procedure to be followed, then the students have to formulate explanations of their findings through evaluating and analyzing the information that they have collected.

Level 3 or, *Guided Inquiry*, starts when the teacher gives just the research question to the students, then the students are responsible of designing and following their own procedures to then be able to answer the question given.

Level 4 or, *Open/True Inquiry*, starts when the students formulate their own research question, design and develop a procedure to find the results.

In the present research, the level of inquiry demanded to the participants was guided inquiry since students were given the research questions and they were responsible for designing and following their own procedures to then be able to answer the different questions given.

Having carefully described the main features of IBL it becomes relevant to highlight that several research studies support the efficiency of the IBL model as an instructional teaching and learning method to learn science (Pedaste et al., 2015). In this branch of studies, different analyses have been developed in order to examine the effects of different teaching and learning models on students learning achievement.

Chu (2009) applied a mixed method design to observe the result of an inquiry project developed by students in Hong Kong with the support of numerous instructors. The results of the study demonstrated that the students who were taught through Inquiry based learning were more motivated and academically successful compared to the control group who was taught with the traditional method. Additionally, Alfieri, Brooks, Aldrich, and Tenenbaum (2011), also compared the IBL model to different models of teaching and learning, such as the transmission or discovery models, and revealed that students who had been instructed trough IBL model achieved better learning outcomes at the end of the teaching and learning process developed. In the same vein, Furtak, Seidel, Iverson, and Briggs (2012) who reviewed the effect of IBL in several studies, concluded that there were more evidences in favor of the inquiry approach over traditional instruction.

In addition, Thoron and Myers (2012) developed a study with students from different high schools, to find out the effect that an IBL instruction of agrarian science had on students' scientific reasoning. The results derived from their investigation concluded that students who were taught through the IBL instruction demonstrated to have higher scientific reasoning than students taught through the subject matter approach.

Coherently, the research study carried out by Abdi (2014) examined the effect of IBL method on pupils' academic achievement in sciences classes. A total of 40 fifth grade pupils from two diverse groups were implicated in the research. The experimental group was instructed through IBL method while the other group was instructed through the traditional method. The results showed that pupils who were instructed through IBL reached higher score than the students who were instructed through the traditional method.

The aim of the research study developed by Hairida (2016) was to explore the usefulness of an IBL science instruction with authentic evaluation to develop students inquiry skills and critical thinking. The results indicated that, after the instruction received, the experiment groups scored higher than the control group in inquiry skills and critical thinking. Therefore, the researcher concluded that science learning by using IBL instruction with authentic assessment was successful to increase students' inquiry skills and critical thinking.

In trying to introduce mobile usage into the classroom, Shih et al. (2010) developed a mobile research activity that guided elementary students to learn through a social science activity with digital support from mobile devices and wireless communications. To assess the efficiency of this innovative way of learning, 33 fifth grade students were required to perform investigations in the Peace Temple of southern Tainan, an IBL mobile system. Thanks to the pre- and post- instruction questionnaires and to observations and focus group interviews, descriptive quantitative and qualitative data were gathered and analyzed. The results showed significant positive results in terms of the students' learning. To be more precise, the results demonstrated that the practices of mobile learning emphasized learning that occurred close to students' real life and provided digital learning contents that facilitated students' field studies.

As seen above, a positive trend supporting IBL science instruction over traditional teaching methods has been found through several research studies (Minner, Levy, & Century, 2010). Consequently, because the recent results derived from this model of teaching and learning in science education have been successful, educational policies around the world consider that teaching and learning processes based on IBL model are crucial in constructing a well-educated science community (National Research Council, 2000; European Comission, 2007). Consequently, it becomes important to study the benefits of teaching and learning processes based on the IBL model to further define in more detail its benefits on students learning achievement.

3.3. IWBL Model in Science Teaching and Learning Process

As we have introduced, IBL can take place with or without technology. Nevertheless, if technology is understood as an additional tool for learning it can play an important role in developing inquiry based learning and in changing the learning process of different educational practices (Mikroyannidis et al., 2013).

Presently, the use of computers and the Internet has produced innovative chances for the students to recognize major conceptual changes in their process of learning and has also allowed other changes that without these new technologies will have been difficult to achieve.

Additionally, the IBL model has increased in popularity in science curricula, international research and development projects as well as teaching. One of the fundamental explanations is that its success can be significantly enhanced thanks to the latest technological developments that allow the inquiry process to be reinforced by ICT (Pedaste et al., 2015).

According to Blumenfeld et al. (1991) there exist six contributions that technology can make to the teaching and learning process:

- Enhance students' interest and motivation.
- Provide increased access to information.
- Allow active representations.

- Structure the process with strategic support.
- Diagnose and correct errors.
- Manage complexity and aid production.

Coherently, all of the fundamental properties of ICT can benefit IBL. For instance, the huge amount of information presented on the World Wide Web offers students the possibility to check several old and recent scientific works on a large amount of scientific topics. This opportunity allows students to explore how scientific theories are constructed, shaped and polished in the fullness of time. Moreover, social media and further communication instruments such as wikis, blogs and emails provide students and teachers the possibility to exchange information through synchronous and asynchronous communication.

These communication tools are a fundamental factor to build scientific learning communities that enrich discussion on scientific queries and promote reflection on IBL. Kubicek (2005) as well highlighted the importance of technological tools that allow developing simulations in IBL. These technological tools can facilitate the experimentation in the science teaching and learning process, because teachers can demonstrate the impact of different variables used in an experiment, without spending time on setting, cleaning and other time consuming procedures in laboratory tasks.

The ICT mentioned above have been considered in several digital learning environments and have demonstrated to facilitate students the possibility to design their own research focus, allowing them to develop the scientific inquiry in a more realistic way (Lau, Lui, & Chu, 2017). Thanks to the technological advances embedded in digital learning environments, researchers have developed the IBL model of teaching and learning in technological environments and IBL model has been renamed as IWBL (Mason, Junyent, & Tornatora, 2014; Raes et al., 2012; Walhout et al., 2015).

Consistently, different research studies have provided evidence of the value that has engaging students in IWBL to improve science content understanding. This research studies also foresee an optimistic and promising path in the design of learning environments capable of increasing students' digital skills while students improve curricular content understanding (Argelagós & Pifarré, 2012).

To evaluate the effectiveness of IWBL on students learning, Mäeots, Pedaste and Sarapuu (2008) investigated how an IWBL environment named IdquoYoung Scientist influenced the development of 11-year old students' inquiry skills. The results derived from the pre-and post- test, obtained from 302 students from all over Estonia were statistically significant in the specific inquiry skills of: formulating problems, making research questions, planning and conducting investigations and analyzing data obtained.

On the same line, Zhang and Quintana (2012) designed the Digital IdeaKeeper, a scaffold software tool to help students engage in IWBL tasks through support for inquiry planning, information search, analysis, and synthesis. Their study examined the differences between regular and IdeaKeeper-supported IWBL performed. Data obtained from their investigation revealed that scaffolding strategies implemented in the software Digital IdeaKeeper were effective.

These results are consistent with the results derived from previous studies which state that students taught with IBL environments scored higher on content knowledge assessments as compared to students who were taught through traditional methods (Thoron & Myers, 2012). Since recent research findings expose that web-based inquiry science environments can increase students' learning success as well as several inquiry skills, such as identifying problems, formulating questions and hypotheses, planning and carrying out experiments, collecting and analyzing data, presenting the results, and drawing conclusions (Mäeots et al., 2008). We can conclude that IWBL environments can become a proper tool to design and develop the instruction of the present research study.

3.4. IWBL Environments for Teaching and Learning Science

Throughout the last two decades numerous virtual learning environments containing several digital tools have been created in order to promote IWBL. Despite the fact that a majority of these virtual learning environments have not been updated since their projects were finalized or their funding ended, it becomes important to revise the key features of each virtual IBL environment to further define the most appropriate learning environment for the development of the present research study. For this reason, the current section develops a revision of the different IWBL environments created with the purpose of designing an environment where students could develop several inquiry skills in the science field. The most outstanding features of each environment are summarized on Table 5.

Table 5
Summary of IWBL environments

Environment	Launch	Designer	Available	Educational principles	Inquiry investigations offered	Empirical research results
BGuILE	1995	North Western University.	No	1. Structure inquiry around explanatory goals. 2. Embed the structure of theories and strategies in the tools used by students. 3. Integrate classroom and technology-supported learning activities. 4. Support ongoing reflection.	4 closed investigations (Tuberculosis Lab, Animal Landlord, Florida Panther and Galapagos Finches).	Students are successful at giving reasonably and justified explanations to the evidence obtained. Students become better at describing evolutionary explanations.
The Progress Portfolio	1997	North Western University.	No	1. Encourage reflective inquiry by promoting students' creation and documentation of their investigative process.	Did not offer specific investigations, since required other investigation environments.	Teachers effectively use the tool to promote aspects of reflective inquiry. Students received support to their reflective inquiry in collaborative learning.
WISE	1997	Berkeley University.	Yes	1. Make science meaningful for students. 2. Support diverse learners. 3. Be IWBL environment accessible to all.	More than 20, plus the possibility of users own creation.	Students increase their understanding of the science.
Geniverse	2010	Concord Consortium.	Yes	1. Support experimentation by immersing students in a game-like environment. 2. Design a learning environment where active learning occurred. 3. Support critical thinking.	1 investigation with four ascending levels.	Students' learning content is considerably better than in the comparison to the students who learn in the usual group.
nQuire	2007	Open University.	No	1. Create engaging and effective inquiry based learning activities in distance learning environment. 2. Help students understand the role of collaboration and user communities to support IBL.	2 kinds of missions (Confidential missions and Social missions), plus the possibility of users own creation.	Students have higher levels of motivation and interaction. Students are better at demonstrating their growing understanding of inquiry.
Lets'GO	2008	Linnaeus University and Stanford University.	No	1. Provide educational activities and technological supports to bridge the gap between collaborative scientific inquiry and data capture from environmental settings.	5 pilot trials.	Students' commitment to conduct scientific inquiries and analyses in innovative ways increases.

SCY	2008	Consortium of 12 partners.	No	1. Represent learners' knowledge creation processes in the form of emerging learning objects. 2. Develop pedagogical scenarios to favor individually and collaboratively work to solve missions.	4 missions (CO2 friendly house, ECO, Canteen Cuisine, forensic).	Students develop a great variety of postures when deciding using ELO. Students take critical postures against other-generated final products.
WeSPOT	2012	European consortium.	No	1. Structure inquiry through the creation of a European reference model for inquiry. 2. Use a diagnostic instrument to measure students' inquiry skills. 3. Use smart support tools to organize inquiry workflows. 4. Integrate social media and viral marketing of scientific inquiry.	8 scenarios (The Food Safety, Breeding program, Investigation of Earthquakes, Classroom under sails, Energy Efficient Buildings, School of the future, From idea to patent, Economic complexity).	Experienced participants with digital technologies have more opportunities to develop other skills related to Critical-Creative Thinking and Scientific Reasoning.

Biology Guided Inquiry Learning Environment (BGuILE). BGuILE was developed from 1995 to 2002 by the North Western University, located in Illinois, supported by the National Science Foundation and funded by the James S. McDonnell Foundation. This learning environment presented different guided investigation activities in which middle and high school students had to construct empirically-supported explanations from a rich base of primary data. The different investigation activities provided the students with: an investigation context, access to the primary data, and support tools for analyzing the data and synthesizing explanations. Furthermore, informal and structured discussions were combined during all the activities' development in order to provide opportunities for students' reflection and for sharing and critiquing ideas (Tabak et al., 1995).

There were four main principles that guided the design of this web learning environment were four. The first principle was to structure inquiry around explanatory goals by allowing students to generate strategic artifacts representing conceptual and epistemic properties. The second principle consisted in embedding the structure of theories and strategies in the tools that students use and the artifacts they create. These tools included: tools to structure students' explanation, tools for access and analysis of data, tools to explicitly represent the students commitments and investigations focused on producing inquiry products that represent casual explanations. The third principle consisted in integrating classroom and technology-supported learning activities by creating previous activities to enable students to practice before the core investigation. The fourth and final principle was to support ongoing reflection within the structure of the learning activities by using reflective tools integrated into the environment used by the students (Reiser, Smith, Sandoval, & Leone, 2001).

Considering the principles mentioned, the BGuILE environment offered four different investigations around biology issues that encouraged students to develop them through

IWBL. The Tuberculosis Lab was the first unit and encouraged students to carry out simulated experiments on injures of Tuberculosis to examine how antibiotics have an effect on bacteria and how bacteria can become resistant to antibiotics. Second unit was the Animal Landlord and allowed students to explore differences and connections among animal behavior examples by studying certain issues such as predation, rivalry and social groups. The Florida Panther was the third unit. Its main purpose was to help students to learn about speciation and the use of scientific investigations for policy choices, while at the same time students were required to assess recovery strategies to save the endangered Florida Panther. The last unit presented was Galapagos Finches and provided students with an environment to learn about natural selection by investigation into how a drought affects the animal and plant populations on Galapagos Island.

Thanks to the creation of this learning environment, different empirical studies of students and teachers using BGuILE technology embedded in classroom curricula were developed (Sandoval & Reiser, 1997; Smith & Reiser, 1997; Smith & Reiser, 1998; Tabak et al., 1995; Tabak, Smith, Sandoval, & Reiser, 1996).

Smith and Reiser (1998) focused on the results regarding the products that students produced thanks to the BGuILE environment, which suggested that students were successful at giving reasonable and justified explanations of the evidence obtained. For instance in the Animal Landlord unit, students gave different explanations to the trees of predation behavior, and they were able to justify their model from the analyses of data and classroom discussions. Moreover, their reflections drove them to more complex issues in animal behavior not incorporated in secondary education textbooks.

Smith and Reiser (1997) centered their attention on students' conceptual and strategic understanding. The results obtained suggested that there existed an intense type of engagement in describing hunting behaviors in the Animal Landlord predation unit because the post-test included justified reasons derived from the behavioral ecology theoretical framework, rather than from common sense asserts. Coherently, Sandoval and Reiser (1997) stated that high school students working with the Galapagos Finches unit become better at describing evolutionary explanations, as judged by their performance on pre-tests and post-tests. However, they also concluded that they had only moderately achieved in helping students comprehend the rhetorical features of constructing scientific justifications, since students did not appear to recognize the significance of explaining the importance of numbers used as proof. In addition, students did not always use universal criteria for scientific work in their personal justifications, omitting evidence for affirmations several times using the reason that seemed to them reasonable and realistic.

The Progress Portfolio. The Progress Portfolio was developed from 1997 to 2011 by researchers from North Western University located in Illinois. This learning environment aimed to help students to conduct inquiry projects on computers by allowing them to document and reflect on their work and communicate results. Data was obtained by using a diversity of integrated tools, such as: screen capture, annotation, organization and presentation. Additionally, teachers could employ the Progress Portfolio to guide students in their investigation thanks to the elaboration of prompts and templates that supported students when thinking about key issues of their investigation (Loh, Radinsky, Russell, & Gomez, 1998).

The most important principle that directed the design of this learning portfolio was to encourage reflective inquiry by promoting students' creation and documentation of their investigative process. To do so, the portfolio had spaces to develop reflective conversations around the investigations carried out, with the intention to help students connect the obtained results with previous knowledge.

Considering the key principle mentioned, The Progress Portfolio offered several tools to allow students to develop reflective inquiry (Loh et al., 1997). For instance, the data camera tool was useful to capture screenshots of students' work. Other relevant tools were the basic drawing or text tools which were used by students to annotate or customize the pages for different kinds of investigations by adding and removing text and picture fields. Finally, the presentation tool supported communication by allowing students to create slide presentations of their captured pages.

As did not happen with other IBL environments, the Progress Portfolio always worked in conjunction with other investigative environments such as simulators, data checker, and digital libraries. On one hand, the investigation environments provided students with tools for exploring content matter, and on the other hand, the Progress Portfolio provided tools to document, organize, and communicate about the investigation.

As a result of the design of this learning environment portfolio, diverse empirical studies of students and teachers using The Progress Portfolio embedded in classroom curricula were developed (Kyza, Golan, Reiser, & Edelson, 2002; Loh et al., 1998; Loh et al., 2001).

Taking into consideration that the Progress Portfolio was designed to support reflective inquiry when students were required to share their investigation procedures, a pilot study developed by Loh et al. (1998) offered evidence that teachers could effectively use the tool to promote aspects of reflective inquiry, and that students could benefit from its use, which was later confirmed by the research study developed by Loh et al. (2001) who explored the role of reflective inquiry using the Progress Portfolio across multiple projects throughout a school year.

Consistently, Kyza et al. (2002) also stated that the Progress Portfolio tool could support reflective inquiry in collaborative learning environments in science, and in particular, demonstrated how it could support one of its aspects which is self-regulated learning in a collaborative learning situation.

Web-based inquiry science environment (WISE). WISE is an environment which was launched in 1997 by Berkeley University and supported by the National Science Foundation. Despite being created in 1997, it is currently available and allows teachers to create free IWBL science projects with durations from two days to four weeks that are addressed to middle school and high school students.

There were three main principles that guided the design of this web learning environment were three. The first principle was to make science meaningful for students. For this reason, WISE units present students challenging science contents through personally and socially relevant topics. The structure of each unit designed values the conceptions that students carry with them and aids them to join new contents gained their own individual experiences by integrating their conceptions into a logical comprehension of science. The second principle consisted of supporting diverse learners, which is why WISE design offers teachers a variety of tools, activity patterns and instructional scaffolds that allow multiple ways of expressing and assessing comprehension to take place. The third principle focused their attention on making a learning environment accessible to all. Therefore, WISE is a free and open source which survives thanks to the generosity of the National Science Foundation. This means that anyone with internet connection can bring science inquiry into the classroom or home environment.

Considering the principles mentioned, the WISE environment offers more than twenty pre-designed units which cover different science contents, that are present in the middle and high school education curricula. All the units designed make use of diverse content from the World Wide Web which helps students learn to use the Internet for inquiry, evaluating Web sites, or contrasting points of view (Linn, Davis, & Bell, 2004).

WISE units can also integrate flash models, forums that make easy online debates, data gathering, drawing, java applets, concept mapping and other fixed components. In addition, the learning environment is browser-based. This means that the students who want to work with WISE only need access to a computer with an Internet connection to work on the unit selected. Then, the work done by the students is saved on the student account and they can access again to the work done from any computer with Internet. It also means that teachers can choose from the WISE library the unit that they want to work on with their students, in addition to having extra material such as a detailed lesson plan, pre and post assessments, among others. Moreover, teachers can supervise and mark student work in real time, offer formative feedback during a unit run, and control their student accounts.

Additionally, WISE's easy to use interface makes it possible to create new units, with the same technology-based components and opportunities mentioned before. By this way, teachers and researchers can design, if they need to, the units of knowledge they want to work on new scientific contents. However, if no units want to be designed, several units regarding different fields of study can be found. For instance, units can encourage students to design solutions to different problems (e.g. constructing a desert residence that is warm at night and cool throughout the day), to explore scientific phenomena (e.g. thermal balance in the classroom), to discuss current science controversies (e.g. the causes of declining amphibian populations), or to criticize scientific statements found in the web sites (e.g. arguments for life on another planet).

WISE environment has been used in middle and high school classrooms for more than twenty years in several school districts of the United States of America. Research results have shown that WISE units improve students' learning of difficult science contents and that students continue integrating their ideas and strengthen their understanding even after the units have been accomplished. Furthermore, several research studies have stated that WISE activities help students integrate ideas about complex science topics while also developing lifelong learning skills (Chiu & Linn, 2014; Slotta & Aleahmad, 2009).

Coherently with previous research studies results, Varma & Linn (2012) designed a technology-enhanced curriculum module in WISE environment in order to examine middle school students' understanding of the greenhouse effect and global warming. More precisely, the module activities encouraged IWBL since students were first required to conduct virtual experiments with a visualization of the greenhouse effect. Then they had to analyze the data obtained and drew conclusions about how individual variables effected changes in the Earth's temperature. The results demonstrated that participating in the unit increased students' understanding of the science.

Geniverse. Geniverse was born in 2010 by the Concord Consortium and it is currently available for free. The Concord Consortium began the exploration of the genetics of virtual dragons with the GenScope project led by Paul Horwitz in 1992, followed by BioLogica in 1998, and then GENIQUEST in 2007. With Geniverse, elements of gaming were added to create an engaging approach for learning genetics, which converted Geniverse into a learning environment where middle school and high school students can discover heredity and genetics of virtual dragons by doing experiments, looking at the data, drawing careful conclusions, and then testing these conclusions by carrying out more experiments.

There were three main principles that directed the design of this web learning environment. The first principle was to support genetics experimentation by immersing students in a game-like environment which simulated a fictional world of dragons. Once immersed in the environment, students were challenged to sort out the genetics of these mythical organisms through simulated experiments that generated realistic and meaningful genetic data. The second principle was to design a learning environment where active rather than passive learning occurred, involving the students in their own learning process. Based on this principle, when students enter in the learning environment for the first time, they are assigned the role of the protagonist of the story and are responsible for saving the ill dragons. The third principle was to support critical thinking in writing about genetics by providing students structured missions which gradually demanded them to reflect on the results obtained after their interactions.

Considering the principles mentioned, the Geniverse environment offers an attractive story that generates an authentic framework for students to dive into genetics investigations. It encourages students to use virtual dragons to investigate the essential mechanisms of heredity and genetic illnesses. The story requires students to join a brave character on a mission to heal a precious dragon. By this way, students take on the role of a character studying genetics and navigating through a series of cases comprising the genetics content of Geniverse. As students complete the challenges put before them, they generate their own experimental data, in order to later publish the findings obtained following the scientific method of argumentation, supporting their claims with evidence and reasoning.

The missions were classified over four categories of ascending level. The first mission was named “training” and consisted of five cases that dealt with mendelian traits (dominant and recessive alleles) and meiosis contents. The second mission was named “apprentice” and also included five cases to be solved by learning about more difficult contents such as X-linkage, polyallelic traits and protein synthesis. The third mission was named “journeyman” and like the two preceding missions also contained five cases which dealt with complex multigenic traits and incomplete dominance. The last mission was named “master” and contained three different, challenging cases which encouraged students to learn about combined patterns of inheritance and genetic disease.

Every case included one or more challenges designed to address a particular trait and its pattern of inheritance. The increasingly complex challenges demanded students to comprehend and apply more complicated genetics concepts as they advanced into the story with the intention to achieve the final purpose. The software gave instant, formative feedback on performance assessments, awarding stars depending on the efficiency of producing the target dragons.

Thanks to the construction of this learning environment, empirical studies of students and teachers using Geniverse embedded in classroom curricula have recently been developed.

For instance, Wilson et al. (2018) involved 48 high school teachers and about 2000 students in a quasi experiment research that studied the substitution of existing high school biology genetics lessons with Geniverse during a period of 6 weeks. The results pointed out that when Geniverse was employed, as the designers of the virtual environment anticipated, students' learning of genetics content was considerably better than the students who learned genetics in the usual group. Nevertheless, a broad variety of levels of Geniverse implementation showed no considerable variation among the groups as a whole. Students' skills to employ scientific explanation and argumentation were better in the Geniverse group, but these differences were not statistically significant. In addition, survey, interview and observation data revealed a variety of obstacles to implementation and researchers suggested that teachers' instructional decisions may have influenced student results.

nQuire. The nQuire platform was released in 2007 by The Open University in partnership with the BBC and is still available. This learning environment encourages students to take part in different types of missions which will allow them to explore the surrounding world. Each mission has a question that can only be solved with the students help. To answer the initial question students are given instructions about what to do. Once the mission is completed the students receive feedback on their contribution.

There were two main principles that directed the design of this web learning environment. The first principle was to create engaging and effective IWBL activities in a distance learning environment. The second principle was to help students understand the role of collaboration and user communities to support IWBL.

Considering the principles mentioned, the nQuire environment offers two kinds of missions. The first are the confidential missions can be found which are composed by surveys to discover more about students' selves (e.g. What's your Chronotype? mission). The overall results of each confidential mission are then published on the nQuire platform, but students' personal data is never shown or shared. The second kind of missions is social missions which are open explorations of the students' world. Students can see and discuss each contribution, and the data obtained is available for anyone to view and download (e.g. Noise map mission). Despite these two types of missions mentioned, nQuire missions can also be employed to develop individual or group work inquiry activities because different parts of the inquiry process can be performed at different class levels. Furthermore, the web-based approach presented in the environment can integrate several devices (smart phone, netbook, PC) and does not require continuous connectivity (Mulholland et al., 2012).

Thanks to the design of this learning environment, several research studies of students and teachers using nQuire embedded in classroom curricula have been lately performed.

In the research study accomplished by Kerawalla et al. (2013) it was concluded that nQuire was an effective tool to support teachers' and students' understanding of the nature of inquiry. It was also shown to help them design and put into practice inquiries of their own. More precisely, nQuire was used to evaluate how a teacher and a group of 12 to 13 year old students adopted nQuire as a tool to construct a coherent inquiry experience over time. Data obtained confirmed that students' usage of nQuire supported their understanding of the inquiry process, since students increased their cognitive engagement in data analysis and demonstration. Moreover, authors stated that nQuire supported the students in collecting and incorporating recent understandings across contexts and over time. Hence it can be concluded that nQuire successfully supported the students' learning paths.

Villasclaras-Fernandez, Sharples, Kelley and Scanlon (2013) used the nQuire environment to develop citizen inquiry, an innovative way to engage students in practical scientific activities that has similarities to IBL and to citizen science. The resulting data stated that the incorporation of scientific tools was successful and that the nQuire environment is appropriate to perform citizen inquiries. In addition, the evaluation of the results demonstrated higher levels of motivation and interaction between inquiry participants.

The creators of the nQuire environment have stated that in the future anyone will be able to propose a new mission and run it for people around the world to contribute. However, all missions will be checked before they go live, to make sure they are safe and legal. As a mission author, people will become a citizen scientist who engages members of the community to take part in experiments and surveys.

Learning Ecology through Science with Global Outcomes (Lets'GO). Lets'GO was born in 2008 by Linnaeus University and Stanford University and was partially funded by Wallenberg Global Learning Network, Intel Research, Pasco and National Geographic Society. This learning environment aimed to develop, implement, research, and scale a new paradigm to foster collaborative student learning in environmental science (Maldonado, Perone, Datoo, Franz, & Pea, 2013). Therefore, sensors for data capture, participation structures for students' collaboration, mobile inquiry, and evidence visualization tools were integrated to generate science learning collaborations among students, teachers and scientists.

The central principle that founded the design of this learning environment was to provide students with educational activities and technological supports that help them to mix collaborative scientific inquiry and data capture from environmental settings near to their schools. Therefore, the authors designed engaging activities and provided teachers and learners with a new environment, rich in opportunities for scientific experimentation, systems thinking and conceptual change via cyclical scientific inquiry (Pea et al., 2012).

Since the beginning of the project five pilot trials have been conducted with students from 14 to 18 years old from two different schools. Two main publications state the chief outcomes from pedagogical and technological perspectives. Spikol, Milrad, Maldonado, and Pea (2009) focused their interest on how to start a co design procedure collectively with teachers, researchers, scientists and designers so as to plan and develop mobile science collaborations that support open IWBL in ecology education. The results obtained on their research pointed in the direction of the need for further methods to support co design taking into consideration future user experiences required for developing and implementing these kinds of learning activities.

Additionally, Vogel, Spikol, Kurti, and Milrad (2010) paid special attention to the technical efforts corresponding to the design and execution of mobile and web applications that incorporated sensory data employed to sustain IWBL in the scientific field. The results obtained pointed towards the potential benefits of using mobile technologies with real time data and visualizations, to augment students' commitment while they conduct scientific inquiries and analyses in innovative ways.

Science created by you (SCY). SCY environment was developed from 2008 to 2012 by a consortium of 12 partners (University of Twente, Joseph Fourier University, Duisburg-Essen University, University of Bergen, Fraunhofer Institute for Intelligent analysis and Information, Systems IAIS, University of Cyprus, University of Turtu, De Praktijk, Stichting Technasium, ENOVATE and Ontario Institute for Studies in Education) from 7 different countries (Nederland, France, Germany, Norway, Cyprus, Estonia and Canada) and funded by the 7th framework program in the European Commission.

This learning environment encouraged students from 12 to 18 years old to embark on missions that could be completed through constructive and productive learning activities which required a combination of knowledge from different domains such as physics, mathematics, biology or engineering. SCY provided a flexible and adaptive support for the different activities through pedagogical scaffolds, collaboration facilities, as well as peer assessment and social tagging tools. The final products elaborated by learners were stored in a repository and could be reused by other students (de Jong et al., 2010).

There were two main principles that guided the design of this web learning environment. The first principle was the representation of learners' knowledge creation processes in the form of emerging learning objects. During activities related to science and technology, learners created elements of knowledge such as collection of data, models of phenomena and conjectures, among others that allowed them to later develop further growth of their knowledge. The second principle was the development of advanced pedagogical scenarios where students worked individually and collaboratively on different missions. These missions were guided by a general socio-scientific question and required a combination of knowledge from different domains to achieve the answer of the question. To do so, students encountered multiple resources and performed several types of productive learning actions.

Considering the principles mentioned, the SCY environment offered different working scenarios where students could create, share, discuss and reuse learning objects. The working scenarios had the necessary tools for the students to answer the questions presented in different missions. To solve the different missions, students had to learn about science topics in the context of addressing socio-scientific problems. The initial environment designed offered four missions (de Jong et al., 2012).

The CO2 friendly house mission was the first SCY mission to be created. This mission encouraged students to describe how domestic CO2 emission occurred and how it could be controlled. To achieve this, students had to take into account materials and energy supply which required them to acquire knowledge on physics and mathematical knowledge. The students' final product was a 3D drawing of their house and an accompanying report that gave the justification of their design selections.

The SCY ECO mission was developed for learning about issues related to biology and ecology. The chosen issues allowed students to discover real life problems that appeared in different areas of Europe. This mission made students aware about how human beings have seriously changed their environment. Therefore, students had to discover natural processes to understand how every person could have a positive effect on saving our environment for the future.

The Canteen Cuisine mission dealt with the need for healthy meals at school canteens around the world. Since children in Europe and the United States eat more food products high in sugar, salt, and fat than they did thirty years ago, health problems including obesity, diabetes, high blood pressure, high cholesterol, heart disease and other diet-related problems have increased. Therefore, the purpose of the Canteen Cuisine mission is to engage students in active practices related to the canteen cuisine of their school. Students' final product is to create a healthy pizza for their school canteen while taking into consideration the nutritional value of the ingredients, the human digestive system, diet-related health issues and daily exercise.

The forensic mission involved students in an investigation to find a criminal offender. Students had to identify the techniques they will use to analyze DNA or ink samples, elaborate or justify their experimental procedure, carry out real experiments, and analyze their results. To achieve this purpose, students dealt with knowledge related to DNA (universality, organization, series of nucleotides), biological techniques (constraint enzymes, electrophoresis gel, DNA profiling), chemistry (solvent, solution, solubility), chemical techniques (chromatography, identification and separation techniques), and mathematics (frequency, probability). The final product was a report for the lawyer that will help to solve the case.

Thanks to the creation of this learning environment, different research studies were developed during the years that the project was active. The investigations focused their attention on discovering how SCY technology was embedded by students and teachers in classroom curricula (de Jong et al., 2012). The main purposes of the developed studies were: to identify the emerging learning objects (ELO) produced by the students as essential to the learning process, to stimulate the usage of ELOs as sharable and reusable objects and to introduce the ELOs as a source for e-portfolios and peer assessment.

An opening study took place in two schools located in France. From each school two classes of 15 year old students were involved. The study was developed in the mission named the CO2 friendly house. The 18 students of each class were divided into ‘expert groups’ and ‘design groups’. The results demonstrated that there were small discrepancies among the diverse probable answers offered by each group, which could be explained by not giving enough to students when they were asked to justify the decisions taken. The information extracted from the research study allowed the researchers to modify the learning environment in order to provide students with clearer assignments and constraints for the work in groups so that ELO were better justified.

A second study took place in a class of nine fourth graders in the Netherlands. The study tried to discover how students used the work of their peers to improve their own learning. The study was developed in the mission named the CO2 friendly house. First, students were asked to create a concept map to represent the previous knowledge of the main topic of the mission. Then, students were given the opportunity to improve their concept maps on the basis of the knowledge acquired through mission work two times. The results presented three main conclusions. First, stated that there was a great variety in the extent of students' ELO. While some students completely ignored additional generated final products as a possible learning resource, others copied and pasted parts of other final product into their own work. Second, various students had ethical objections against using other created ELO since constructing work from classmates is seen as a socially undesirable behavior even when it is recommended to do so and when students are assured that no negative consequences should be expected. Furthermore, various students did not recognize other ELO as a helpful resource. Third, students took critical postures against final products generated by others.

The SCY environment offered students the possibility of sharing results and ideas, which is an important benefit of networked communities. In educational design, teachers determine educational scenarios that can be (re-)used, exchanged and modified at a later stage by another teacher which is, without a doubt, a positive way of construct learning.

Working Environment with Social Personal and Open Technologies (WeSPOT). WeSPOT was developed from 2012 to 2015 by a consortium of nine partners (the Centre for Learning Sciences and Technologies, the Knowledge Media Institute, Knowledge Technologies Institute, the Human-Computer Interaction Lab, the Centre of Information Society Technologies, the Innovation in Learning Institute, the Institute of Applied and Computational, the eXact learning solutions and the Institute for symbolic analysis and development of information technologies) from nine European countries (Nederland, United Kingdom, Austria, Belgium, Bulgaria, Germany, Greece, Italy, Slovenia) and funded by the ICT European Commission.

This learning environment wanted to propagate scientific inquiry as the approach for science learning and teaching in combination with today's curricula and teaching practices.

At the same time everyday life was linked with science teaching in schools by technology. To achieve this purpose, different scenarios were presented to learners from 12 to 25 years old who took on the roles of explorers and scientists. They were motivated by their personal curiosity, guided by self-reflection and developed knowledge through personal and collaborative reasoning (Mikroyannidis et al., 2013).

There were four main principles that guided the design of this web learning environment. The first principle was to structure inquiry through the creation of a European reference model for inquiry skills and inquiry workflows. The second principle was to use a diagnostic instrument for measuring students' inquiry skills. The third principle consisted in the usage of smart support tools for orchestrating inquiry workflows including mobile apps, learning analytics support and social collaboration on scientific inquiry. The fourth and final principle focused on social media integration and viral marketing of scientific inquiry linked to school legacy systems and an open badge system (Protopsaltis et al., 2014).

Considering the principles mentioned, the WeSPOT environment offered eight scenarios that dealt with different science curricula topics where students had to gain science knowledge through IWBL activities. The designed activities demanded students: to select among given questions and post new scientific questions, to collect certain data, to formulate explanations from evidence, to link areas and sources of scientific knowledge and to communicate explanations based on scientific reasoning.

The first scenario, Food Safety, proposed that students become chemical engineers and food scientists able to find solutions to problems with plastics contaminating food. In order to solve the given problems, students had to learn about material properties, food chemistry and chemical reactions.

The second scenario, the Breeding Program for Endangered Species, asked students to become experts on animal breeding and genetics able to operate internationally to solve problems within breeding endangered species. To achieve this, students had to design and evaluate breeding programmes, understand genetic variation and establish biological relationships.

The third scenario, Investigation of Earthquakes, required students to become explorers of earthquake magnitude, wave amplitude and energy release. They also had to map and analyze historical earthquake data and seismogram displays from various sources. To accomplish the objective, students had to understand elementary statistics and elaborate a comparison of earthquakes in terms of size, location distribution and occurrence frequency.

The fourth scenario, Classroom Under Sails, asked students to simulate going on a trip across the Atlantic Ocean to explore the environment (water, air, physics on board, astronomy) to later develop a personal project. Because each student developed their own project, different contents of the curriculum where involved such as sea life, substances in the water, physics on board and volcanism, among others.

The fifth scenario, Energy Efficient Buildings, demanded students become energy experts able to identify disadvantages of a building from energy-efficiency point of view. They also had to predict future energy problems considering different type of materials and new energy resources keeping in mind ecology.

The sixth scenario, School of the Future, asked students to provide research on changes they would to in the school of the future. This scenario allowed students to take different directions to design a virtual classroom, introduce new ICTs in education, describe students relationships, propose new educational approaches, suggest ways of lifelong learning, among others.

The seventh scenario, From Idea to Patent, encouraged students to reflect on the environment that surrounds them and determine some of the most pertinent problems. In order to become inventors and decide what could be changed or what could not. To reach this goal, students had to identify problems in their nearby environment, select the problem to be solved, brainstorm possible solutions, select the most appropriate solution and inquire into existing technical solutions.

The eighth scenario, Economic Complexity, asked students to investigate how countries with high economic complexity index can be used for faster economic and social developments. Therefore, students were required to analyze data on economic complexity, interpret collected data, compare economical environments of different countries and assess the impact for economic and social development.

Thanks to the creation of this learning environment, different empirical studies of students and teachers using WeSPOT technology embedded in classroom curricula were developed (Mikroyannidis et al., 2013).

Okada, Serra, Ribeiro and Pinto (2015) developed a qualitative study on central abilities for co-learning and co-inquiry in the digital age. The method applied was cyber-ethnography with asynchronous observation (forum and wiki) and synchronous discussions (webconference) to analyze the abilities developed by a co-learning community in two open platforms: the educational environment EDUCARED and WeSPOT. The results revealed that the EDUCARED environment led to the development of more explicit digital literacies, possibly because it was a simpler and familiar interface (forum). And in the WeSPOT environment, experienced participants with digital technologies had more opportunities to develop other skills related to Critical-Creative Thinking and Scientific Reasoning.

3.5. IWBL to Improve Students' IPS Skills

Numerous studies mention that IWBL is viewed as an approach to solving problems and for that reason involves the application of several problem solving skills (Pedaste & Sarapuu, 2006). Coherently, prior research studies have provided evidence that it is possible to progress IPS skills by actively involving students in their own learning as constructors of knowledge (Chu, Tse, & Chow, 2011; Wang, Ke, Wu, & Hsu, 2012). According to that fact, a significant amount of research conducted in different domains and with different outcome measures largely demonstrate support for the better effectiveness of the constructive approach over the traditional didactic approach (Hmelo-silver, Duncan, & Chinn, 2007).

Hutchison and Colwell (2014), who examined empirical research to illustrate digital tools potential to transform instruction, stated that students are able to achieve significant knowledge, and form ideas and products by constructing their own learning as the IBL suggests. IWBL is viewed as an approach to solving problems and for that reason involves the application of several problem solving skills (Pedaste & Sarapuu, 2006). Coherently, despite the small amount of literature published on the relationship among IWBL and IPS skills, certain studies have analyzed the role of IPS skills in supporting students' inquiry and the use of IWBL to develop IPS skills.

Based on studies that have analyzed the role of IPS skills in supporting students' inquiry, the research study developed by Gehring and Eastman (2008) focused the attention on employing the use of IWBL to improve and study information literacy skills in an undergraduate Developmental Biology course. In this study, an information literacy tutorial and a set of linked tasks using primary literature investigation were incorporated with two inquiry-based laboratory research projects.

Regarding the results obtained from the investigation developed three main conclusions could be extracted. First, the quantitative analysis of student answers demonstrated that the capabilities of students to locate and apply valid sources of information were better. Second, the qualitative evaluation exposed a set of patterns by which students gather and use information. Third, self-assessment answers revealed that students related their tasks development success with their capabilities to gather and use information, which allowed them to be more confident about these capabilities for future biology courses.

Furthermore, regarding the role of IPS skills in supporting students' inquiry, Mazella and Grob (2011) developed an information literacy instruction in collaboration with an inquiry-driven course for English students. The main objective of this instruction was to bring students' information gathering and critical thinking skills up to a disciplinary level. Students were asked to complete a series of increasingly complex special collections assignments to practice working among archival items, electronic databases, and conventional print works. The results demonstrated that the collaboration among literacy instruction and the inquiry driven course became essential to achieving their goal of imparting a more advanced, comprehensive, and disciplinary version of information literacy to students.

Reasonably, Hepworth and Walton (2009) mention that teaching information literacy for IBL is extremely beneficial to those who teach or train people and need to develop systematic ways of using information sources and tools to help them participate in IBL. In addition, their book presents an interesting debate between IBL and the relationship with IPS, and suggests some detailed examples of IBL for IPS development. Although, they do not offer empirical data relating to the practical implementation of the strategies suggested.

A small number of examples of IBL for the development of IPS have been developed. For instance, Argelagós and Pifarré (2012) developed an empirical study which consisted of an investigation of the effects on the development of IPS skills in a long term instruction based on IWBL. The results suggested that the variable students demonstrated a more skilled pattern than the control students concerning the constituent skill of defining the information problem and the two web search sub-skills of search terms typed in a search engine and selected results. Additionally, data of tasks performance was statistically superior in variable students than in control group students.

Mason et al. (2014) examined the efficiency of a short-term instructional intervention with high school students. The students who received instruction had the chance to apply declarative knowledge in a basic inquiry task on the topic of the probable damage attributable to mobile phones. The results from the study demonstrated that students who received the instruction performed better than the others in the inquiry task of the instructional context and in the transfer inquiry task. Among the different changes observed, instructed students were characterized by having a more suitable navigation behavior, a better source assessment, and a deeper comprehension of the consulted information.

Gasque (2016) presented a review of the literature on the development of curriculum based on the research process of IWBL in terms of information literacy. After formulating some hypotheses to explain the lack of studies on this topic and recommending further research on the topic, it was concluded that IWBL allow better integration of information literacy content. This is because it provides more meaningful learning since encourages students' reflection, allows students to be the protagonists of the learning process, and stimulates learning how to learn.

3.6. Synthesis

As mentioned earlier, over the years, several models of teaching and learning science have been suggested with the purpose of providing the most appropriate educative framework in order to help students to learn. However, based on the strong points of the different models mentioned before as well as on the efforts of science education researchers, numerous science teachers agree that the IBL model of science teaching and learning contains certain crucial characteristics that a model needs to succeed at the present time.

IBL can take place with or without technology. Nevertheless, technology can play a particular role in sustaining IBL and in changing the learning process (Mikroyannidis et al., 2013). That's why several inquiry based learning environments have emerged during the last decades. However, after having analyzed the main features of the most recent outstanding learning environments designed to encourage students develop inquiry, it can be concluded that WISE is exceptionally appropriate, because facilitates educators the design of curricular activities focused on knowledge integration through inquiry activities. The huge amount of tools presented in WISE scaffold the students' learning process with programmed scores that generate knowledge integration guidance. Also, these tools support teachers by letting them monitor student development and offer their individual guidance to certain students if necessary.

Another specific feature that supports WISE as one of the best learning environments analyzed is the huge amount of WISE projects already designed which address a wide range of science, mathematics, and engineering topics. A relevant strength is that WISE has an authoring language that is extremely simple to employ which permits authors to create new activities of knowledge as well as modify existing units to new frameworks. This fact is chiefly essential because previous research studies show that when teachers modify their units founded on the answers of their students, the next group of students performs better (Gerard, Varma, Corliss, & Linn, 2011).

In the end, it is important to highlight that between 2011 and 2017 over 10,000 teachers and 80,000 students joined the WISE community from several locations around the world (Linn, Eylon, Rafferty, & Vitale, 2015). In addition, different researchers also have used WISE to carry out systematic investigations to answer central questions concerning the most successful manner to design inquiry instruction (Raes, Schellens, De Wever, & Vanderhoven, 2012; Williams, Debarger, Montgomery, Zhou, & Tate, 2012).

Numerous studies state that IWBL involves the application of several valuable problem solving skills, which fits perfectly with the approach of the current research.

4. Concluding Remarks of the Theoretical Framework

The last chapter that closes the theoretical framework of the present investigation aims to synthesize the most important theoretical lines that underpin current research study.

As previously mentioned, the present information and knowledge of this century has brought people into a situation where information plays a crucial part and people are expected to be able to manage the overload of information successfully (Becerril & Badia, 2015). Therefore, for several years, IPS has been a relevant focus of research around the world (Behrens, 1994). Nevertheless, with the rapid emergence of the Internet in the last decades, this process of seeking for information has changed, being renamed as IPS-I-model (Brand Gruwel et al, 2009).

Additionally, students today are immersed in technology and are almost always connected through a smart phone, tablet, or laptop (Gómez & Badia, 2016) which means that they are constantly exposed to an overload of online information. However, this does not mean that they have the declarative and procedural knowledge to access, and evaluate electronic sources when seeking information on an unfamiliar topic. Consequently, it becomes crucial to equip our students with the necessary skills to deal with IPS.

Considering the current framework, numerous research studies have been undertaken which have sought to gain a deeper knowledge on the IPS field. From an exhaustive revision of what has been done until today, three main research lines can be drawn on the field of study of IPS: problems students face when developing the IPS process, effective teaching and learning methods focused on IPS skills acquisition, and factors that influence IPS process.

In modern education, when students have to learn a new concept, it becomes crucial to build upon from their previous knowledge, which implies discovering at the same time which are the main weaknesses or misconceptions that students present when developing the learning process. To do so, an important amount of research studies have dealt with the detection of the main problems that students face when seeking for information on the Internet. From the five constituent skills of the IPS process, previously described, the two first ones, named defining information and searching for information, are the ones which have been detected to be more problematic for students, although they have also been the two skills in which researchers have paid more attention during the years (Walraven, Brand-Gruwel and Boshuizen, 2010). Because few research studies have paid attention to the remaining constituent skills of scanning, processing, and organizing and presenting information, it becomes pertinent to carefully explore them in more detail. This intention may bring to light different problems which have not been identified yet, but which may be as important as the difficulty that students' present when writing the information found in their own way, since they frequently copy and paste the information located to give a correct answer to the informational problem given (Raes et al., 2012).

Once a first research line has focused on detecting which problems students' may face when developing IPS process, other researchers have made an effort to find an optimal instruction method to help students in the acquisition and mastering of the IPS skills. The obtained results from prior studies confirmed that teaching IPS had a positive impact on the development of the students' skills and content knowledge construction. From these effective research studies, three main principles have been extracted because they have been demonstrated to provide successful results on IPS learning process. They are: present IPS as an organized knowledge base, embed the instruction in other domains, and support the instruction by using technological scaffolding. All three agree with the findings of the recent investigation made by Frerejean et al. (2019) who demonstrated that students have improved in IPS development after the instruction received.

Hence, considering the previously mentioned principles, it becomes decisive when designing an efficient IPS instruction that the three of them will be the bases of the instruction designed based on the present research. Conversely, despite the fact that not many research studies have taken into account students individualities when designing IPS instruction, as happens in our daily life, we live establishing relations with people who present differences of personality, of interests, of previous knowledge, among others. These specific characteristics which create our person can already be appreciated from the very beginning of our lives, as can be seen in our schools. Therefore, when developing an IPS instruction we also have to consider that each student is special and unique and for this reason an instruction which may be extremely useful for some students may not have the same effect on others.

The purpose of considering students individualities for a more concrete IPS instruction addressing student diversity is not an easy task, since there are many factors which might affect the IPS task development. Lazonder and Rouet (2008) distinguished among contextual factors, individual factors and resource factors. The ones which more closely concern the students' individualities are the ones named individual factors, which research has demonstrated to have an important weight on student' development of different IPS skills.

According to research studies which have tried to describe the effect of certain students' individualities on IPS task the most outstanding ones on the IPS process have been three: reading skills (Salmerón et al., 2017), ICT skills (Hahnel, Goldhammer, Naumann & Kröhne, 2016) and students' previous knowledge (Sanchiz, Chevalierf & Amadieu, 2017). Furthermore, if the attention is on the effect that these individualities have on the two constituent skills in which the present research is focused, which are scanning and processing information skills, several relations can be established.

For instance, regarding the reading skills, Salmerón et al. (2017) stated that expert readers scanned faster and consulted sections of the hypertext that did not have important information fewer times, particularly in integrated questions type, which coincided with Hahnel, Goldhammer, Naumann and Kröhne (2016) who mentioned that students who were skilled in reading linear texts were predictabed to comprehend and transmit important concepts offered on the hypertexts.

Concerning the ICT skills influence on both IPS skills mentioned, Coiro (2011) suggested that students ICT skills were indispensable prerequisites for functional digital reading since the results obtained showed that students with ICT skills were better at locating information from hypertext. Rohatgi, Scherer, and Hatlevik (2016) also mentioned that self-efficacy in basic ICT skills was positively related to computer and information literacy achievement.

Dealing with the last group of students' individualities highlighted, Wood et al. (2016) revealed that the combination of high search expertise and high previous domain knowledge produced the most effective searches in view of the fact that students with higher previous domain knowledge used the sites more systematically, which is closely related with Kim and Hannafin (2011) findings, who mentioned that students who have less previous knowledge were more limited to effectively performing different problem-solving processes.

Considering that previous research studies have tried to demonstrate the influence that certain students' individualities have on the IPS process development the present research study has been designed to precisely describe how close this relationship might be.

Before ending this chapter, it becomes indispensable to emphasize the main reasons that have led the current investigation to conclude that IWBL model is a proper methodology to embed IPS skills development while the curricular contents of science are learnt by secondary education students.

To start with, despite the fact that several models of teaching and learning science have been suggested to provide an appropriate educational framework to help students learn, IBL is seen as a distinctive pedagogical method because it encourages students to get in touch with authentic situations, and to explore and solve problems that are similar to real life (Li & Lim, 2008). Consequently, the IBL model has been the one which has most increased in popularity in science curricula. Another important reason which might explain its attractiveness is that its success can be significantly enhanced thanks to the latest technological developments that allow the inquiry process to be reinforced by ICT (Pedaste et al., 2015). As detailed before, these technological tools frequently used on the Internet have renamed the model as IWBL.

Different research studies have provided evidence concerning the value of students engaging in IWBL to improve science content understanding and state that there is an optimistic and promising path in the design of instructional processes which help progress students' content understanding when using web information (Argelagós & Pifarré, 2012).

This huge potential of IWBL has shown the fact that during the last two decades numerous virtual learning environments containing several digital tools have been created in order to promote IWBL. Despite the fact that, unfortunately, numerous research environments have not been updated since the projects ended or the funding finished, research findings based on the different learning environments built demonstrate that web-based inquiry science environments can increase students' learning success as well as several inquiry skills (Mäeots et al., 2008).

Coinciding with what previous authors said, Hepworth and Walton (2009) also mentioned that teaching information literacy for IWBL is outstandingly beneficial to those who teach people and need to develop systematic ways of using information sources and tools to help them participate in IWBL. These facts allowed us to conclude that IWBL environments are a proper tool to design and develop the instruction of the present research study.

Argelagós and Pifarré (2012) coincide with this conclusion since the data obtained by them stated that the development of IPS skills in a long term instruction based on IWBL had positive effects on instructed students, who demonstrated to have a more skilled pattern than the control students concerning the constituent skill of defining the information problem.

From the broad range of web-based inquiry science environments that have been offered to be used by the educational community during the past years, only two of them are still available to be used for free. Of the two available ones, the one which better fits the current investigation was the one which allowed teachers and researchers the possibility of users own creation and design. This feature was crucial to design a didactic sequence were science curricular contents were worked on while at the same time IPS skills instruction was embedded considering the three principles above mentioned.

To conclude this chapter, it is worth mentioning that although the potential growth of research studies on the field of IPS has been widely acknowledged; more research is needed to design appropriate guidelines in schools, which help the educational community to use the Internet and new technologies as tools for students to develop properly the process of IPS. In consequence, the purpose of the present research is to explore in depth the relation between certain students' individual characteristics and students' performance of scanning and processing information skills through an instruction developed on a science IWBL environment called WISE.

EMPIRICAL FRAMEWORK

5. Research Design

This study aims to understand the effectiveness of an IPS instruction embedded in an IWBL environment on secondary education students while considering certain individual characteristics, for this reason, design-based research (DBR) becomes the most appropriate research methodology to be used in the current research study. DBR can be defined as a research methodology designed by and for educators which aims to transfer obtained results of education research into improved practice (Anderson & Shattuck, 2012). The basic process of DBR involves developing interventions in order to solve educational problems emerging in different educational practices. Then, the interventions are put into practice with the intention of analyzing whether they work properly to establish new theories useful for designing new educational processes, instructions or educational reforms.

Numerous research studies have used DBR methodology in the learning sciences field of study. For instance, Ketelhut, Nelson, Clarke and Dede (2010) developed an investigation based on a scientific inquiry-based project funded by the National Science Foundation, which aimed to introduce scientific inquiry into a standards-based curriculum by using a three-dimensional virtual learning environment. The results obtained revealed that the instructional approach meets the project objectives since participants acquire social competencies in the virtual medium that can be applied in the real world.

With the purpose of analyzing the influence on students' knowledge on illnesses and health as well as on students' level of expertise in scanning and processing information skills performance after the instruction developed on the IWBL environment, a Pre- Post- test will also be employed. The results obtained will allow comparisons to be made regarding the evolution made by the participants of the study.

Regarding the techniques used to collect data, it is worth considering the special emphasis made among the research community on using quantitative and qualitative methods together. Examining different perspectives of a phenomenon, which means triangulation of the results from diverse data sources, enriches the quality of the research developed. Hence, in order to improve the current available knowledge on students' problem-solving processes different techniques such as log-files, thinking-aloud protocols and different previous and post tests are used.

5.1. Research Objectives

Before going deeper into the research objectives of the present investigation, it is important to highlight that each of them is designed considering the IPS skills explained in Figure 1 and the potential factors that affect the IPS detailed in Figure 2.

As previously mentioned, numerous studies have identified that student from primary school to postgraduate need to learn information literacy skills. Moreover, according to the research available on the current field of study, certain students' individual characteristics might have an effect on students' development of IPS skills. However, less is known about studies in which students' individual characteristics are analyzed to establish relations among certain informational problem solving cognitive processes with the aim of overcoming possible difficulties that students might face. Therefore, the purpose of the present research is to analyze the relation among certain students' individual characteristics and students' performance of scanning and processing information skills through an instruction developed on a science IWBL environment called WISE.

The exhaustive literature review achieved on the theoretical framework of this research has been crucial to design an effective didactic sequence that promotes in students a gradual development of certain IPS skills in an attractive and IWBL environment. Furthermore, in order to achieve the main purpose of the research the point of view has also been focused on collecting information about certain specific students' individual characteristics. The information collected includes: students' prior domain knowledge on the topic of illnesses and health, students' ICT skills, students' reading skill and students' personal information (year of birth, gender, high school to which the students belong to and academic achievement).

In order to facilitate preciseness in the area of interest, the present research study has analyzed two specific IPS skills: scanning information and processing information. This precision made the main objective of the present research challenging, because research studies that pay attention to how students' individual characteristics can influence the way in which two specific skills of the process of IPS are developed, are scarce.

Students' individual characteristics have been carefully analyzed in order to establish possible relations between the time devoted to the development of scanning and processing information skills, and the quality of the skill performance. On the one hand, the quality of the development of the scanning information skill has been measured taking into account the type of scanning used and the amount of time spent scanning for useful and unnecessary information. On the other hand, to analyze the quality of the processed information the correctness of the answers given by the students and the way that have been answered as well as the time devoted to answer each task has been measured.

From the main purpose of the present research, several specific objectives are developed:

1. To determine if there are any differences between the two genders in relation to the different individual students' variables.
2. To determine the relations established among students' individual characteristics and students' performance when scanning information.
3. To determine the relations established among students' individual characteristics and students' performance when processing information.

4. To determine the relations established among students’ scanning information skill performance and students’ processing information skill performance in different types of tasks.
5. To identify the difference among the students’ initial and final learning performance.
6. To describe the main differences in students' performance of scanning and processing information skills in each type of final task, according to students’ final science knowledge profile.

Figure 4 shows how the different variables of the study are related in order to ensure the achievement of the different specific objectives previously established.

Objective 1 aims to determine if there are any differences between the two genders in relation to the different individual students’ variables. Students’ individual variables considered in the present investigation are the ones that deal with students’ high school, students’ year of birth, students’ initial scientific knowledge, students’ reading skills and students’ ICT skills.

Objective 2 aims to determine the relations established among certain students’ individual characteristics such as: students’ scientific knowledge, students’ reading and students’ ICT skills, and students’ performance when scanning information.

Objective 3 complements the previous objective mentioned since it aims to determine the relations established among certain students’ individual characteristics and students’ performance when processing information.

Objective 4 aims to determine the relations established among students’ scanning information skill performance and students’ processing information skill performance in different types of tasks.

Objective 5 aims to identify the difference among the students' initial and final learning performance considering both students' scanning and processing information performance and students scientific knowledge which will allow us to value the effectiveness of the instruction developed.

Objective 6 seeks to describe the main differences in students' performance of scanning and processing information skills in each type of final task, according to students' final science knowledge profile, which will allow us to identify the main differences that emerged during the process.

The objectives derived from the main purpose can be summarized on Figure 4.

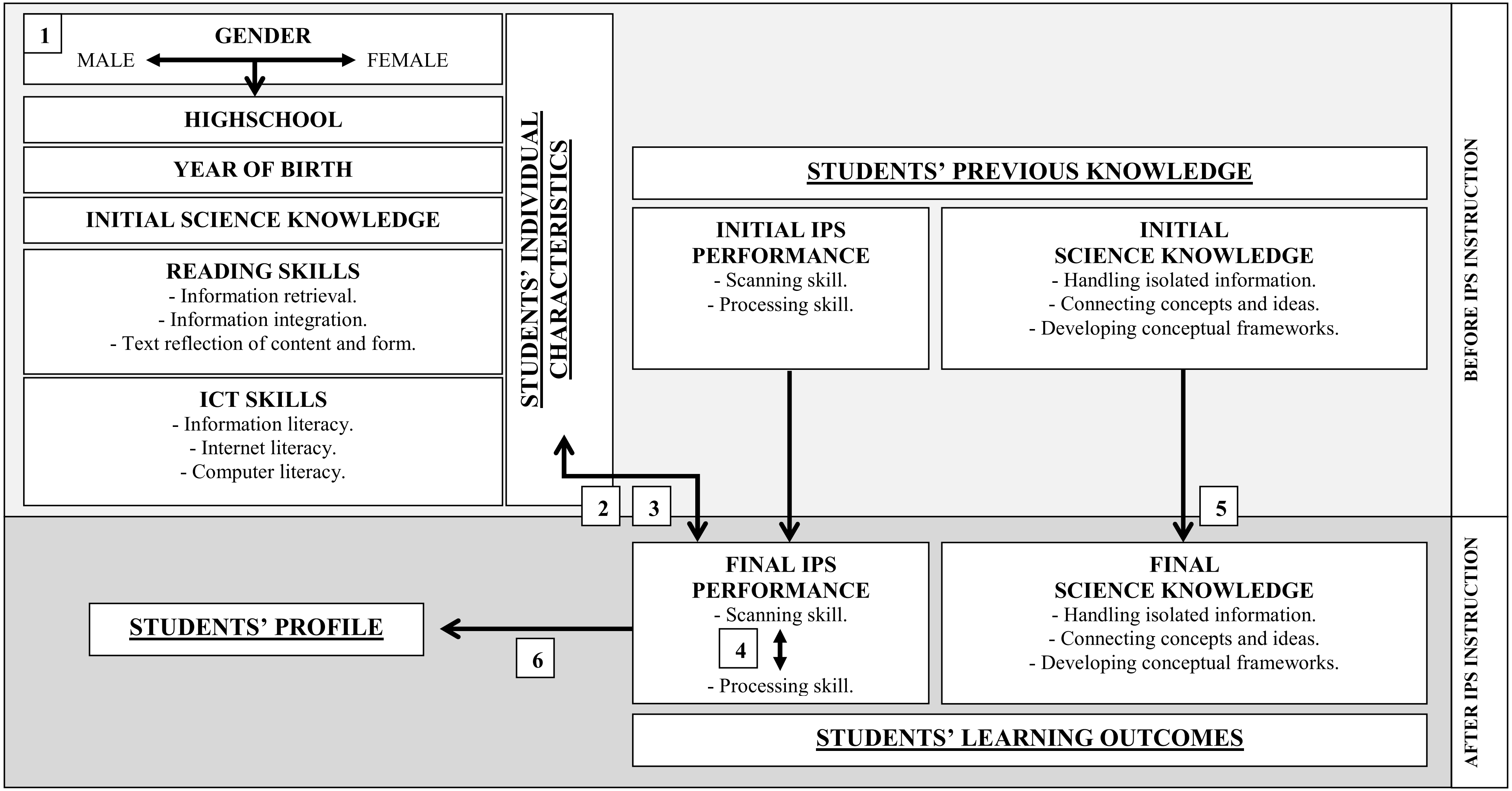


Figure 4. Research design map.

5.2. Curricular Context of the Study

According to the Organic Law 8/2013, for the Improvement of Educational Quality in Spain, Compulsory Secondary Education also named Educació Secundària Obligatòria (ESO) is the educational stage of four courses that is taught to students from 12 to 16 years old. Along with early childhood education and primary education it completes basic compulsory education. The areas of knowledge of this stage in the Balearic Islands are: biology and geology, physics and chemistry, geography and history, Spanish language and literature, Catalan language and literature, mathematics, first foreign language, fine arts, visual and media education, music, technology, classical culture, introduction to entrepreneurial and business activity and second foreign language.

In order to assure the proper development of the teaching and learning practices of the different subjects at the autonomic level, the Decree 34/2015 from the 15th of May establishes the curriculum of Compulsory Secondary Education in the Balearic Islands.

The curriculum for Compulsory Secondary Education in the Balearic Islands is organized considering the following curricular elements: objectives, key competences, contents, evaluation criteria, assessable learning standards and didactic methodology.

Consistent with the core elements of the curriculum mentioned any didactic sequence designed during Secondary Education has to consider them. Therefore, for the didactic intervention derived from the present research, a curricular concretion in the subject of biology is developed for the third grade of ESO.

First, objectives are defined as benchmarks related to the achievements that the students must achieve when finalizing the educational process, as a result of the teaching-learning experiences intentionally planned for this purpose. Apart from those which are considered through the whole educational stage of Secondary education, each area of study determines certain specific objectives to be achieved during the development of the area of knowledge. The specific objectives for biology and geology are can be found on Table 6.

Table 6
Objectives of biology and geology area

Objectives	
1	To understand and use the basic strategies and concepts of biology and geology to interpret natural phenomena and to analyze and evaluate the repercussions of scientific and technical development and the applications of this development.
2	To apply, in the resolution of problems, strategies typical of the sciences, such as the discussion of the interest of the problems raised, the formulation of hypotheses, the development of resolution strategies and experimental designs, the analysis of results, consideration of the applications and repercussions of the study carried out and the search for global coherence.
3	To understand and express scientific information using the correct oral and written language by elaborating and interpreting diagrams, graphics, charts, figures, maps and other models of representation to be able to communicate the findings in the field of science.
4	To obtain information on scientific topics using different sources, including ICT, and evaluate their content to base and guide work on these topics.
5	To adopt critical attitudes based on the knowledge of biology and geology to analyze scientific issues individually or in a group.
6	To develop attitudes and habits that are favorable to the promotion of personal and community health and to facilitate strategies that allow us to face the risks of today's society in aspects related to food, consumption, drug addiction and sexuality.
7	To understand the importance of using the knowledge of biology and geology to meet human needs and participate in the necessary decision-making about local and global problems.
8	To know and value the interactions of science and technology with society and the environment, as well as the need to seek and apply appropriate solutions to advance towards sustainability, paying attention to the problems with which humanity is faced today, especially those that most directly affect the Balearic Islands.
9	To recognize the provisional and creative nature of biology and geology, as well as the contributions they have made to human thought throughout history, and appreciate the importance of those in overcoming dogma and causing scientific revolutions that have marked the cultural revolution.
10	To understand and value the natural heritage of the Balearic Islands and be aware of the need to conserve and manage it in a sustainable way, as well as the importance of promoting it and, where appropriate, participating in initiatives aimed at preservation.
11	To acquire knowledge about the natural and socio-cultural elements of the environment of the Balearic Islands and other geographic areas of wider scope and use them to base values, attitudes and behaviors favorable to the conservation of resources and the improvement of environmental quality.

Source: Decree 34/2015 from the 15th of May.

The objectives for biology and geology mainly covered during the didactic sequence designed for the present research are the objectives number: 2, 3, 4, 5, and 7.

Secondly, key competences are defined as the capabilities to apply the contents of the educational stage in an integrated manner in order to carry out activities properly and solve complex problems effectively. The 7 key competences defined by the current educational law in Spain are the ones detailed on Table 7.

Table 7
Seven key competences description

Competence	Description
Linguistic Communication	This competence is defined as the ability to communicate within particular social practices, in which the individuals interact with other interlocutors orally and through written texts in multiple modalities and formats.
Mathematics, Science and Technology	This competence is defined as the ability to use and relate numbers, basic operations, symbols and forms of mathematical expression and reasoning. It involves the ability to apply mathematical thinking and mathematical tools to describe, interpret and predict different phenomena in context.
Digital	This competence is defined as the ability to use information and communication technologies in a creative, critical and safe way, in order to achieve the objectives related to work, learning, use of free time, and inclusion and participation in society.
Learning to Learn	This competence is defined as the ability of lifelong learning taking place in different contexts, both formal and non-formal ones. This competence is characterized by the ability to start, organize and persist in learning. This requires the ability to feel motivated to learn, and the need to foster organization and learning management.
Social and Civic	This competence is defined as the ability to use the knowledge and attitudes towards society, in order to interpret social problems in diverse contexts. It implies building responses, taking decisions and solving conflicts, as well as interacting with other people and groups according to norms based on mutual respect and democratic convictions.
Sense of Initiative and Entrepreneurship	This competence is defined as the ability to transform ideas into actions. It means becoming aware of the situation to be solved, know how to choose, plan and manage their knowledge, and the necessary skills or abilities and attitudes with self-criteria, so as to achieve the desired objective.
Cultural Awareness and Expression	This competence is defined as the ability to know, understand and appreciate the different cultural and artistic demonstrations, using them as a resource of enrichment and personal enjoyment, and considering them as part of peoples' wealth and heritage.

Source: Decree 34/2015 from the 15th of May.

Though the seven competences must play a crucial role in each area of knowledge, the didactic sequence designed for the current research has focused its attention on improving mainly two of the seven key competences, which are: learning to learn competence and digital competence.

Thirdly, the contents are the set of knowledge, abilities, skills and attitudes that help achieve the objectives of the stage and acquire competences. The contents are ordered into subjects, which are classified in subjects and fields. The contents of biology and geology that must be covered through the third level of Secondary Compulsory education can be divided into 7 blocks of content that together compose the contents to be achieved during the Secondary Education stage (See Table 8).

Table 8
Blocks of content from biology and geology area for third of ESO

Block	Title	Description
Block 1.	Scientific methodology.	This block is transversal throughout the course and promotes the techniques of scientific work (research, selection and interpretation of scientific information and the realization of simple experimental works).
Block 2.	The Earth in the Universe.	The purpose of this block is to develop the knowledge of the Earth and to situate, in the whole of the Universe in general and the solar system in particular, the internal structure of this planet and the flowing layers that surround it, as well as the main types of minerals and rocks that make up it.
Block 3.	The biodiversity on Earth.	This block is dedicated to the study of the functions and general characteristics of living things and the cell as a basic element in the constitution of them, as well as the knowledge of the five great realms of nature.
Block 4.	People and health.	In this block, the anatomy and physiology of the human body are studied, the main diseases that affect it and the healthy habits that contribute to preventing them.
Block 5.	The land relief and its evolution.	This block addresses the study of the constant changes suffered by the earth's relief as a consequence of the joint action of the external and internal energies that affect our planet.
Block 6.	Ecosystems.	This block includes the study of the components of an ecosystem and the main types of ecosystems, as well as the most common factors that destabilize them and how to avoid them.
Block 7.	Research project.	This block includes the design, realization and exhibition of a team research project related to the subject of one of the blocks set out above. This block can be treated transversally throughout the course.

Source: Decree 34/2015 from the 15th of May.

The current research will develop a didactic sequence where contents from Block 4, named people and health, will be worked on.

Fourth, once having carefully defined the main curricular features that compose what the students should achieve in this area of knowledge, the curricular features that consider the process of evaluation arise. On the one hand, evaluation criteria are the specific reference to evaluate the learning of the students. They describe what they want to value and what the students must achieve, both in knowledge and in skills. They respond to what is intended to be achieved in each subject. On the other hand, assessable learning standards are specifications of the evaluation criteria that allow us to define the learning outcomes and which specify what the student must know, understand and do in each subject. They must be observable, measurable and evaluable and must allow teachers to measure the performance or achievement gained. Its design should contribute and facilitate the design of standardized and comparable tests.

The contents worked on during the didactic sequence have been extracted from the Block 4 of contents, which is named: People and health. For that reason, in order to coherently assess the achievement of the aforementioned curricular features, from an educational point of view, Table 9 specifies the evaluation criteria and assessable learning standards taken into account when designing the learning environment of the study.

Table 9
Evaluation criteria related to assessable learning standards for Block 4 of contents

Evaluation criteria	Assessable learning standards
1. To discover, based on the knowledge of the concepts of health and illness, the factors that determine them.	1.1. Discusses the implications that are beneficial for health and justifies with ambiguous the choices that it does or can do to promote it individually and collectively.
2. To classify diseases and assess the importance of lifestyles to prevent them.	2.1. Recognizes the most common diseases and infections and relates them to the causes that cause them.
3. To determine the most common infectious and non-infectious diseases that affect the population, the causes that cause them and how they can be prevented and treated.	3.1. Distinguishes and explains the different mechanisms of transmission of infectious diseases.
4. To identify healthy habits as a method of preventing illnesses.	4.1. Describes habits of healthy living and identify them as a means to promote their health and that of others. 4.2. Proposes methods to prevent infection and the spread of the most common infectious diseases.
5. To determine the basic operation of the immune system, as well as the continuous contributions of the biomedical sciences.	5.1. Explains what the immunity process consists in and evaluates the role of vaccines as a method of preventing illnesses.
6. To recognize and convey the importance of prevention as a common practice and integrated into their lives and the positive consequences of donating cells, blood and organs.	6.1. Details the importance of the donation of cells, blood and organs to society and to the human being.

Source: Decree 34/2015 from the 15th of May.

All the evaluation criteria defined with the different assessable learning standards have been considered when designing the IPS instruction embedded in the didactic sequence related to people and health.

The last curricular feature to be defined is the didactic methodology which can be described as a set of actions, strategies and procedures organized and planned by the teachers, in a conscious and reflective way, in order to enable the learning of the students and the achievement of the objectives set.

As detailed before, the current research study was embedded in the biology and geology lessons of third of ESO students. Therefore, the next section will precisely define the main features of the methodology used in the instruction designed.

5.3. WISE Learning Context

Various previous research studies have provided evidence that it is possible to improve IPS skills and individual learning in a technology environment by implementing appropriate questions and reflection prompts that cause students to activate key cognitive processes to solve the learning task (Mason et al., 2014). Furthermore, some effective embedded instruction research studies in secondary education have revealed a positive impact on learning different aspects of IPS (Argelagós & Pifarré, 2012; Britt & Aglinskas, 2002; Raes et al., 2012). Therefore, IPS skills might be acquired by embedding them within a relevant and meaningful context with a view to improving the learning process of a knowledge field. For these reasons, the instruction designed in the present research will be developed by using WISE. WISE[4] is the educational online platform used to develop the instruction on IPS embedded in the curricular content of illnesses and health.

Thanks to the endless possibilities that the WISE platform offers, the didactic sequence designed was characterized by the following educative principles:

- Stimulate students to pay explicit attention to the various steps that have to be taken during the IPS process by offering them a clear and organized knowledge base.
- Encourage students to connect the IPS process knowledge acquired with concrete experiences and with representations in other domains.
- Embed the IPS process training in science curricular contents about illnesses and health.

---

[4]WISE platform is a free, open source curriculum platform with tools for authoring, grading, and monitoring student progress: https://wise.berkeley.edu/

- Promote students' development of inquiry learning tasks in an IWBL environment to better solve IPS tasks.
- Support students' learning process by providing them initial reminders and metacognitive questions to make them reflect about the IPS and simultaneously scaffold the task development for them in the IWBL environment.

The different learning tasks that students developed during the didactic sequence were carefully designed considering the theoretical and methodological contributions of other studies previously mentioned on the theoretical background of the present research.

The initial session of the didactic sequence was created to stimulate students to pay explicit attention to the various steps that have to be taken in IPS and to the way in which these steps can be used flexibly in different situations (see Figure 5). In order to achieve this purpose, the students had to watch different videos that demanded them to reflect on different questions presented, allowing them to connect the organized knowledge base acquired with similar representations that refer to personal experiences and with representations in other domains (see Figure 6). These connected, rich representations will make learning outcomes durable, flexible and generalizable (Walraven et al., 2010).

In the following sessions, the organized knowledge base on IPS presented to the students was used to solve six different real situations by allowing them to significantly construct their own learning while they developed inquiry based activities (see Figure 7). At the same time, prompts appeared to help students' while using a specific IPS skill.

The final session was devoted to allowing students to individually face a new real problem solving task which required them to apply all the previous knowledge learned and practiced (see Figure 8 and 9).

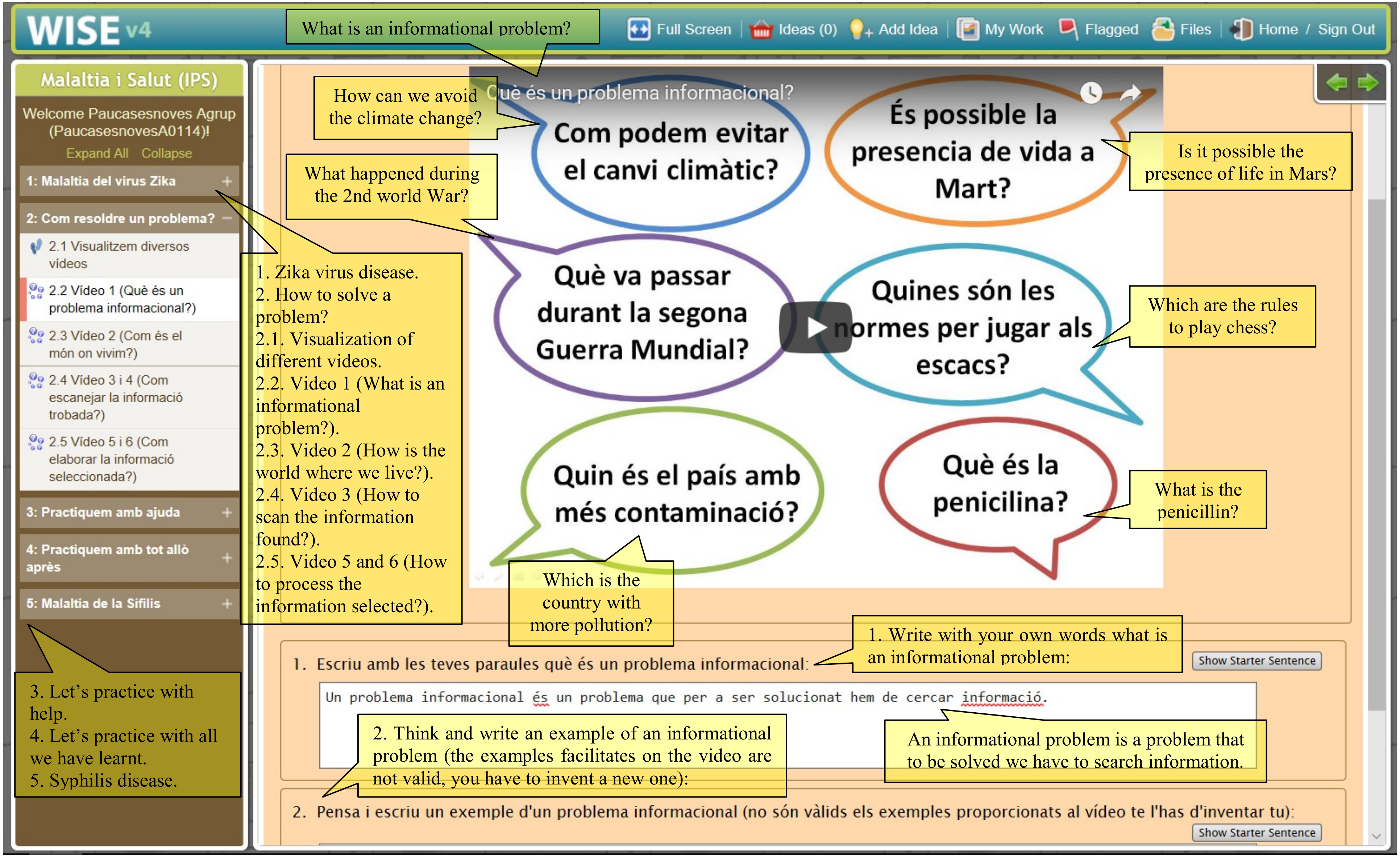


Figure 5. Screen shot of the activity 2.2. of the initial session.

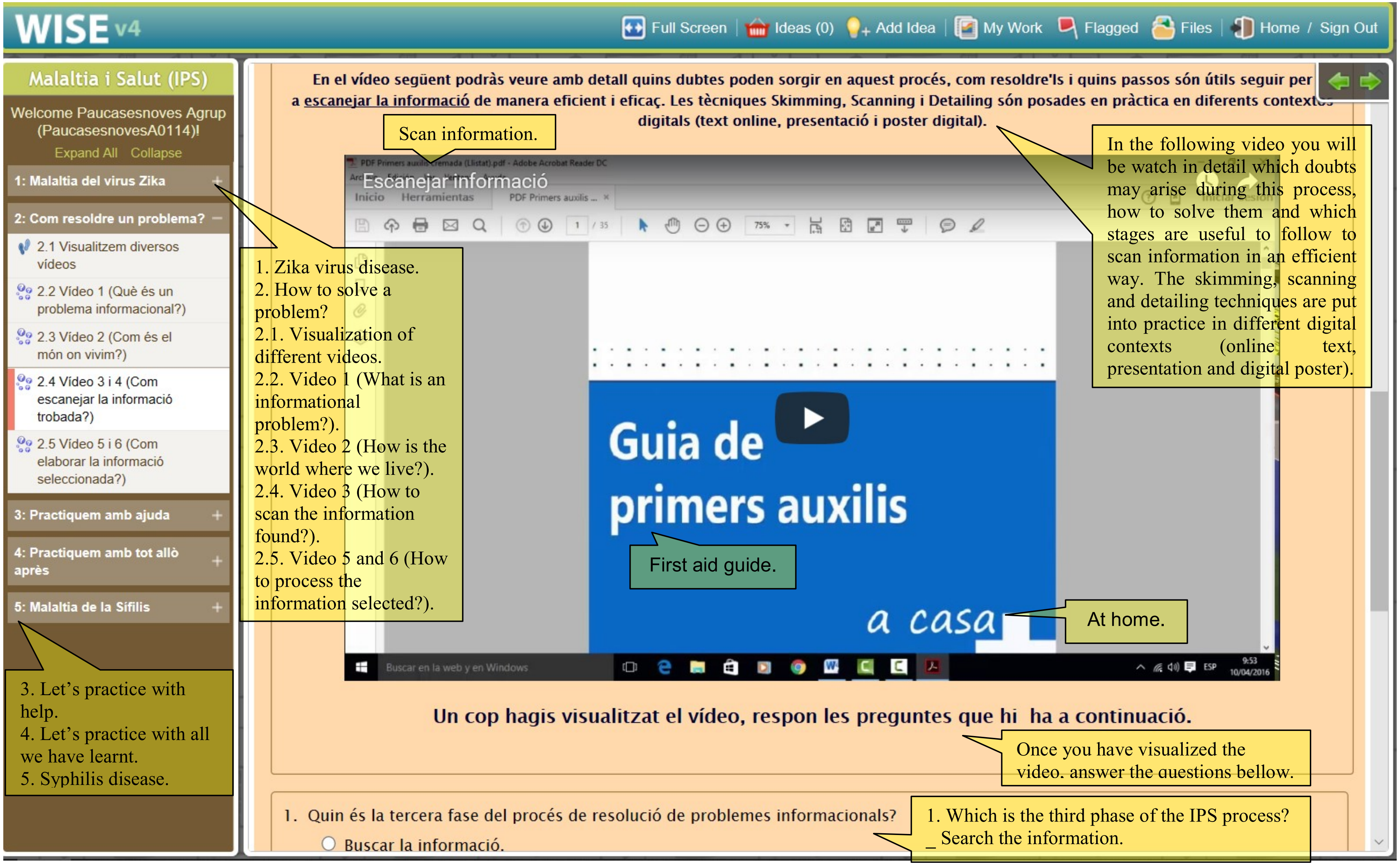


Figure 6. Screen shot of the activity 2.4. of the initial session.

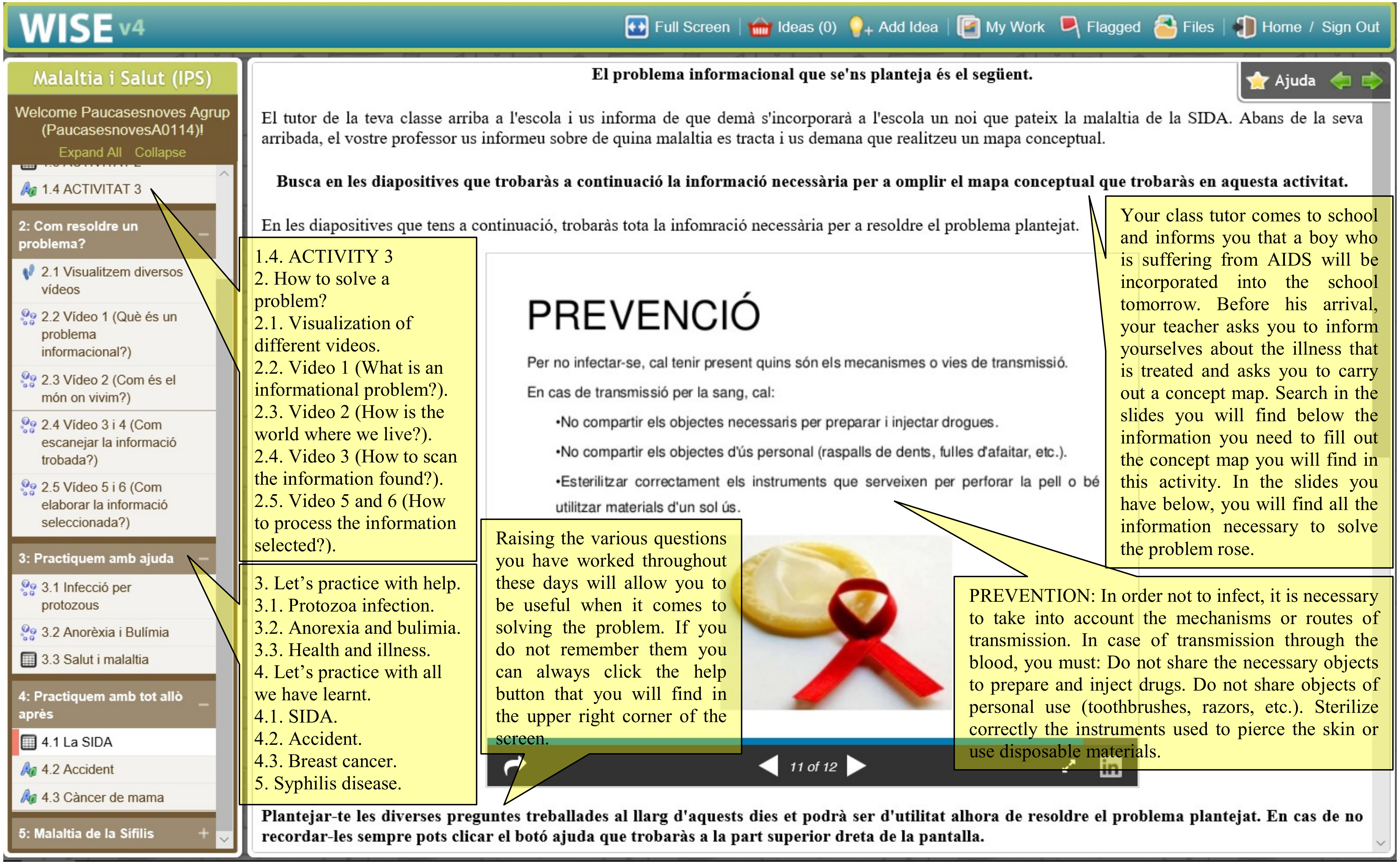


Figure 7. Screenshot of the 4th real situation faced by the students.

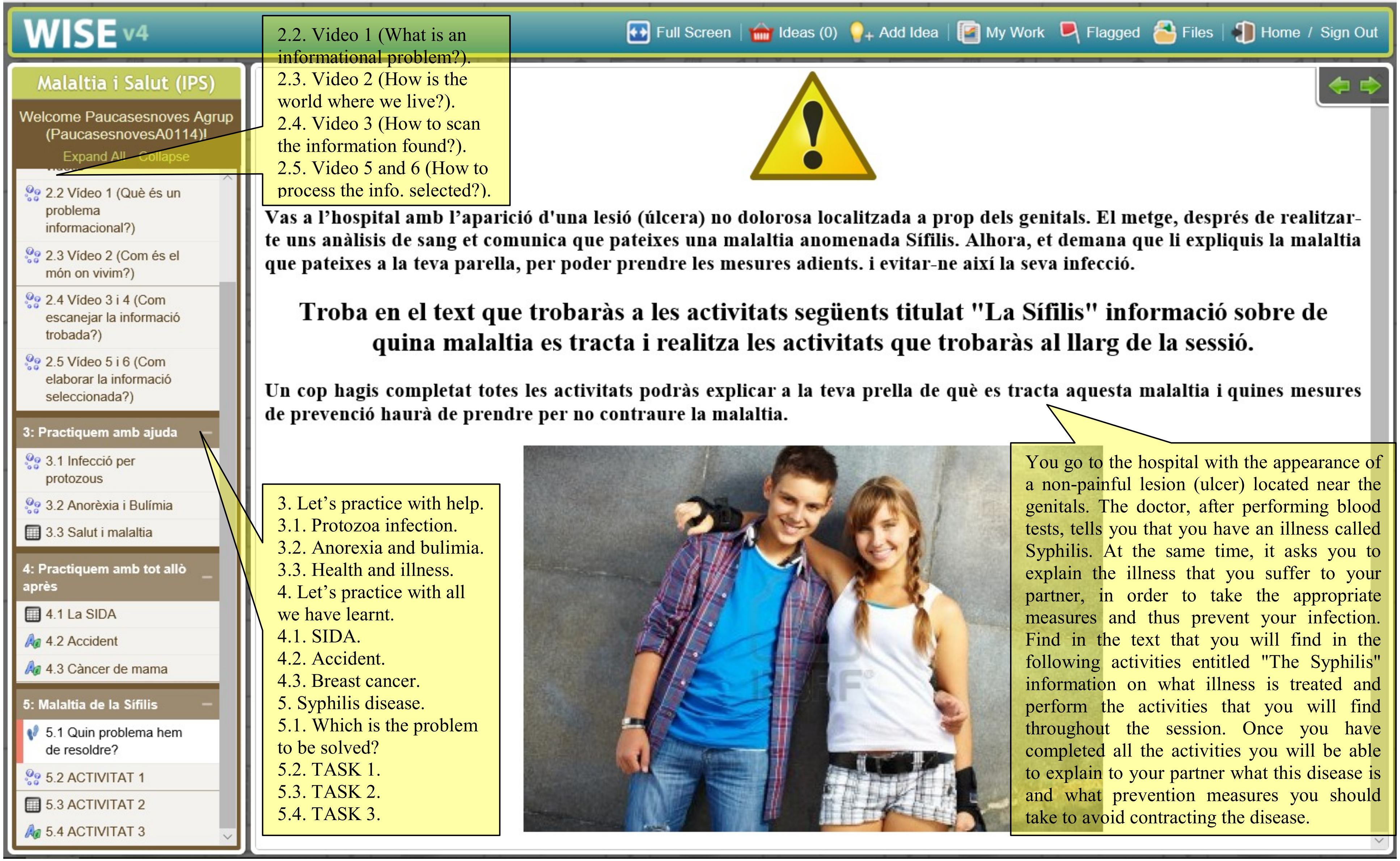


Figure 8. Screenshot of the final real situation faced by the students.

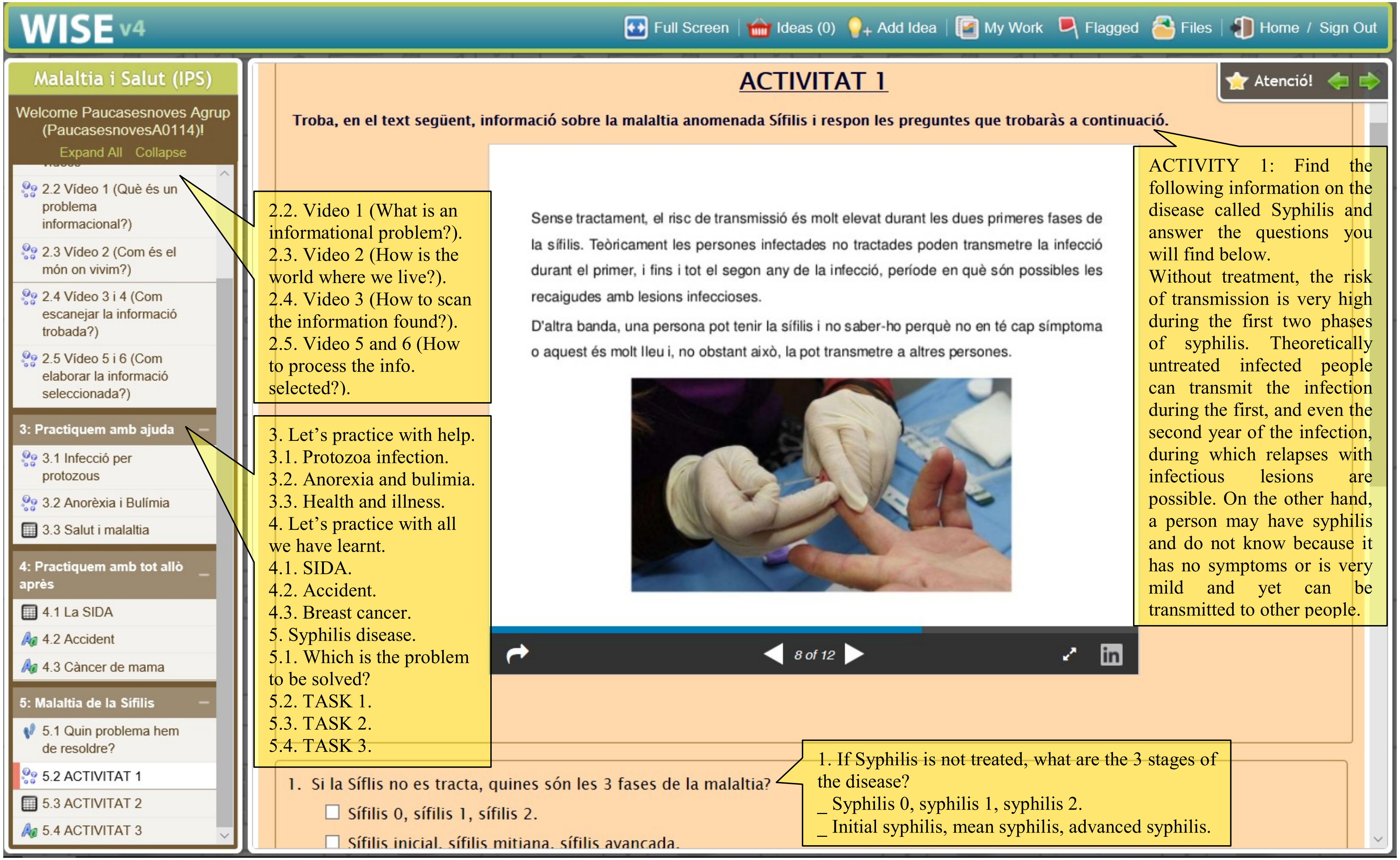


Figure 9. Screenshot of one of the activities faced by the students in the final session.

Figure 10 synthesizes the different learning tasks developed by the students.

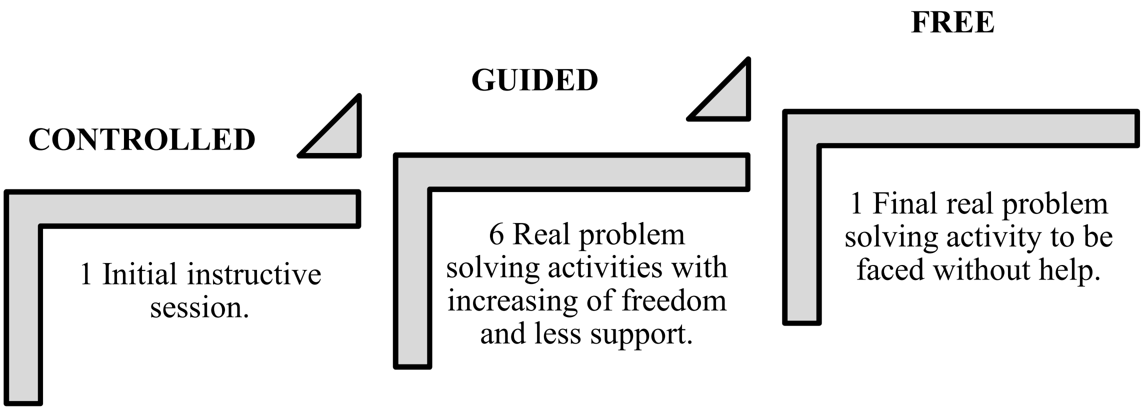


Figure 10. Learning tasks developed by the students.

All the learning tasks were performed by the students in the real context of the classroom, as curricular learning activities, in order to ensure ecological validity (Wopereis & van Merriënboer, 2011), and effectiveness (Frerejean et al., 2016).

5.4. Participants

The two comparable high schools that participated in the study belong to the major island of the Balearic Islands, Mallorca. To be more precise, the high schools where the research developed took place are located in two different towns, Inca and Manacor. Both have similar socio-demographic statistics according to the Institut d'Estadística de les Illes Balears (IBESTaT) since they are the second largest cities of the island after the capital.

To be able to accurately describe the context where the current research was developed, the following information has been gathered regarding the Educational School Project of both high schools.

The first high school is located in Inca, a town with an average population of 30.944 people. The inhabitants of the town work mainly in the sectors of commerce and social services that have displaced other traditional sectors such as industry. However, an important emergent sector is construction, mostly developed by people who have immigrated to the island. Focusing on the main characteristics of the high school, there are 456 students schooled in the secondary education stage. From these students, the 14,5% of the students of the high school were born abroad but they have been schooled in Mallorca since the beginning of Primary Education. In addition, it is relevant to remark that 113 are classified as students who need specific educational support, the majority of whom are placed in the first cycle of the secondary educational stage.

The other high school is located in Manacor, a town with an average population of 40.249 people. The inhabitants of the town work mainly in the sectors of tourism and commerce services that have displaced other traditional sectors such as the manufacturing industry. However, an important emergent sector is construction mostly developed by people who have immigrated to the island. Focusing on the main characteristics of the high school, there are 468 students schooled in secondary education stage. From these students, the 17,4% of the students of the high school were born abroad but they have been schooled in Mallorca since the beginning of Primary Education. In addition it is relevant to remark that 145 from the stage are classified as students who need specific educational support, the majority of whom are placed in the first cycle of the secondary educational stage.

To be more precise, data was collected from 82 secondary students that were in the third of ESO, which theoretically corresponds to students that are 14-15 years old.

From these 82 secondary students, a total of 50 participants were males while the other 32 were females. After analyzing the data, it can be observed that more male students participated in this study, a total of 61% were males, while the 39% were females.

In relation to the age of the participants, it is relevant to remark that despite the fact that all the participants were studying the third of ESO when the research was developed, the students were in three different years. Data revealed that the 13.4% of the students were born in 1999, the 23.2% were born in 2000 and 63.4% were born in 2001. These numbers indicate that 36.6% of the students were not at the grade corresponding to their age.

The participants from the sample of the study belonged to two different urban high schools from Mallorca (Spain). 57.3% of the participants belonged to the high school from Manacor and 42.7% of the participants belonged to the high school from Inca.

According to students' level of expertise on different individual skills before the instruction was carried out, several pieces of information regarding the sample can be mentioned. Firstly, the participants' average academic achievement was 5.80 points out of 10 in the subject of science. Secondly, the participants' average reading skills was 11.54 points out of 20. Third, the students' perception of their own domain of ICT skills was 3.97 on a scale of 1-5, ranging between "strongly disagree" and "strongly agree". Finally, the students' initial knowledge on illnesses and health was of 12.04 out of 30, which means that, on average, the students were failing on specific science knowledge.

In both high schools, laptops were located in the students' classroom, the physical space where data collection was carried out.

5.5. Data Collection

5.5.1. General procedure.

Before developing data collection, an initial contact was established with the participants in order to ensure their participation with the investigation. To be more precise, the high schools that participated in our study were initially phoned and invited to join the study by the researcher. Once the high schools had accepted, a formal e-mail (See annex 1) was sent to the headmaster of each participating high school, detailing the purpose of the study and stating that participation is voluntary and anonymous. Then, the headmasters of each high school were also contacted by phone one week after sending the e-mail, to confirm a date and time for a visit to their schools to meet the teachers that would be involved in the study. Teachers teaching sciences in third of ESO attended the meeting and expressed their interest on future active collaboration with the researcher of the present research.

After the first meeting with the personnel involved in the research intervention at the participating high schools, four different meetings with the teachers teaching sciences in the third of ESO were carried out before the collection of data in order to carefully define the content of the instructive sessions. At the first two meetings, educational questions regarding the content of the sessions were discussed. At the third meeting, the researcher provided a protocol for the educational intervention to the teachers (See annex 2). At the last meeting, questions regarding the educational intervention were answered and teachers were shown the complete didactic sequence designed in WISE.

Similarly, after this first meeting, two more meetings took place with the computer technicians of both high schools in order to ensure that any computer issues were addressed. In order to facilitate this process, the computer technicians were given a logistic survey to be filled in for the second meeting with the researcher (See annex 3). Once the computer technicians had filled in the logistic survey the second meeting was held in order to resolve any possible problems which might have emerged. After the technicians had installed all the necessary requirements for the study mentioned by the researchers, the last meeting was held and a pilot test was carried out in order to ensure that everything worked correctly.

Once the previous instruction of the teachers and the necessary computer and ICT programmes had been put into place, we held the first meeting with the students. At that meeting, the students were given the main details of the instruction. The WISE webpage was presented in order to assure that the students knew how to navigate around the webpage without getting lost. Moreover, at that point, students were also given the different codes and passwords to access the website. Different questions regarding the future educational process were answered. The researcher thanked the students for their participation in the study. After the main pedagogical and technical instructions had been given in order to ensure an effective instructional process, data collection procedure started.

The data collection procedure was mainly divided into two main parts. The initial data collection phase was developed before the implementation of the instruction had been designed, while the final data collection phase was developed after the implementation of the instruction had been designed. The two main phases of data collection procedure are synthesized on Figure 11.

Data collection stage	Data collection tool	Variable	Duration
INITIAL DATA COLLECTION	a) Personal information survey.	Gender, year of birth, high school belonging.	
	b) Reading literacy test (CompLEC).	Students' reading skill.	90 minutes
	c) ICT Literacy survey (5-point Likert scale).	Students' ICT skills.	
	d) Initial science knowledge on illness and health test.	Students' previous knowledge on illnesses and health.	60 minutes
	e) Initial log-files and thinking aloud of three IPS tasks.	Students' initial performance of scanning and processing skills.	60 minutes
INSTRUCTION PERIOD (8 sessions of 1 hour)			
	d) Final science knowledge on illness and health test.	Students' previous knowledge on illnesses and health.	60 minutes
FINAL DATA COLLECTION	e) Final log-files and thinking aloud of three IPS tasks.	Students' final performance of scanning and processing skills.	60 minutes

Figure 11. Data collection procedure from the 82 participants.

The initial data collection phase started with the different data collection instruments that gathered information about certain students' individual differences. Before the instruction, the students completed in one session of 90 minutes: their students' personal information survey, the ICT Literacy survey (5-point Likert scale) and the Reading literacy test (CompLEC) the three of which are accessible at the following link (http://goo.gl/forms/zSVLkT0plb). Once this information had been collected, and during the same week, the students devoted one science session of 60 minutes to individually fill in the science knowledge test on illnesses and health (See annex 5).

One week after the collection of certain students' individual information from different tests and surveys, three different initial tasks were carried out by the students on the WISE platform. The information derived from the students' completion of these tasks was collected with Camtasia Studio 8.6 software, by using observational techniques such as screen recording and students' concurrent reporting. This recording provided data about how students' performed on IPS tasks, without any previous instruction.

Once the students had completed the six different sessions of the instruction period, the time for final data collection arrived. At that point, data was collected in two different ways. Firstly, as they had been asked to before the instruction had been received, students completed three different final tasks on the WISE platform. The information derived from the students completion of these tasks was collected using Camtasia Studio 8.6 software, by using observational techniques such as screen recording and students' concurrent reporting. This recording provided data about how students' performed on IPS tasks after the instruction had been received. Secondly, after the students had ended the instruction period, they were asked to individually fill in the science knowledge test on illnesses and health in a science session of 60 minutes. The information obtained from this test offered information about the students' final knowledge on illnesses and health after the didactic sequence developed on the WISE platform.

It is relevant to mention that in total 164 hours of Camtasia recordings were obtained to be analyzed.

Last but not least, it is worth mentioning that although the present research does not meet the ethical and data transfer standards that are currently demanded -because they were not required when data collection was developed- it is relevant to emphasize that the current investigation has been developed in accordance with the ethical standards of the American Psychological Association (2010). Therefore, participants were informed in advance of the general aim of the research, its duration, and the procedure to collect, store, and analyze the information provided by them.

5.5.2. Data collection tools.

In the present research study, five different instruments were used to collect information from the different variables analyzed of the 82 participants:

Personal information survey. Participants were asked to provide basic personal information concerning gender, year of birth, high school to which the students belong. This information was collected by asking the students to fill in an online survey made with a tool named Google Questionnaire.

Reading literacy assessment. In order to assess students' reading skill, a standardized assessment that evaluates reading literacy was used (CompLEC). CompLEC (Tatay et al., 2011) is based on the PISA assessment framework and new definitions of reading literacy. The assessment, which is easy to apply and score, assesses the level of reading literacy of children between 11 and 14 years of age in several reading situations and with different types of texts. The scale has been standardized with a sample of 1,854 students from five different Spanish regions. Empirical results show that CompLEC is a homogeneous, reliable and valid instrument. CompLEC has 20 questions which are divided into three categories according to the three fundamental features of evaluating PISA reading literacy (information retrieval questions, information integration questions, content and form of the text reflection questions).

ICT literacy survey. In order to measure students ICT skills, an ICT literacy survey which has been confirmed to have good validity and reliability in studies (Kaymak & Horzum, 2013; Lau & Yuen, 2014b) was used. This survey assesses fundamental skills in dealing with computer interfaces using 17 items. The 17 items from the survey were distributed into three scales (information literacy, Internet literacy and computer literacy). The ICT literacy survey uses a 5-point Likert scale to rate items from “strongly disagree” (1) to “strongly agree” (5).

Science knowledge on illnesses and health assessment. In order to measure the science knowledge on illnesses and health of students, participants were asked to complete a knowledge assessment of the didactic sequence content (illnesses and health). To design this assessment, as Becerril and Badia (2015) used in their research of shared knowledge construction process when developing IPS, the cognitive complexity of the assignment has been taken into account. Therefore, the science knowledge assessment has been created taking into account three types of learning tasks (handling isolated information without transforming the content in any way; connecting concepts and ideas from more than one information source in a simple fashion; thinking about concepts and developing complex conceptual frameworks). This has been presented to the students in the form of three different activities: multiple-choice questions, a conceptual map creation task and a specific writing task.

- Multiple-choice questions: 10 questions with four possible options each about illnesses and health had to be answered by the students.
- Conceptual map: 25 concepts given about illnesses and health had to be related by the students.
- Specific writing of preventive measures: Students were asked to think and reflect on the scientific content of illnesses and health in order to write 10

preventive measures to be taken into account in order to avoid catching an infectious illness.

- Moreover, from these tasks two different data sets were extracted: initial science knowledge on illnesses and health and final science knowledge on illnesses and health.

Log-files and concurrent non-mediated thinking aloud protocols of three IPS tasks. In order to analyze students' scanning and processing information skills performance before and after the instruction, two different methods were used to gather information from both cognitive processes in different IPS task fulfillment.

Regarding the design of the different IPS tasks developed before and after the instruction that the students were expected to complete, it has to be mentioned that in the initial session devoted to analyzing the students' scanning and processing information skills performance before the instruction, students were required to complete three different IPS tasks, which also happened in the last session after the instruction in order to analyze students' scanning and processing information skills performance.

The three different tasks from the initial session and the final session dealt with different content related to illnesses and health. However, despite the fact that the tasks differed from the specific content covered, as (Becerril & Badia, 2015) used in their research of shared knowledge construction process when developing IPS, the different tasks designed for both sessions were planned considering the graduation of the cognitive complexity required, so they shared a common structure. Therefore, the first task from both sessions dealt with handling isolated information without transforming the content in any way and was in the form of multiple-choice questions. The second task from both sessions dealt with connecting concepts and ideas from more than one information source in a simple fashion and took the form of a conceptual map with specific concepts. Finally, the third task from both sessions dealt with thinking about concepts and developing complex conceptual frameworks and which took the form of a specific writing task.

- Multiple-choice questions: 5 questions with three possible options each about a certain infectious illness had to be answered by the students.
- Conceptual map: 15 concepts given about a certain infectious illnesses had to be related by the students.
- Specific writing of preventive measures: Students were asked to think and reflect on the certain infectious illnesses in order to write 5 preventive measures to be taken into account in order to avoid catching an infectious illness.

As can be appreciated after the precise description developed, the IPS tasks have a similar structure to the assessment of science knowledge of illnesses and health developed to collect the students' previous knowledge on the field of study.

Concerning the different methods used to collect information from both IPS cognitive processes while the different tasks proposed were completed by the students before and after the instruction, two main methods were used: observational techniques and verbal protocol analysis.

The first methods employed to obtain data from the students performance were observational techniques, which can be defined as a procedure of gathering and analyzing information obtained through directly or indirectly observing others in natural or planned environments (Creswell, 2002). Since this tool of data collection aims to obtain information about the scanning and processing information skills performance while the different tasks designed are completed on the computer screen, an appropriate observation technique to be used is the log-file technique. According to Csapó and Funke (2017), in the framework of computer based measurement, log-files are a frequently used tool to record students tasks development and precisely describe different actions performed by the students on the screen of the computer while they are solving an IPS task.

Numerous previous research studies have used observational techniques such as log-files in their researches because they offer several advantages (Argelagós, 2012). Firstly, the log-file technique allows researchers to explore in-depth the attitudes and behavior of the participants completing an IPS task in an unobtrusive way. Moreover, log-files provide the researchers the opportunity to observe what it is that users actually do on the screen of the computer rather than relying on reports of what participants say they do. In addition, data is collected as and when the event or the activity is occurring.

Although the log-file technique has many advantages, as with other observational techniques, it also presents some drawbacks. Firstly, researchers have no control over the situations and contexts used in the observational investigations. Secondly, log-files require researchers to have a lot of patience and time to devote to watching a certain number of users or environments to get the needed information. For instance, on the current research study the initial and final log-files of each participant were watched twice, which means that around 328 hours were devoted to collecting data from the log-files obtained from the 82 participants. Thirdly, researchers collecting data from observational techniques might become distracted while observing the collected material, which may perhaps invalidate the results of the research. However, this last limitation was overcome in the current research study as the recorded log-files allow the possibility of watching and analyzing the same task being performed as many times as required.

With the intention if complementing and better understanding the data obtained from the log-file techniques recorded through Camtasia Studio 8.6 software, a second method of data collection named verbal protocol was also used, information being simultaneously collected using the same software Camtasia Studio 8.6. Verbal protocol can be defined as a method of verbal data collection in which participants are asked to describe the provide cognitive and physical processes performed by them to complete a specific task (Mosher, 2011).

According to Green (1998) verbal protocols can be classified according to three parameters (See Table 10).

Table 10
Verbal protocols classification

Parameters	Sub-parameters
1. Form of Report	1.1. Talk aloud reports include information that is already encoded in verbal form. 1.2. Think aloud reports include both information in verbal form and information that is not in verbal form such as the location of a piece of text.
2. Temporal Variations	2.1. Concurrent reports require the participant to produce a report while the task is performed. 2.2. Retrospective reports require the participant to repot the task development after the end of the task.
3. Procedural variations	3.1. Non-mediated reports require the researcher to be in silent and only prompt the participant when long pauses occur. 3.2. Mediated reports require the researcher to ask and clarify the reasons for which a particular decision is taken by the participant.

Adapted from Green (1998).

Considering the classification previously made, concurrent non-mediated thinking aloud protocols are used in the present investigation in order to offer more precise information about the actions developed by the students on the computer screen during the resolution of the different IPS tasks, since verbal protocols require students to verbalize all thoughts that come to mind during task performance, this complements the information collected from the log-files previously described.

Although one of the main advantages of verbal protocols is that it provides precise and comprehensive information about the work of an individual or a job related to a particular task, one of the main disadvantages, as also occurs with log-files, is the huge amount of time that has to be consumed in order to capture and analyze the information collected.

The information collected by these two methods mainly aims to determine the time spent by students while performing the different processes of scanning and processing information and the main features of the skills performance.

With the intention of examining the students' performance of the scanning information skill precisely, six variables were analyzed. These six variables can be grouped into two main groups: type of scanning information performed and the time spent scanning information.

For the purpose of accurately inspecting the students' performance of the processing information skill, five variables were analyzed. These five variables can be grouped into two main groups: type of answer given and the time spent processing information.

The aim of collecting data from the initial and final students' IPS performance for the three different tasks was to determine the effect that IPS instruction designed in an IWBL environment has on students' cognitive processes of scanning and processing information performance. In total 164 hours of Camtasia recordings to be analyzed were obtained.

5.6. Data Analysis

From the information collected throughout the different instruments methods in the previous section, two main sections emerge: measures and analytical strategy.

5.6.1. Measures

This section aims to clarify how the information of each variable has been measured in order to later develop data analysis according to the objectives of the study.

Personal information. To collect data related with students' personal information, participants were asked to complete three questions from a multiple choice questionnaire. The first question dealt with students' gender and could be answered by choosing among male or female. The second question dealt with students' year of birth and could be answered by choosing among years 1999, 2000, and 2001. The third question dealt with students' high school and could be answered by choosing high school 1 or high school 2.

Reading skills. Students' level of reading skills was assessed considering four different categories obtained by using CompLEC (Tatay et al., 2011). The 20 questions that CompLEC presents are divided into three categories: 5 questions for information retrieval, 10 questions for information integration, and 5 questions for text reflection. To be more precise, 1 point was given for each of the 5 questions of correctly answered information retrieval which means that the mark obtained for information retrieval could range from 0 to 5 points. Coherently, 1 point was given for each of the 10 questions of information integration correctly answered which means that the mark obtained for information integration could range from 0 to 10 points. The same happened with questions that dealt with text reflection, which were given 1 point for each of the 5 questions correctly answered which means that the mark obtained for questions that dealt with text reflection could range from 0 to 5 points. The final score, obtained by adding the score achieved in each of the previous categories, gives us the fourth category named global reading skill which is measured out of 20 points.

ICT skills. Students' level of ICT skills was assessed considering four different categories obtained by using ICT literacy survey which has been confirmed to have good validity and reliability in studies (Kaymak & Horzum, 2013; Lau & Yuen, 2014b). The 17 items which were measured by a 5-point Likert scale to rate items from "strongly disagree" (1) to "strongly agree" (5) were distributed into three main categories: 7 items for information literacy, 5 items for Internet literacy, and 4 items for computer literacy. The final score, obtained by calculating the average of the averages for each category, gives us the fifth category named global ICT skill which, as the previous categories, rose from "strongly disagree" (1) to "strongly agree" (5).

Science knowledge on illnesses and health. In order to measure students' science knowledge on illnesses and health, participants were asked to complete the previous described knowledge assessment about illnesses and health. As described before, the assessment had three different types of questions: multiple-choice questions, a conceptual map creation task and a specific writing task.

Multiple-choice questions. The quantitative measurement of these multiple-choice questions had a maximum of 10 points, 1 point was given for each correct answer.

Conceptual map. The quantitative measurement of the conceptual map was marked out of 40 points using the weighted linear combination of the elements of the map. As Novak and Gowin (1988) did, first of all an external model of the conceptual map was designed (See annex 6), then a relationship among the elements of the map and the punctuation was established, the final punctuation was obtained by the addition of the total weight of each element. The quantitative measurement of the conceptual map construction had a maximum of 10 points obtained from the scoring model used according to the elements of the map (See Table 11).

Table 11
Conceptual map scoring model

Validity of answers	Score
Key concept (red).	0.5p
Valid hierarchy (orange).	0.25px5p
Correct statement with link, without link 0.25p (green).	0.5px9p
Correct statement without link (blue).	0.25px15p
TOTAL	10p

Specific writing of preventive measures. The quantitative measurement of the preventive measures listed by the students was graded out of 10 points. In order to determine the correctness of the measures written by the students, a list of correct preventive measures was designed (See annex 7). Table 12 presents the punctuation/grading model used according to the validity of the measures written.

Table 12
Preventive measures scoring model

Validity of the measures	Score
Uses properly a key concept[5] or similar and does not use an incorrect concept.	1p
There is not anything written.	
Repeats a key concept already used before.	0p
Does not use a key concept or similar.	
TOTAL	10p

The maximum score that each student could obtain from the completion of the science knowledge assessment on illnesses and health was 30 points, which were obtained by the addition of the marks obtained on the three questions of the assessment.

Moreover, from this task two different data sets were extracted: initial science knowledge on illnesses and health and final science knowledge on illnesses and health.

The aim of collecting data from the initial and final science knowledge assessments on illnesses and health was to assess the science knowledge acquired by the students after the development of the different instructive sessions designed in an IWBL environment. Therefore, the initial science knowledge assessment on illnesses and health was taken one week before the instruction started and again one week after the instruction ended.

We have considered that a student has learned when he shows a growth in science knowledge between the final assessment with respect to the initial assessment.

Scanning information skill. With the intention of examining precisely the students' performance of the scanning information skill, six categories have been analyzed. These six categories can be grouped into two main groups. The first group includes the three categories that define the type of information scanning performed, which are: number of slides lineally read, number of slides scanned, and number of slides scrolled. The second group includes the three categories that define the time spent scanning information, which are: time scanning useful information, time scanning useless information, and time scrolling information.

[5]Words underlined in the table of answers examples.

When the students' type of scanning had to be analyzed, three types of reading were distinguished. In order to determine which type of reading the students were doing, the time-stamp data was processed so that linear reading, scanning reading and scrolling could be calculated for each interaction/event. The time cutoffs used to distinguish linear reading from scanning reading from scrolling fit with other document navigation research (Alexander & Cockburn, 2008). Any time between events more than five seconds was classified as linear reading. Any time over two seconds but less than five seconds was classified as scanning reading and any time less than two seconds was classified as scrolling.

According to Salmerón, Naumann, García, and Fajardo (2017) highly skilled readers scan more quickly and revisit segments of the hypertext that do not contain non-useful information less often when the time spent scanning information was calculated. When the time the student spent scanning information had to be analyzed, the time that the student spent in front of the information encompassed the time that the participant spent scanning information. From the slides that the students had available to consult information, some of them contained useful information to solve the IPS task and others contained non-useful information to solve the information problem proposed see Table 13.

Table 13

Slides usefulness to achieve each task completion

Type of slide	Task	Before the instruction	After the instruction
Slides with useful information	Task 1	2, 4, 6, 7, 9.	2, 4, 5, 6, 9.
	Task 2	2, 4, 5, 6, 7, 10, 11, 12.	2, 4, 5, 6, 7, 9, 10, 12.
	Task 3	10, 11, 12.	10, 11, 12.
Slides with non-useful information	Task 1	1, 3, 5, 8, 10, 11, 12.	1, 3, 7, 8, 10, 11, 12.
	Task 2	1, 3, 8, 9.	1, 3, 8, 11.
	Task 3	1, 2, 3, 4, 5, 6, 7, 8, 9.	1, 2, 3, 4, 5, 6, 7, 8, 9.

At that time, three variables were calculated: total time spent scanning slides with useful information, total time spent scanning slides with useless information and total time spent scrolling through the slides of information. These categories were calculated for each type of task, so nine different categories emerged from these categorizations established for the initial data collection and nine different categories emerged for the final data collection. The time spent on the type of scanning information has been measured in seconds while the quantity of slides has been measured through number of slides. The established categories mentioned below allow us to detail the students' level of expertise on scanning information at the end of the research.

Processing information skill. With the purpose of accurately inspecting the students' performance at the processing information skill, five variables have been analyzed. These five variables can be divided into two main groups. The first group includes the four categories that define the type of answer given, which are: number of correct answers consulted, number of correct answers non-consulted, number of incorrect answers consulted, and number of incorrect answers non-consulted. The second group includes one category that defines the time spent processing information as: time processing information.

According to Hahnel et al. (2016) processing significant information to accomplish the task could be associated with extensive processing times. Nevertheless, if students become aware of unconnected information, students might stop processing information and present shorter processing information times. Therefore, the authors suggest that maybe the duration of students' access to hypertext could facilitate the understanding of how students use their time, and therefore facilitate a different insight into students' cognitive processing information process. Therefore, the students' total time spent processing information was calculated by counting the time that the student spent in front of the answer sheet searching for the right answer. The time spend on processing information has been measured in seconds.

When the students type of answer had to be analyzed four types of answers were distinguished: correct answer previously consulted, correct answer previously non-consulted, incorrect answer previously consulted and incorrect answer previously non-consulted. In order to determine the correctness of the answers given by the students' initial and final answers', a correctness sheet was designed for each of the three tasks developed (See annex 7). According to the answer sheet designed, students obtained 1 point for each correct answer given to each of the 5 questions of Task 1, which means that the total score for this task could range from 0 to 5 points. Likewise, students obtained 1 point for each of the fifteen questions answered correctly in Task 2, which means that the total score for this task could range from 0 to 15 points. Finally, in Task 3 students were given from 0 to 2 points for each of the 5 measures appropriately written according to the parameters established on Table 46.

Once the different categories for the scanning information skill performance and for the processing skill performance were assigned a code, an Excel template sheet was carefully created, considering the features mentioned for each variable, in order to meticulously analyze the log-files and the concurrent non-mediated thinking aloud protocols obtained in the audiovisual file. For each student, one Excel file with the template for analyzing the audiovisual files was created and saved following a pattern: number of participant _ student's name _ student's surname. The excel file contained two Excel sheets, the first Excel sheet was devoted to analyzing the student's initial task performance and the other one was devoted to analyze the student's final task performance. For each Excel sheet template, different codes and Excel formula were assigned in order to automatically calculate certain parameters established derived from the categories above mentioned. The Excel sheet was divided into four main sections (See Annex 8).

Section 1 was named student's performance and was formed of 5 columns with indefinite rows which were added depending on the student's performance. The first column was named CODE and indicated what the student was doing. It had to be filed in manually by the observer during the screening of the video by following an established pattern. The second column was named START and indicated the moment in which an action started to be performed by the student. It had to be filled in manually during the screening of the video by following the pattern 0:00:00 each time a different action started. The third column was named END and determined the moment in which a student ended an action. It had to be filled in manually during the screening of the video by following the pattern 0:00:00 each time an action finished. Both measures of time coincided with those that appear in the audiovisual file. The fourth column was named Duration and indicated the amount of time that the students spent performing an action. It was automatically filled in with a formula that subtracts the END column from the START column. The fifth column was named Scrolling and indicated the amount of slides that were scrolled through by the student when scrolling. It had to be filled in manually during the screening of the video with the number of slides scrolled through, only if the student scrolled through the information.

Table 14
Steps to code an action performed by the student

Steps		
1st Identify the task.	Write "t" and the number of task, which can be: 1, 2 or 3.	
2nd Identify the skill performed.	Scanning skill performance is identified if the student is located on the slides of information.	Processing skill performance is identified if the student is located on the questions to be answered.
3rd Code what the student is doing.	- Option 1: Write "s" and the number of slide scanned, which can be: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11 or 12. The distinction between scanning and skimming will be automatically done by the times cuts off entered on columns *START* and *END*. - Option 2: Write "d" if the student is scrolling the slides, which means that devotes less than 2 seconds in front of a slide.	- Write "q" and the number of question, which can be: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14 or 15.

Section 2 was named processing information and was formed by 5 columns and 26 rows of which 25, corresponded to the total number of questions from all tasks performed and 1 row included the heading of the columns of the section. The first column was named Question and specified in order the task and the type of question answered by the student, starting with Task 1 Question 01 and finishing with Task 3 Question 05. It was a fixed column which means that it could not be modified by the observer. The second column was named Time and indicated the amount of time the student devoted to processing information to give an answer for each question from each task. This column was automatically filled in, with the information introduced by the observer on the previous section, using the conditional Excel formula. The third column was named Correctness and indicated if the answer given by the student was correct or incorrect. It had to be filled in manually during the screening of the video depending on the student's answer. If the answer was correct "1" was introduced, if the answer was incorrect "0" was introduced. The correctness of the answers was evaluated according to an established template. The fourth column was named Type and indicated if the answer given was previously consulted by the student, before being answered or not. It had to be filled in manually during the screening of the video depending on the student's answer. If the answer had previously been consulted "1" was introduced, if the answer had not been consulted "0" was introduced. The fifth column was named Queries and indicated the number of times that a student had to consult information before answering it. It was automatically filled in with the information introduced by the observer on the previous section, using the Excel formula counted the number of times that a question was consulted.

Section 3 was named Scanning information (time) and was formed of 4 columns and 15 rows. The first row of this section gave a heading to the columns, the next 12 rows corresponded to the total amount of slides of information per each initial and final task performance, and the last 2 rows scored the total amount of time devoted to scan useful and non-useful information per task. The first column was named Slide number and indicated the number of each slide. It was a fixed column which means that it could not to be modified by the observer at any time. Columns two, three and four, which were named Task 1, Task 2 and Task 3 respectfully, followed the same pattern and indicated the amount of time that the student devoted to scanning each slide of information per type of task. They were automatically filled in, with the information introduced by the observer on section 1, using the conditional Excel formula. Finally, the last two rows named Time per task, as briefly mentioned before, indicated first, the total amount of time that the student spent scanning useful information per each type of task and the total amount of time that the student spent scanning non-useful information per each type of task.

Section 4 was the last section of the Excel sheet and was responsible for collecting all the information obtained after the screening of the audiovisual file, which provided the numbers of each category previously defined to be later introduced in the SPSS software for the data analysis.

5.6.2. Analytical strategy.

The data was analyzed using IBM SPSS Statistics for Windows, Version 21.0, and different consecutive steps of analysis were followed regarding the six research objectives (See Table 15).

Table 15
Data analysis

Objectives	Measures linked with	Data Analysis	Findings
1. To determine if there are any differences between the two genders in relation to the different individual students' variables.	Qualitative variable: Personal information: Gender. Quantitative variables: Reading skills, ICT skills, and science knowledge (previous and final).	Mean differences between both the two categories of a qualitative variable (gender). N > 30 T-test independent variables. Parametric analysis.	Tables of mean differences (between male and female).
2. To determine the relations established among students' individual characteristics and students' performance when scanning information.	Quantitative variables: Reading skills, ICT skills, Previous knowledge, and scanning information skill development (task 1, 2, and 3).	Correlation among quantitative variables.	Tables of correlations.
3. To determine the relations established among students' individual characteristics and students' performance when processing information.	Quantitative variables: Reading skills, ICT skills, previous science knowledge, and processing information skill development (task 1, 2, and 3).	Correlation among quantitative variables.	Tables of correlations.
4. To determine the relations established among students' scanning information skill performance and students' processing information skill performance in different types of tasks.	Quantitative variables: Scanning information skill development (task 1, 2, and 3), and processing information skill development (task 1, 2, and 3).	Correlation among quantitative variables.	Tables of correlations.
5. To identify the difference among the students' initial and final learning performance.	Qualitative variable: Initial and final data. Quantitative variables: Science knowledge and for tasks 1, 2, and 3: Time scanning useful information, time scanning non-useful information, time scrolling information, scanned slides using lineal reading, scanned slides using scanning reading, scrolled slides, time processing information, correct answers consulted, correct answers non-consulted, incorrect answers consulted, and incorrect answers non-consulted.	Mean differences between both the two categories of initial and final. N > 30 T-test paired variables. Parametric analysis.	Tables of mean differences (between initial and final variables).
6. To describe the main differences on students' scanning and processing information skills performance in each type of final task, according to students' final science knowledge profile.	Qualitative variable: Students' profile according students' final science knowledge. Quantitative variable: For tasks 1, 2, and 3: Time scanning useful information, time scanning non-useful information, time scrolling information, scanned slides using lineal reading, scanned slides using scanning reading, scrolled slides, time processing information, correct answers consulted, correct answers non-consulted, incorrect answers consulted, and incorrect answers non-consulted.	Cluster Analysis. Mean differences among clusters (in each task). Non-parametric analysis.	Tables of mean differences (among the four clusters).

The first research objective aimed to determine if there were any differences between the two genders in relation to the different individual students' variables. To achieve research objective number 1, we first performed a Levene's test to assess the equality of variances. As some variables presented statistical significance, an independent two sample t-test with equal variance among the categories of each measured variable was developed at 95% of confidence ($^{a}p<0.05$).

The second research objective aimed to determine the relations established among students' individual characteristics and students' performance when scanning information. To achieve research objective number 2, we performed a two tailed t-test with paired samples in order to study the effect of the instruction received on students' scanning information skill performance for each type of task. Then the results were correlated with students' individual variables by applying Pearson's correlations analysis. Both studies were performed at 95% of confidence ($^{a}p<0.05$ $^{b}p<0.01$).

The third research objective aimed to determine the relations established among students' individual characteristics and students' performance when processing information. To achieve research objective number 3, we performed a two tailed t-test with paired samples in order to study the effect of the instruction received on students' processing information skill performance for each type of task. Then the results were correlated with students' individual variables by applying Pearson's correlations analysis. Both studies were performed at 95% of confidence ($^{a}p<0.05$ $^{b}p<0.01$).

The fourth research objective sought to determine the relations established among students' scanning information skill performance and students' processing information skill performance in different types of tasks. To achieve the research objective number 4, we performed a two tailed t-test with paired samples in order to study the effect of the instruction received on students' scanning information skill performance and students' processing information skill performance for each type of task. Then the results were correlated among them by applying Pearson's correlations analysis. Both studies were performed at 95% of confidence ($^{a}p<0.05$ $^{b}p<0.01$).

The fifth research objective wished to identify the difference among the students' initial and final learning performance including students' science knowledge on illnesses and health and students' scanning and processing information skill performances for each type of task. To achieve research objective number 5, a two tailed paired samples t-test analysis between students' initial and final learning performance including students' science knowledge on illnesses and health and students' scanning and processing information skill performances was developed at 95% of confidence ($^{a}p<0.05$; $^{b}p<0.01$; $^{c}p<0.001$).

The last research objective aimed to describe the main differences in students' performance of scanning and processing information skills in each type of final task, according to the students' final science knowledge profile. Therefore, a two-step quantitative data analysis was used to analyze data regarding research question number 6. In the first step, a hierarchical cluster analysis (HCA) was conducted to classify cases using Ward's method. The data sets analyzed were extracted from the students' final science knowledge. Four final groups of students were selected based on the obtained results. The second step consisted of comparing those clusters of students with data from the students' performance of scanning and processing information skills for each type of final task. Therefore, different ANOVA (ONEWAY) tests were applied in order to explore the differences among the average of the quantitative variables that describe the performance of scanning and processing information skills in each type of task and the qualitative variable of students' profile. Then, because an ANOVA test can tell you if the results are significant overall, but it cannot tell you exactly where those differences lie, a BTUKEY ALPHA test analysis was developed at 95% of confidence with the intention of indicating the differences between the averages of the pairs.

6. Results and Discussion

In this section, we present the results sorted according to the different research questions of the study derived from the specific objectives from the present research.

6.1. Research Question 1: Are there any differences between the two genders in relation to the variables of reading skill, ICT skills, previous and final scientific knowledge?

From the analysis conducted examining the differences between female students and male students of each quantitative individual variable, the results revealed that male students are better than female students on certain aspects presented.

Table 16 shows the differences between students' reading skill depending on students' gender.

Table 16
Differences of students' reading skill depending on students' gender (Men/Women) (N = 82)

	Male students M (SD)	Female students M (SD)	TOTAL) M (SD)
Information retrieval.	3.22 (1.56)	2.91 (1.63)	3.10 (1.59)
Information integration.	5.72 (2.01)	5.03 (2.19)	5.45 (2.09)
Text reflection of content and form.	3.26 (1.19)[a]	2.56 (1.21)[a]	2.99 (1.24)
Global reading skill	12.20 (4.01)	10.5 (4.13)	11.54 (4.12)

[a]$p<0.05$

Describing the differences between reading skills, the data shows that male participants are better than female participants are when answering reading questions that demanded of them text reflection of content and form (M = 3.26) against (M = 2.56) from female participants.

Table 17 shows the differences between students' ICT skills depending on students' gender.

Table 17
Differences of students' ICT skills depending on students' gender (Men/Women) (N = 82)

	Male students M (SD)	Female students M (SD)	TOTAL) M (SD)
I am able to identify appropriately the needed information from question.	3.74 (0.92)	3.56 (0.94)	3.67 (0.93)
I am able to collect/retrieve information in digital environments.	3.86 (1.01)	3.78 (0.87)	3.83 (0.95)
I am able to use ICT to process appropriately the obtained information.	3.88 (0.98)[a]	3.38 (1.15)[a]	3.68 (1.07)
I am able to interpret and represent information, such as using ICT to synthesize.	3.64 (0.98)	3.47 (1.16)	3.57 (1.05)
I am able to use ICT to design or create new information from information already acquired.	3.56 (0.92)	3.59 (1.07)	3.57 (0.98)
I am able to use ICT to convey correct information to appropriate targets.	3.94 (0.79)	3.53 (1.16)	3.78 (0.96)
I am able to judge the degree to which information is practical or satisfies the needs of the task.	3.76 (0.77)	3.72 (0.77)	3.74 (0.76)
Information Literacy	3.80 (0.78)	3.56 (0.87)	3.71 (0.82)

I am able to set a homepage for an internet browser.	4.44 (1.07)	4.16 (1.37)	4.33 (1.19)
I am able to search for information on the internet using a search engine.	4.52 (0.88)	4.41 (1.07)	4.48 (0.95)
I am able to use email to communicate	4.32 (1.03)	4.47 (1.01)	4.38 (1.02)
I am able to use instant messaging software to chat with friends.	4.46 (1.05)	4.66 (0.86)	4.54 (0.98)
I am able to download files from the internet.	4.40 (0.94)	4.41 (1.04)	4.40 (0.98)
Internet literacy	4.44 (0.86)	4.47 (1.01)	4.45 (0.91)
I am able to set header/footer in word processor software.	4.00 (1.03)	3.81 (1.17)	3.93 (1.08)
I am able to plot a graph and chart using spreadsheet software.	3.92 (1.02)	3.59 (1.24)	3.79 (1.11)
I am able to insert an animation in presentation software.	4.06 (0.95)	4.13 (1.15)	4.09 (1.03)
I am able to edit a photo using image-processing software.	4.02 (0.97)	4.25 (1.07)	4.11 (1.01)
I am able to set up a printer.	4.02 (1.02)[a]	3.38 (1.36)[a]	3.77 (1.20)
Computer literacy	4.06 (0.81)	3.88 (1.04)	3.99 (0.90)
Global ICT skill	4.03 (0.61)	3.89 (0.79)	3.97 (0.68)

[a]$p<0.05$

In the results obtained for ICT skill, it can be observed that of the 17 items that students were asked to answer according to their success in developing the task, only in two of them did male participants get slightly better results. One of the items deals with being able to use ICT to appropriately process the obtained information where male participants (M = 3.88) considered themselves to be more able than female participants (M = 3.38) did. In contrast, the other item deals with being able to set up a printer (e.g. installing printer drivers) where male participants (M = 4.02) thought themselves to be more able than female participants (M = 3.38) did.

Table 18 shows the differences between students' science previous knowledge depending on students' gender.

Table 18
Differences of students' science previous knowledge depending on students' gender (Men/Women) (N = 82)

	Male students M (SD)	Female students M (SD)	TOTAL) M (SD)
Handling isolated information without transforming the content in any way.	5.88 (1.48)[a]	4.97 (1.63)[a]	5.52 (1.59)[a]
Connecting concepts and ideas from more than one information source.	2.76 (1.83)	2.63 (1.93)	2.71 (1.86)
Thinking about concepts and developing complex conceptual frameworks.	4.18 (2.32)[a]	3.16 (1.78)[a]	3.78 (2.17)[a]
Global previous knowledge	12.88 (3.99)[a]	10.78 (3.81)[a]	12.06 (4.03)[a]

[a]$p<0.05$

In addition, male participants again stand out on the students' previous scientific knowledge (M = 12.88) compared to the results of female participants (M = 10.78). Nevertheless, none of them successfully passed the initial scientific knowledge assessment that was evaluated out of 30 points. By contrast, on the first activity from the assessment which required students to handle isolated information without transforming the content in any way, male participants succeeded and passed this activity (M = 5.88) which was evaluated out of 10 points, while female participants were not able to pass the first activity of the assessment (M = 4.97). Additionally, the third activity of the assessment that demanded that the students think about concepts and develop complex conceptual frameworks is also better developed by male participants (M = 4.18) than female participants (M = 3.16). However, neither male participants nor female participants passed the activity that was evaluated out of 10 points.

Table 19 shows the differences between students' final science knowledge depending on students' gender.

Table 19
Differences of students' science final knowledge depending on students' gender (Men/Women) (N = 82).

	Male students M (SD)	Female students M (SD)	TOTAL) M (SD)
Handling isolated information without transforming the content in any way.	8.50 (1.21)[a]	7.53 (1.79)[a]	8.12 (1.53)
Connecting concepts and ideas from more than one information source.	5.12 (1.61)	4.81 (1.99)	5.00 (1.76)
Thinking about concepts and developing complex conceptual frameworks.	6.14 (1.90)	5.59 (2.19)	5.93 (2.02)
Global final knowledge	19.74 (3.26)[a]	17.96 (4.44)[a]	19.04 (3.84)

[a]$p<0.05$

According to the results obtained on students' science final knowledge, male participants again get better results (M = 19.74) compared to the results of female participants (M = 17.96). However, both of them successfully passed the final science knowledge assessment that was evaluated out of 30 points. Coherently, on the first activity from the assessment which demanded that students handle isolated information without transforming the content in any way, male participants (M = 8.50) and female participants (M = 7.53) succeeded and passed this activity which was evaluated out of 10 points, despite the fact that female participants had a lower mark.

Based on the analysis of the results presented in the previous section, two main considerations can be discussed:

a) Male participants are slightly better than female participants are on specific items of certain individual aspects.

The obtained results show that male participants are slightly better than female participants are on specific items of certain individual aspects.

Firstly, regarding the differences between students' reading skills male participants are better than female participants in one of the three items considered, which deals with answering reading questions that demanded text reflection of content and form of them. Secondly, regarding the differences between students' ICT skills, the male participants are better than the female participants are in two of the seventeen items considered, which deal with being able to use ICT to appropriately process the obtained information and with being able to set up a printer. Thirdly, regarding the differences between students' previous and final science knowledge, the results demonstrate that male participants are better than female participants in the global results of assessment.

The findings are consistent with available literature on the topic, which states that despite the fact that females obtain higher grades in school in every subject, it has been shown that females score significantly lower on many standardized assessment, which include both language and scientific items (Halpern et al., 2007). In addition, according to Ryan, Willingham and Cole (1999), females also score lower than males, on average, in science when the assessments are not closely related to material that has been taught in school (despite getting higher grades in school-based exams). Accordingly, O'Reilly and McNamara (2007) observed that male students scored higher on scientific knowledge and on reading comprehension. To be more specific, in terms of the format of questions and differences by gender on content-based assessments, males were shown to score higher on both multiple choice and open-ended questions than females (O'Reilly & McNamara, 2007; Penner, 2003).

However, the results obtained through the current research study present a small difference between the two genders which might be statistically but not practically meaningful. In addition, there is no particular factor by itself that has been revealed to establish gender distinctions. Previous experience, biological conditions, educational guidelines, and cultural background each have effects, and these effects interact in complex and occasionally unpredictable ways (Halpern et al., 2007).

b) Both genders succeed and pass the science final knowledge assessment.

The results presented demonstrate that despite the fact that male participants are slightly better than female participants on final science knowledge, both succeed and pass the final science knowledge assessment after having participated in the science didactic sequence about illnesses and health designed in an IWBL environment.

From my point of view, these results may demonstrate that the instruction received by the students about IPS embedded in science curricular content and developed in an IWBL environment, was effective for both groups of students independently of their gender, because both genders improved their final mark compared to the initial one and were able to pass with merit the science final knowledge assessment.

The findings are consistent with the available literature on the topic, which states that thanks to an IPS instruction embedded in science curricular content and developed in an IWBL environment, students have increased their learning outcomes in scientific knowledge by showing a higher knowledge on illnesses and health after the instruction had been accomplished (Alfieri et al., 2011; Argelagós & Pifarré, 2012).

6.2. Research Question 2: Is there any relationship between certain students' individual characteristics and the students' performance improvement when scanning information skill?

In order to analyze possible significant relationships between students' individual characteristics and their improvement when scanning information and processing information skills are performed, several Pearson correlations were developed.

The results developed in this section deal with the possible relationship between certain individual skills and the scanning information skill achievement.

Table 20 shows the correlations between students' reading skill and their improvement when scanning information skill performance.

Table 20

Relations between students' reading skill and scanning information skill performance (N = 82)

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Students' reading skill																							
1. Info retrieval	3.10 (1.59)	-																					
2. Info integration	5.45 (2.09)	0.60^b	-																				
3. Text reflection	2.99 (1.24)	0.41^b	0.56^b	-																			
4. Global reading skill	11.54 (4.12)	0.81^b	0.91^b	0.74^b	-																		
Scanning information skill performance for task 1																							
5. Time scanning useful info	-135.57 (119.53)	-0.15	-0.10	-0.05	-0.12	-																	
6. Time scanning useless info	-233.76 (140.99)	-0.16	-0.07	-0.14	-0.14	0.65^b	-																
7. Time scrolling info	14.52 (17.32)	0.15	0.24^a	0.30^b	0.27^a	-0.19	-0.36^b	-															
8. Nº slides lineally read	-5.88 (4.59)	-0.17	-0.06	-0.11	-0.13	0.68^b	0.59^b	-0.16	-														
9. Nº slides scanned	3.51 (3.23)	0.13	-0.03	0.05	0.05	-0.14	-0.17	0.10	-0.00	-													
10. Nº slides scrolled	13.85 (16.10)	0.14	0.23^a	0.34^b	0.27^a	-0.09	-0.30^b	0.91^b	-0.10	0.14	-												
Scanning information skill performance for task 2																							
11. Time scanning useful info	-129.76 (118.39)	-0.05	-0.11	-0.17	-0.11	-0.26^a	-0.13	0.01	-0.08	-0.24^a	-0.01	-											
12. Time scanning useless info	-42.24 (55.33)	-0.03	0.05	0.06	0.03	-0.22^a	-0.29^b	0.19	-0.14	-0.03	0.20	0.50^b	-										
13. Time scrolling info	-12.33 (25.99)	-0.08	-0.18	-0.12	-0.16	-0.05	-0.14	0.07	0.06	-0.10	0.03	0.34^b	0.13	-									
14. Nº slides lineally read	-10.41 (8.55)	-0.13	-0.10	-0.14	-0.14	-0.21	-0.15	0.18	-0.03	-0.27^a	0.19	0.87^b	0.43^b	0.41^b	-								
15. Nº slides scanned	2.13 (5.61)	-0.07	-0.26^a	-0.16	-0.21	-0.11	0.06	-0.19	-0.11	-0.17	-0.24^a	0.51^b	0.09	0.35^b	0.46^b	-							
16. Nº slides scrolled	-11.17 (24.57)	-0.03	-0.16	-0.13	-0.13	-0.09	-0.18	0.12	0.03	-0.12	0.10	0.32^b	0.12	0.93^b	0.39^b	0.34^b	-						
Scanning information skill performance for task 3																							
17. Time scanning useful info	-7.41 (45.45)	0.08	-0.01	-0.10	-0.01	-0.08	-0.03	-0.01	-0.06	-0.17	-0.11	0.15	-0.14	0.08	0.21	0.28^a	0.12	-					
18. Time scanning useless info	-10.15 (35.70)	0.12	0.02	0.13	0.09	-0.14	-0.19	0.06	-0.29^b	0.05	0.12	0.02	0.17	0.03	-0.10	-0.02	0.03	-0.18	-				
19. Time scrolling info	0.91 (13.57)	-0.02	-0.09	-0.16	-0.10	0.02	-0.05	-0.08	-0.01	-0.25^a	-0.06	-0.05	-0.04	0.12	-0.03	0.12	0.13	0.24^a	-0.08	-			
20. Nº slides lineally read	-1.34 (3.62)	0.14	-0.01	-0.00	0.05	-0.07	-0.08	-0.01	-0.17	-0.16	-0.03	0.20	0.04	0.07	0.22^a	0.18	0.15	0.73^b	0.25^a	0.21	-		
21. Nº slides scanned	1.11 (3.51)	0.02	-0.05	-0.16	-0.07	-0.14	-0.07	-0.14	-0.16	-0.08	-0.15	-0.04	-0.20	-0.05	-0.04	0.17	-0.02	0.45^b	0.02	0.23^a	0.27^a	-	
22. Nº slides scrolled	0.30 (11.94)	-0.06	-0.14	-0.16	-0.15	0.06	-0.04	-0.11	0.05	-0.22	-0.05	-0.06	-0.07	0.15	-0.03	0.16	0.18	0.25^a	-0.06	0.91^b	0.26^a	0.23^a	-

$^a p<0.05$; $^b p<0.01$

The results obtained from the analysis show a high, positive and significant relationship between the amount of information scrolled through in task 1 and students' reading skill.

Firstly, the analysis of the relation between "time scrolling for information" in task 1 and "information integration" shows that a high positive correlation exists [$r = 0.24$, $p<0.05$]. Secondly, the relation between "time scrolling for information" in task 1 and "text reflection" demonstrates that a high positive correlation exists between them [$r = 0.30$, $p<0.01$]. Thirdly, the variable "time scrolling for information" in task 1 also correlates positively and significantly with the "global reading skill" [$r = 0.27$, $p <0.05$].

Coherently with the previous results mentioned, "the number of slides scrolled" in task 1 is again significantly correlated with "information integration" [$r = 0.23$, $p<0.05$], with "text reflection" [$r = 0.34$, $p<0.01$] and with the "global reading skill" [$r = 0.27$, $p <0.05$].

However, there are not many significant correlations between students' reading skill and the scanning information skill performance in task 2. In fact, there is only one significant negative correlation between "the number of slides scanned" in task 2 and "information integration" [$r = -0.26$, $p <0.05$].

No relationships were found between scanning information skill performance in task 3 and students' reading skill.

These results indicate, in our research, that the students' reading skill is only significantly positively correlated with the amount of information scrolled through in task 1, which means that students with greater reading skill develop more scanning strategies to select the appropriate information to answer multiple-choice questions. As the students become familiar with the information provided to be consulted for the resolution of the different tasks suggested, this significant correlation disappears and there is not a significant correlation between students' reading skill and the scanning information skill performance for task 2 and task 3.

Table 21 shows the correlations between students' ICT skills and their achievement during the scanning information skill performance.

Table 21

Relations between students' ICT skill and scanning information skill performance (N = 82)

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Students' ICT skill																							
1. Info literacy	3.71 (0.82)	-																					
2. Internet literacy	4.45 (0.91)	0.54[b]	-																				
3. Computer literacy	3.99 (0.90)	0.46[b]	0.70[b]	-																			
4. Global ICT skill	3.97 (0.68)	0.77[b]	0.86[b]	0.84[b]	-																		
Scanning information skill performance for task 1																							
5. Time scanning useful info	-135.57 (119.53)	0.07	0.10	0.08	0.15	-																	
6. Time scanning useless info	-233.76 (140.99)	0.04	0.01	0.04	0.05	0.65[b]	-																
7. Time scrolling info	14.52 (17.32)	0.25[a]	0.19	0.10	0.22	-0.19	-0.36[b]	-															
8. Nº slides lineally read	-5.88 (4.59)	0.20	0.12	0.07	0.17	0.68[b]	0.59[b]	-0.16	-														
9. Nº slides scanned	3.51 (3.23)	0.06	-0.05	-0.14	-0.03	-0.14	-0.17	0.10	-0.00	-													
10. Nº slides scrolled	13.85 (16.10)	0.29[b]	0.16	0.06	0.20	-0.09	-0.30[b]	0.91[b]	-0.10	0.14	-												
Scanning information skill performance for task 2																							
11. Time scanning useful info	-129.76 (118.39)	-0.10	-0.03	-0.01	-0.04	-0.26[a]	-0.13	0.01	-0.08	-0.24[a]	-0.01	-											
12. Time scanning useless info	-42.24 (55.33)	0.10	-0.02	-0.01	0.05	-0.22[a]	-0.29[b]	0.19	-0.14	-0.03	0.20	0.50[b]	-										
13. Time scrolling info	-12.33 (25.99)	-0.28[a]	-0.06	0.01	-0.09	-0.05	-0.14	0.07	0.06	-0.10	0.03	0.34[b]	0.13	-									
14. Nº slides lineally read	-10.41 (8.55)	-0.10	0.07	0.08	0.02	-0.21	-0.15	0.18	-0.03	-0.27[a]	0.12	0.87[b]	0.43[b]	0.41[b]	-								
15. Nº slides scanned	2.13 (5.61)	-0.24[a]	-0.11	-0.09	-0.15	-0.11	0.06	-0.19	-0.11	-0.17	-0.24[a]	0.51[b]	0.09	0.35[b]	0.46[b]	-							
16. Nº slides scrolled	-11.17 (24.57)	-0.25[a]	-0.04	-0.02	-0.10	-0.09	-0.18	0.12	0.03	-0.12	0.10	0.32[b]	0.12	0.93[b]	0.39[b]	0.34[b]	-						
Scanning information skill performance for task 3																							
17. Time scanning useful info	-7.41 (45.45)	-0.06	0.14	0.13	0.06	-0.08	-0.03	-0.01	-0.06	-0.17	-0.11	0.15	-0.14	0.08	0.21	0.28[a]	0.12	-					
18. Time scanning useless info	-10.15 (35.70)	0.05	-0.05	-0.15	-0.03	-0.14	-0.19	0.06	-0.29[b]	0.05	0.12	0.02	0.17	0.03	-0.01	-0.02	0.03	-0.18	-				
19.Time scrolling info	0.91 (13.57)	-0.10	-0.08	-0.11	-0.11	0.02	-0.05	-0.08	-0.01	-0.25[a]	-0.06	-0.05	-0.04	0.12	-0.03	0.12	0.13	0.24[a]	-0.08	-			
20. Nº slides lineally read	-1.34 (3.62)	-0.10	0.10	0.04	0.03	-0.07	-0.08	-0.01	-0.17	-0.16	-0.03	0.20	0.04	0.07	0.22[a]	0.18	0.15	0.73[b]	0.25[a]	0.21	-		
21. Nº slides scanned	1.11 (3.51)	0.06	-0.05	-0.01	-0.05	-0.14	-0.07	-0.14	-0.16	-0.08	-0.15	-0.04	-0.20	-0.05	-0.04	0.17	-0.02	0.45[b]	0.02	0.23[a]	0.27[a]	-	
22. Nº slides scrolled	0.30 (11.94)	-0.14	-0.08	-0.11	-0.12	0.06	-0.04	-0.11	0.05	-0.22	-0.05	-0.06	-0.07	0.15	-0.03	0.16	0.18	0.25[a]	-0.06	0.91[b]	0.26[a]	0.23[a]	-

[a]$p<0.05$; [b]$p<0.01$

The results derived from the analysis show a high, positive and significant relationship between the amount of information scrolled through in task 1 and information literacy.

The analysis of the relation between "time scrolling for information" in task 1 and "information literacy" shows that a high positive correlation exists [$r = 0.25$, $p<0.05$]. In addition, the relation between "number of slides scrolled" in task 1 and "information literacy" again demonstrates that a high positive correlation exists between them [$r = 0.29$, $p<0.01$].

Contrary to the previous results mentioned, there are three significant negative correlations between some variables that define the scanning information skill performance for task 2 and students' information literacy. The first negative correlation is between the "time scrolling information" and "information literacy" [$r = -0.28$, $p<0.05$]. The second negative correlation is between the "number of slides scanned" and "information literacy" [$r = -0.24$, $p<0.05$]. The last negative correlation is between the "number of slides scrolled" and "information literacy" [$r = -0.25$, $p<0.05$].

As happened with the correlations between students' reading skill and scanning information skill performance of task 3, again no relationships were found between students' ICT skill and scanning information skill performance in task 3.

The obtained results show, in our investigation, that the students' ICT skill is meaningfully positively correlated with the amount of information scrolled through in task 1.Students with greater information literacy use more scanning strategies to develop task 1. Hence, students' information literacy is negatively correlated with the amount of information scrolled through in task 2 and the number of the slides scanned, which may indicate that after students with greater information literacy have been familiarized with the information in task 1 they need to develop less strategies for scanning information because the students already know where to find the appropriate information to construct the conceptual map in task 2.

Conversely, when students have to develop the scanning information skill in task 3 there is no difference between students with greater information literacy and the way in which the scanning information skill is performed in task 3, which is to write a specific text. This may indicate that as students become familiar with the information provided the information literacy on the topic is less important in order to perform the scanning information skill.

Table 22 shows the correlations between students' previous knowledge on illnesses and health and their achievement in scanning information skill performance.

Table 22

Relations between students' previous knowledge and scanning information skill performance (N = 82)

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Students' previous knowledge																							
1. Multiple choice questions	5.52 (1.59)	-																					
2. Conceptual map	2.71 (1.86)	0.36^{b}	-																				
3. Specific writing	3.78 (2.17)	0.24^{a}	0.28^{a}	-																			
4. Global previous knowledge	12.06 (4.03)	0.67^{b}	0.73^{b}	0.76^{b}	-																		
Scanning information skill performance for task 1																							
5. Time scanning useful info	-135.57 (119.53)	0.00	-0.10	-0.08	-0.08	-																	
6. Time scanning useless info	-233.76 (140.99)	-0.00	-0.08	-0.08	-0.08	0.65^{b}	-																
7. Time scrolling info	14.52 (17.32)	0.17	0.26^{a}	0.11	0.24^{a}	-0.19	-0.36^{b}	-															
8. Nº slides lineally read	-5.88 (4.59)	0.04	-0.08	-0.07	-0.06	0.68^{b}	0.59^{b}	-0.16	-														
9. Nº slides scanned	3.51 (3.23)	0.09	0.31^{b}	0.16	0.26^{a}	-0.14	-0.17	0.10	-0.00	-													
10. Nº slides scrolled	13.85 (16.10)	0.18	0.24^{a}	0.14	0.25^{a}	-0.09	-0.30^{b}	0.91^{b}	-0.10	0.14	-												
Scanning information skill performance for task 2																							
11. Time scanning useful info	-129.76 (118.39)	-0.17	-0.21	-0.02	-0.18	-0.26^{a}	-0.13	0.01	-0.08	-0.24^{a}	-0.01	-											
12. Time scanning useless info	-42.24 (55.33)	-0.08	0.08	0.04	0.02	-0.22^{a}	-0.29^{b}	0.19	-0.14	-0.03	0.20	0.50^{b}	-										
13. Time scrolling info	-12.33 (25.99)	0.22^{a}	-0.05	0.08	0.10	-0.05	-0.14	0.07	0.06	-0.10	0.03	0.34^{b}	0.13	-									
14. Nº slides lineally read	-10.41 (8.55)	-0.17	-0.24^{a}	0.01	-0.18	-0.21	-0.15	0.18	-0.03	-0.27^{a}	0.12	0.87^{b}	0.43^{b}	0.41^{b}	-								
15. Nº slides scanned	2.13 (5.61)	-0.02	-0.12	-0.06	-0.10	-0.11	0.06	-0.19	-0.11	-0.17	-0.24^{a}	0.51^{b}	0.09	0.35^{b}	0.46^{b}	-							
16. Nº slides scrolled	-11.17 (24.57)	0.18	-0.09	0.04	0.04	-0.09	-0.18	0.12	0.03	-0.12	0.10	0.32^{b}	0.12	0.93^{b}	0.39^{b}	0.34^{b}	-						
Scanning information skill performance for task 3																							
17. Time scanning useful info	-7.41 (45.45)	0.02	-0.00	-0.06	-0.03	-0.08	-0.03	-0.01	-0.06	-0.17	-0.11	0.15	-0.14	0.08	0.21	0.28^{a}	0.12	-					
18. Time scanning useless info	-10.15 (35.70)	0.32^{b}	0.07	0.13	0.22^{a}	-0.14	-0.19	0.06	-0.29^{b}	0.05	0.12	0.02	0.17	0.03	-0.10	-0.02	0.03	-0.18	-				
19. Time scrolling info	0.91 (13.57)	0.14	-0.01	-0.18	-0.04	0.02	-0.05	-0.08	-0.01	-0.25^{a}	-0.06	-0.05	-0.04	0.12	-0.03	0.12	0.13	0.24^{a}	-0.08	-			
20. Nº slides lineally read	-1.34 (3.62)	0.16	-0.10	-0.01	0.01	-0.07	-0.08	-0.01	-0.17	-0.16	-0.03	0.20	0.04	0.07	0.22^{a}	0.18	0.15	0.73^{b}	0.25^{a}	0.21	-		
21. Nº slides scanned	1.11 (3.51)	0.05	0.09	0.06	0.08	-0.14	-0.07	-0.14	-0.16	-0.08	-0.15	-0.04	-0.20	-0.05	-0.04	0.17	-0.02	0.45^{b}	0.02	0.23^{a}	0.27^{a}	-	
22. Nº slides scrolled	0.30 (11.94)	0.16	-0.05	-0.08	-0.00	0.06	-0.04	-0.11	0.05	-0.22	-0.05	-0.06	-0.07	0.15	-0.03	0.16	0.18	0.25^{a}	-0.06	0.91^{b}	0.26^{a}	0.23^{a}	-

$^{a}p<0.05$; $^{b}p<0.01$

The results derived from the analysis show a high, positive and significant relationship between the amount of information scanned using scanning strategies in task 1 and students' previous knowledge in question 2 which consists in the creation of a conceptual map and students' global previous knowledge.

The analysis of the relation between "time scrolling information" in task 1 and "conceptual map" shows that a high positive relation exists[$r = 0.26$, $p<0.05$]. The same happens with the relation between "time scrolling information" in task 1 and the students' "global previous knowledge"[$r = 0.24$, $p<0.05$].In addition, the relation between "number of slides scanned" in task 1 and "conceptual map" demonstrates that a high positive relation exists between them [$r = 0.31$, $p<0.01$]. The same happens with the relation between "number of slides scanned" in task 1 and the students' "global previous knowledge"[$r = 0.26$, $p<0.05$].Again with "number of slides scrolled" in task 1 and "conceptual map" for the previous knowledge assessment a significant positive relation exists between them [$r = 0.24$, $p<0.05$].A similar thing occurs with the relation between "number of slides scrolled" in task 1 and the students' "global previous knowledge"[$r = 0.25$, $p<0.05$].

For scanning information skill in task 2 there exist two significant relations. One significant positive correlation is established between the "time scrolling information" and the students' development of "multiple-choice questions" in the previous knowledge assessment [$r = 0.22$, $p<0.05$]. One significant negative correlation exists between the "number of slides lineally read" and the students' development of "conceptual map" creation in the previous knowledge assessment [$r = -0.24$, $p<0.05$].

Finally, there are two correlations which are difficult to explain which show that the students' who performed better in "multiple choice questions" in the previous knowledge assessment spent more "time scanning useless information" in task 3 development [$r = 0.32$, $p<0.05$]. The same thing happens with the relation between students' "global previous knowledge” and “time scanning useless information” in task 3 development [$r = 0.22$, $p<0.05$].

The acquired results show, in our analysis, that the students’ previous knowledge is meaningfully positively correlated with the amount of information scrolled through and scanned in task 1. Students who better perform in the conceptual map question and in the global previous knowledge assessment use more scanning strategies to develop task 1. These students also spent more time scrolling through information in task 2 as well as reading less number of slides lineally in task 2. Conversely, when students have to develop the scanning information skill in task 3 there is no difference between students with greater previous knowledge and the way in which the scanning information skill is performed in task 3, which is to write a specific text. This may indicate that as students become familiar with the information provided, the previous knowledge on the topic is less important in order to perform the scanning information skill.

Based on the analysis of the results presented in the previous section, four main considerations can be discussed:

a) There are not many significant correlations between students’ individual skills and students’ improvement of scanning information skill performance.

From my point of view, these results could indicate that the difference in students’ performance of the scanning information skill before and after the instruction received by the students, is not highly influenced by the students’ individual skills, which could let to think that it is influenced by the instruction received which was based on IBL. These results obtained together with the ones that will be below be presented may open a door to demonstrate a highlighting fact, which is that the instruction designed helps students to improve the performance of the scanning information skill regardless of the individual characteristics of the students.

The findings are modestly consistent with available literature on the topic, since research studies which have focused their attention on analyzing the possible relations between students' individual skills and students' performance of certain specific skills such as scanning information or processing information are scarce (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

b) Students' reading skill seems to be correlated to the amount of information scrolled through by students in task 2.

From my point of view, these results might indicate that students' reading skill is quite closely related with the way in which students develop scanning skills, when they are asked to perform an activity which asks them to connect concepts and ideas from a given text in order to create a partly constructed conceptual map.

Outcomes are consistent with some previous research studies developed such as the one developed by Hahnel, Goldhammer, Naumann and Kröhne (2016) who observed that students who were skilled in reading linear texts were estimated to understand and relate significant concepts presented on nodes in the hypertexts. Coherently, Salmerón et al. (2017) emphasizes that skilled readers scanned quicker and revisited segments of the hypertext that did not contain relevant information less often, especially in integrated questions.

However, Potocki et al. (2017) specifies that in their research study the differences observed in students' strategies development were not related to the participants decoding of comprehension skills but rather to their knowledge of reading strategies.

c) Students' ICT skill only has a significant positive correlation with students' scanning information skill performance, only students' information literacy seems to be related to the amount of information scrolled through in tasks 1 and 2.

From my point of view, these results possibly indicate that from the different items which form the ICT skill the one which has a major correlation with the IPS skills analyzed is the information literacy skill, which is closely related to the IPS process because it deals with the capacity of the students to identify information needs, assess information quality, manage information, use information effectively and ethically and create and communicate knowledge through the application of information (Lau & Yuen, 2014).

The results presented are roughly on the same line as the results obtained by Coiro (2011) who suggested that students reading skills and ICT skills were important prerequisites for an effective digital reading since data showed that skilled readers with ICT skills were better at locating information from hypertext.

However, there are not enough research studies that focus their attention on the possible relation between students' ICT skills and their IPS task performance to establish more relations or differences with previous research studies (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

d) Students' previous knowledge seems to be correlated to the amount of information scrolled through and scanned by students in task 1.

From my point of view, these results could point out that students with greater previous knowledge use more scanning strategies to develop task 1 because they know where to locate the information they are searching for and they do not need to read all the information given in a lineal way to solve the task.

The results obtained agree with previous research studies which state that there could be a narrow relationship between students' previous knowledge and their decisions on selecting a particular piece of information (Rouet et al., 2011). For instance, Wood et al. (2016) examined how students' previous domain knowledge and students' level of expertise in search skills influenced the way in which students scanned information on the Internet. Data revealed that the combination of high search expertise and high previous domain knowledge produced most effective searches since students with higher previous domain knowledge accessed more thorough the sites.

Similarly, students who have less previous knowledge may be more limited to effectively perform different problem solving processes which could mean that they do not use scanning strategies since they feel the need to lineally read each piece of information provided to solve the task suggested (Kim & Hannafin, 2011).

6.3. Research Question 3: Are there any relations between students' individual characteristics and the students' performance improvement when processing information skill?

The results developed in this section deal with the possible relation between certain individual skills and the improvement of processing information skill performance.

Table 23 shows the correlations among students' reading skill and their improvement when processing information skill performance.

Table 23

Relations between students' reading skill and processing information skill performance (N = 82)

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Students' reading skill																				
1. Info retrieval	3.10 (1.59)	-																		
2. Info integration	5.45 (2.09)	0.60^{b}	-																	
3. Text reflection	2.99 (1.24)	0.41^{b}	0.56^{b}	-																
4. Global reading skill	11.54 (4.12)	0.81^{b}	0.91^{b}	0.74^{b}	-															
Processing information skill performance for task 1																				
5. Time processing info	-32.29 (34.15)	-0.14	-0.04	-0.19	-0.13	-														
6. Nº correct answers consulted	1.57 (1.89)	0.04	0.10	0.19	0.12	0.19	-													
7. Nº correct answers non-consulted	-1.37 (1.80)	-0.14	-0.10	-0.17	-0.15	-0.18	-0.92^{b}	-												
8. Nº incorrect answers consulted	-0.09 (0.50)	0.12	-0.09	-0.02	-0.01	0.08	-0.07	-0.16	-											
9. Nº incorrect answers non-consulted	-0.12 (0.61)	0.19	0.07	-0.08	0.08	-0.12	-0.33^{b}	0.05	-0.15	-										
Processing information skill performance for task 2																				
10. Time processing info	-89.18 (110.52)	0.03	-0.10	-0.28^{b}	-0.13	0.09	-0.04	-0.04	0.17	0.09	-									
11. Nº correct answers consulted	3.27 (3.80)	-0.03	-0.28^{a}	-0.23^{a}	-0.22^{a}	-0.11	-0.07	0.05	0.01	0.05	0.25^{a}	-								
12. Nº correct answers non-consulted	1.80 (2.51)	0.10	0.19	-0.01	0.13	0.09	0.14	-0.18	0.01	0.10	0.09	-0.46^{b}	-							
13. Nº incorrect answers consulted	-3.01 (2.21)	0.08	0.06	0.12	0.10	-0.08	0.03	-0.05	0.01	0.06	0.15	-0.31^{b}	-0.20	-						
14. Nº incorrect answers non-consulted	-2.06 (3.08)	-0.11	0.15	0.21	0.10	0.12	-0.04	0.12	-0.03	-0.19	-0.49^{b}	-0.64^{b}	-0.11	-0.18	-					
Processing information skill performance for task 3																				
15. Time processing info	-46.89 (113.51)	0.13	-0.08	-0.19	-0.05	-0.13	-0.21	0.18	0.11	0.05	0.13	0.16	0.01	-0.00	-0.20	-				
16. Nº correct answers consulted	0.77 (2.18)	0.07	-0.16	-0.12	-0.09	-0.10	-0.20	0.18	-0.10	0.18	0.00	0.18	-0.00	-0.03	-0.29	0.47^{b}	-			
17. Nº correct answers non-consulted	0.23 (1.54)	0.03	0.24^{a}	0.12	0.17	0.10	0.19	-0.15	-0.01	-0.14	0.06	-0.11	0.13	0.10	-0.04	-0.08	-0.52^{b}	-		
18. Nº incorrect answers consulted	-0.49 (0.86)	0.01	0.02	-0.04	0.00	-0.18	-0.00	0.01	-0.04	0.00	0.09	0.03	-0.10	0.09	-0.02	0.07	-0.32^{b}	-0.09	-	
19. Nº incorrect answers non-consulted	-0.52 (1.72)	-0.12	-0.02	0.07	-0.04	0.12	0.09	-0.09	0.15	-0.11	-0.10	-0.16	-0.06	-0.08	0.31^{b}	-0.56^{b}	-0.64^{b}	-0.20	-0.03	-

$^{a}p<0.05$; $^{b}p<0.01$

The results obtained from the analysis show a high, negative and significant relationship between the number of correct answers consulted in task 2 and students' reading skill.

In addition, the analysis of the correlation between "time processing information" in task 2 and students' "text reflection" shows that a high negative correlation exists [$r = -0.28$, $p<0.01$]. This result may reveal that students that better develop text reflection need less time to process the information in order to achieve task 2, which consists of a conceptual map construction.

According to the correlation between "number of correct answers consulted" in task 2 and the different variables that compose the students' reading skill, the results show that firstly, students who are better in "information integration" have a high negative correlation with the "number of correct answers consulted [$r = -0.28$, $p<0.05$]. Secondly, students who are better at "text reflection" also have a high negative correlation with the "number of correct answers consulted [$r = -0.23$, $p<0.05$]. Finally, students who are better in the "global reading skill" again have a high negative correlation with the "number of correct answers consulted [$r = -0.22$, $p<0.05$]. These results obtained, may demonstrate that students with greater reading skill do not need to consult the information in order to answer the questions for task 2 which consist of establishing relations between different concepts through a conceptual map construction.

Coherently with the previous results mentioned, "the number of correct answers non-consulted" in task 3 is significantly positively correlated with students' ability in "information integration" [$r = 0.24$, $p<0.05$], which may indicate that students who have better information integration abilities also answer more correct answers without consulting in task 3, because they do not need to consult information in order to achieve task 3.

Table 24 shows the correlations between students' ICT skill and their improvement when processing information skill performance.

Table 24

Relations between students' ICT skill and processing information skill performance (N = 82)

	M(SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Students' ICT skill																				
1. Info literacy	3.71 (0.82)	-																		
2. Internet literacy	4.45 (0.91)	0.54[b]	-																	
3. Computer literacy	3.99 (0.90)	0.46[b]	0.70[b]	-																
4. Global ICT skill	3.97 (0.68)	0.77[b]	0.86[b]	0.84[b]	-															
Processing information skill performance for task 1																				
5. Time processing info	-32.29 (34.15)	0.01	-0.06	0.07	-0.03	-														
6. Nº correct answers consulted	1.57 (1.89)	0.24[b]	0.05	0.03	0.11	0.19	-													
7. Nº correct answers non-consulted	-1.37 (1.80)	-0.21	-0.07	-0.03	-0.13	-0.18	-0.92[b]	-												
8. Nº incorrect answers consulted	-0.09 (0.50)	-0.10	-0.02	-0.03	-0.02	0.08	-0.07	-0.16	-											
9. Nº incorrect answers non-consulted	-0.12 (0.61)	-0.07	0.08	0.02	0.04	-0.12	-0.33[b]	0.05	-0.15	-										
Processing information skill performance for task 2																				
10. Time processing info	-89.18 (110.52)	-0.21	-0.12	-0.02	-0.13	0.09	-0.04	-0.04	0.17	0.09	-									
11. Nº correct answers consulted	3.27 (3.80)	-0.28[a]	-0.12	-0.05	-0.19	-0.11	-0.07	0.05	0.01	0.05	0.25[a]	-								
12. Nº correct answers non-consulted	1.80 (2.51)	0.12	0.06	0.06	0.08	0.09	0.14	-0.18	0.01	0.10	0.09	-0.46[b]	-							
13. Nº incorrect answers consulted	-3.01 (2.21)	0.08	0.05	0.12	0.16	-0.08	0.03	-0.05	0.01	0.06	0.15	-0.31[b]	-0.20	-						
14. Nº incorrect answers non-consulted	-2.06 (3.08)	0.19	0.06	-0.08	0.05	0.12	-0.04	0.12	-0.03	-0.19	-0.49[b]	-0.64[b]	-0.11	-0.18	-					
Processing information skill performance for task 3																				
15. Time processing info	-46.89 (113.51)	-0.12	0.10	0.21	0.09	-0.13	-0.21	0.18	0.11	0.05	0.13	0.16	0.01	-0.00	-0.20	-				
16. Nº correct answers consulted	0.77 (2.18)	-0.11	0.02	-0.03	-0.07	-0.10	-0.20	0.18	-0.10	0.18	0.00	0.18	-0.00	-0.03	-0.20	0.47[b]	-			
17. Nº correct answers non-consulted	0.23 (1.54)	0.17	-0.01	0.04	0.10	0.10	0.19	-0.15	-0.01	-0.14	0.06	-0.11	0.13	0.10	-0.04	-0.08	-0.52[b]	-		
18. Nº incorrect answers consulted	-0.49 (0.86)	-0.01	-0.03	0.09	0.04	-0.18	-0.00	0.01	-0.04	0.00	0.09	0.03	-0.10	0.09	-0.02	0.07	-0.32[b]	-0.09	-	
19. Nº incorrect answers non-consulted	-0.52 (1.72)	0.00	0.00	-0.04	-0.02	0.12	0.09	-0.09	0.15	-0.11	-0.10	-0.16	-0.06	-0.08	0.31[b]	-0.56[b]	-0.64[b]	-0.20	-0.03	-

[a]$p<0.05$; [b]$p<0.01$

The results obtained from the analysis show that numerous significant correlations between students' ICT skill and students' processing information skill performance in all tasks do not exist. Only students with greater "information literacy" are shown to be significantly and positively correlated with the "number of correct answers consulted" in task 1 [$r = 0.24$, $p<0.05$]. Conversely, students' "information literacy" is shown to be considerably and negatively correlated with the "number of correct answers consulted" in task 2 [$r = -0.28$, $p<0.05$]. These results may indicate that students' with better information literacy consult information in order to properly answer the multiple-choice questions of task 1. However, these students' with greater information literacy do not need to consult information in order to answer the questions of task 2 which consist in constructing a conceptual map.

No relationships were found between processing information skill performance in task 3 and students' reading skill. This may demonstrate that as students become familiar with the information to be processed the students' reading skill is less important in order to perform the processing information skill in a determined way.

Table 25 shows the correlations between students' previous knowledge on illnesses and health and their improvement in processing information skill performance.

Table 25

Relations between students' previous knowledge and processing information skill performance (N = 82)

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Students' previous knowledge																				
1. Multiple choice question	5.52 (1.59)	-																		
2. Conceptual map	2.71 (1.86)	0.36^{b}	-																	
3. Specific writing	3.78 (2.17)	0.24^{a}	0.28^{a}	-																
4. Global previous knowledge	12.06 (4.03)	0.68^{b}	0.73^{b}	0.76^{b}	-															
Processing information skill performance for task 1																				
5. Time processing info	-32.29 (34.15)	-0.16	0.07	-0.15	-0.11	-														
6. Nº correct answers consulted	1.57 (1.89)	-0.03	0.18	0.17	0.15	0.19	-													
7. Nº correct answers non-consulted	-1.37 (1.80)	-0.01	-0.21	-0.13	-0.16	-0.18	-0.92^{b}	-												
8. Nº incorrect answers consulted	-0.09 (0.50)	0.03	0.01	-0.15	-0.07	0.08	-0.07	-0.16	-											
9. Nº incorrect answers non-consulted	-0.12 (0.61)	0.10	0.03	-0.02	0.05	-0.12	-0.33^{b}	0.05	-0.15	-										
Processing information skill performance for task 2																				
10. Time processing info	-89.18 (110.52)	-0.04	-0.15	-0.10	-0.14	0.09	-0.04	-0.04	0.17	0.09	-									
11. Nº correct answers consulted	3.27 (3.80)	-0.09	-0.35^{b}	-0.20	-0.29^{b}	-0.11	-0.07	0.05	0.01	0.05	0.25^{a}	-								
12. Nº correct answers non-consulted	1.80 (2.51)	0.08	0.23^{a}	0.04	0.15	0.09	0.14	-0.18	0.01	0.10	0.09	-0.46^{b}	-							
13. Nº incorrect answers consulted	-3.01 (2.21)	-0.04	0.24^{a}	0.24^{a}	0.21	-0.08	0.03	-0.05	0.01	0.06	0.15	-0.31^{b}	-0.20	-						
14. Nº incorrect answers non-consulted	-2.06 (3.08)	0.08	0.08	0.04	0.09	0.12	-0.04	0.12	-0.03	-0.19	-0.49^{b}	-0.64^{b}	-0.11	-0.19	-					
Processing information skill performance for task 3																				
15. Time processing info	-46.89 (113.51)	-0.13	-0.12	-0.15	-0.18	-0.13	-0.21	0.18	0.11	0.05	0.13	0.16	0.01	-0.00	-0.20	-				
16. Nº correct answers consulted	0.77 (2.18)	0.22	0.06	-0.07	0.06	-0.10	-0.20	0.18	-0.10	0.18	0.00	0.18	-0.00	-0.03	-0.20	0.47^{b}	-			
17. Nº correct answers non-consulted	0.23 (1.54)	-0.14	-0.04	0.04	-0.03	0.10	0.19	-0.15	-0.01	-0.14	0.06	-0.11	0.13	0.10	-0.04	-0.08	-0.52^{b}	-		
18. Nº incorrect answers consulted	-0.49 (0.86)	-0.22	-0.11	0.04	-0.11	-0.18	-0.00	0.01	-0.04	0.00	0.09	0.03	-0.10	0.09	-0.02	0.07	-0.32^{b}	-0.09	-	
19. Nº incorrect answers non-consulted	-0.52 (1.72)	-0.03	0.02	0.03	0.01	0.12	0.09	-0.09	0.15	-0.11	-0.10	-0.16	-0.06	-0.08	0.31^{b}	-0.56^{b}	-0.64^{b}	-0.20	-0.03	-

$^{a}p<0.05$; $^{b}p<0.01$

The results derived from the analysis primarily illustrate that there are not many significant correlations between students' previous knowledge and students' processing information skill performance in the majority of the tasks. Students who perform better in the "conceptual map" question for the previous knowledge assessment are shown to be significantly and negatively correlated with the "number of correct answers consulted" in task 2 [$r = -0.35$, $p<0.01$] but coherently these students are shown to have a significantly and positive correlation with the "number of correct answers non-consulted" in task 2 [$r = 0.23$, $p<0.05$]. On the other hand, students who demonstrate a better global previous knowledge are shown to have a significant and negative correlation with the "number of correct answers consulted" in task 2 [$r = -0.29$, $p<0.01$].

These results may indicate that students with better previous knowledge have less need to consult information in order to answer questions for task 2 and they answer the questions without consulting information because after having developed task 1 and having been familiarized with the information, they do not need to do it in order to succeed when answering the question.

However, there are two correlations which are difficult to explain which show that as students' perform better in "conceptual map" in the previous knowledge assessment the "number of incorrect answers consulted" increases in task 2 development [$r = 0.24$, $p<0.05$]. A similar thing happens with the correlation between students' "specific writing" performance in the previous knowledge assessment and the "number of incorrect answers consulted" in task 2 development [$r = 0.24$, $p<0.05$].

Based on the analysis of the results presented in the previous section, three main considerations can be discussed:

a) There are not many significant correlations between students' individual skills and their achievement in processing information skill performance.

The results presented show that there are not many significant relations between students' individual skills and their achievement in processing information skill performance.

From my point of view, these results may indicate that the difference in students' processing information skill performance before and after the instruction received by the students is not influenced by the students' individual skills, but seems to be influenced by the instruction received based on IBL, as could have happened with the previous results obtained that do not show numerous significant relations between students' individual skills and their achievement when scanning information skill performance.

b) Students' reading skill and students' previous knowledge seem to be the individual skills that are most correlated with the students' processing information skill performance especially in task 2.

The acquired results demonstrate that students' reading skill and students' previous knowledge seem to be correlated with the students' processing information skill performance in task 2.

From my point of view, these results might indicate that students' reading skill and students' previous knowledge is significantly related to the way in which students develop the processing skill, when they are asked to complete an activity which mainly asks them to connect concepts and ideas from a given text in order to create a partly constructed conceptual map as happens in task 2.

The results that connect students' reading skill with students performance of processing skill are consistent with some previous research studies developed such as the one developed by Hahnel, Goldhammer, Naumann, & Kröhne (2016) who observed that students who were skilled in reading linear texts were estimated to understand and relate significant concepts presented on nodes in the hypertexts.

The results that connect students' previous knowledge with students performance of processing skill agree with earlier research studies which affirm that there could be a narrow relationship between students' previous knowledge and their time spent processing information since data revealed that the more previous knowledge participants had, the faster they were at processing the first search engine page (Rouet et al., 2011). However, researchers revealed that participants who had higher previous knowledge had also less tendency to use keywords extracted from the search problem statements in their initial search and during the following scanning for information.

c) Students' ICT skill only seems to have a positive significant correlation on students' processing information skill performance, only students' information literacy seem to be correlated with the number of students' correct answers consulted in tasks 1 and 2.

The obtained results reveal that students' ICT skill only has a positive significant correlation on student' processing information skill performance, only students' information literacy seems to be correlated with the number of students' correct answers consulted in tasks 1 and 2.

From my point of view, as has been stated before, these results possibly indicate that from the different items which form the ICT skill, the one which has a major correlation with the IPS skills analyzed is the information literacy skill which is closely correlated to the IPS process because it deals with the capacity of the students to identify information needs, assess information quality, manage information, use information effectively and ethically and create and communicate knowledge through the application of information (Lau & Yuen, 2014).

The results presented reveal the possibility that students with greater information literacy may be better at processing the information previously scanned in order to give a correct answer to the question given when they are required to handle isolated information without transforming the content in any way and to connect concepts and ideas from more than one information source in a simple fashion, something that does not happen when students are required to think about concepts and develop complex conceptual frameworks as is required in task 3.

The data obtained is consistent with previous empirical research studies which stated that students with powerful basic computer skills were able to find, access, and relocate information in digital environments, indirectly supporting their comprehension of digital text (Goldhammer et al., 2014; Hahnel et al., 2016; Naumann, 2015). However, there are none sufficient research studies that center their interest on the potential relation between students' ICT skills and their IPS task development to establish more relations or differences with previous research studies (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

6.4. Research Question 4: Are there any relations between the improvement of students' scanning information skill performance and students' processing information skill performance in each task?

The results shown in this section, deal with the possible relations between the improvement of students' scanning information skill performance and students' processing information skill performance.

To start with, Table 26 shows the correlations between the improvement of students' scanning information skill performance and students' processing skill performance in task 1.

Table 26
Relations between students' scanning information skill performance and students' processing information skill performance in task 1 (N = 82)

	1	2	3	4	5	6	7	8	9	10	11
Scanning information skill performance for task 1											
1. Time scanning useful info	-										
2. Time scanning useless info	0.65^{b}	-									
3.Time scrolling info	-0.19	-0.36^{b}	-								
4. Nº slides lineally read	0.68^{b}	0.59^{b}	-0.16	-							
5. Nº slides scanned	-0.14	-0.17	0.10	-0.00	-						
6. Nº slides scrolled	-0.09	-0.30^{b}	0.91^{b}	-0.10	0.14	-					
Processing information skill performance for task 1											
7. Time processing info	-0.03	-0.09	0.07	0.09	0.05	0.01	-				
8. Nº correct answers consulted	-0.13	-0.40^{b}	0.48^{b}	-0.02	0.36^{b}	0.54^{b}	0.19	-			
9. Nº correct answers non-consulted	0.16	0.46^{b}	-0.48^{b}	0.09	-0.33^{b}	-0.51^{b}	-0.18	-0.92^{b}	-		
10. Nº incorrect answers consulted	0.07	-0.13	0.11	0.04	0.04	0.07	0.08	-0.07	-0.16	-	
11. Nº incorrect answers non-consulted	-0.10	0.01	-0.17	-0.23^{a}	-0.15	-0.23^{a}	-0.12	-0.33^{b}	0.05	-0.15	-

$^{a}p<0.05$; $^{b}p<0.01$

The results resultant from the analysis primarily illustrate that are numerous significant correlations between students' scanning information skill performance and students' processing information skill performance in task 1. In addition, several significant correlations exist between different variables of scanning information skill performance in task 1. However, only two significant negative correlations exit between different variables of processing information skill in task 1.

If the attention is focused on the correlations established between different students' variables of scanning information skill performance in task 1, it can be identified that the more "time scanning useful information" the more "time scanning useless information" as well [r = 0.64, p<0.01] and the more “number of slides lineally read” read too [r = 0.68, p<0.01]. Otherwise, the “time scanning useless information” is demonstrated to have a significant and positive correlation with “the number of slides lineally read” [r = 0.59, p<0.01]. However, the “time scanning useless information” seems to be highly and negative related with the “time scrolling information [r = -0.36, p<0.01] and the “number of slides scrolled” [r = -0.30, p<0.01]. Coherently, the amount of “time scrolling information” seems to be significant and positively correlated to the “number of slides scrolled” [r = 0.91, p<0.01]. These results may indicate that students who devote more time to scanning information tend to lineally read the slides of information instead of using scanning techniques. Moreover, students who spent more time scanning useless information show a lower amount of information scrolled through.

If the attention is focused on the correlations between students' scanning information skill performance and students' processing information skill performance in task 1, several significant correlations can be identified. Firstly, the results show that there is a significant negative correlation between the “time scanning useless information” and the “number of correct answers consulted” [r = -0.40, p<0.01] but there exists a significant positive correlation between the “time scanning useless information” and the “number of correct answers non-consulted” [r = 0.46, p<0.01]. Secondly, the results also demonstrate that there is a significant positive correlation between the “time scrolling information” and the “number of correct answers consulted” [r = 0.48, p<0.01] but there is a significant negative correlation between the “time scrolling information” and the “number of correct answers non-consulted” [r = -0.48, p<0.01]. Thirdly the, results show that There is a negative correlation between the “number of lineally read” and the “number of incorrect answers non-consulted” [r = -0.23, p<0.05].Fourth, the results indicate that there is a significant positive correlation between the “number of slides scanned” and the “number of correct answers consulted” [r = 0.36, p<0.01] but there exists a significant negative correlation between the “number of slides scanned” and the “number of correct answers non-consulted” [r = -0.33, p<0.01]. Additionally, the results indicate that the “number of slides scrolled” is significantly positively correlated to the “number of correct answers consulted” [r = 0.54, p<0.01] while on the contrary the “number of slides scrolled” is significantly negatively correlated to the “number of correct answers non-consulted” [r = -0.51, p<0.01]. Less high but also significantly and negative is the correlation between “number of slides scrolled” and “the number of incorrect answers non-consulted” [r = -0.23, p<0.05].

Finally, if the attention is focused on the correlations established between different students’ variables of processing information skill performance in task 1 only two significant negative relations can be identified. The “number of correct answers consulted” has been shown to be highly and positively correlated with the “number of correct answers non-consulted” [r = -0.92, p<0.01] and the “number of incorrect answers non-consulted”[r = -0.33, p<0.01].

These results may indicate that longer times scanning useful and useless information imply a higher number of slides read lineally, without using any particular scanning strategy which may mean that the students who do not use scanning techniques to scan information spent more time scanning information in order to achieve the purpose of the task given. Additionally, long times of scanning useless information indicate less correct answers consulted but more correct answers non-consulted which can be due to the useless information being scanned without having in mind the purpose of the question to be answered. Reasonably, as the time spent developing the scanning technique of scrolling information rises, so does the number of correct answers consulted, but the number correct answers non-consulted decreases, which may indicate that students scroll information having in mind the question to be answered. According to the relation between the way in which the slides have been scanned and its relation with the way in which the information has been processed, we can say that higher numbers of slides read lineally involve less incorrect answers non-consulted, but a higher number of slides scanned using scanning and scrolling techniques involving more correct answers consulted but less correct answers non-consulted, which may mean that the usage of scanning techniques leads to an increase of the correct answers consulted because students use the scanning techniques bearing in mind the purpose of the question to be answered, something that does not happen when students read slides lineally.

Secondly, Table 27 shows the correlations between the improvement of students' scanning information skill performance and students' processing skill performance in task 2.

Table 27

Relations between students' scanning information skill performance and students' processing information skill performance in task 2 (N = 82)

	1	2	3	4	5	6	7	8	9	10	11
Scanning information skill performance for task 2											
1. Time scanning useful info	-										
2. Time scanning useless info	0.50[b]	-									
3.Time scrolling info	0.34[b]	0.13	-								
4. Nº slides lineally read	0.87[b]	0.43 [b]	0.41 [b]	-							
5. Nº slides scanned	0.51[b]	0.09	0.35[b]	0.46 [b]	-						
6. Nº slides scrolled	0.32[b]	0.12	0.93[b]	0.39 [b]	0.34 [b]	-					
Processing information skill performance for task 2											
7. Time processing info	0.36[b]	-0.02	0.33[b]	0.39 [b]	0.30 [b]	0.33 [b]	-				
8. Nº correct answers consulted	0.23[a]	-0.05	0.18	0.25[a]	0.50 [b]	0.26[a]	0.25[a]	-			
9. Nº correct answers non-consulted	-0.11	-0.04	-0.04	-0.11	-0.25[a]	-0.05	0.09	-0.41 [b]	-		
10. Nº incorrect answers consulted	0.34[b]	0.11	0.30 [b]	0.35 [b]	0.16	0.20	0.15	-0.31 [b]	-0.20	-	
11. Nº incorrect answers non-consulted	-0.44[b]	0.01	-0.40 [b]	-0.46 [b]	-0.53 [b]	-0.42 [b]	-0.49 [b]	-0.64 [b]	-0.11	-0.18	-

[a]$p<0.05$; [b]$p<0.01$

The results subsequent from the analysis mainly demonstrate that there are numerous important correlations between students' scanning information skill performance and students' processing information skill performance in task 2. In addition, several considerable correlations exist between different variables of scanning information skill performance in task 2. Likewise, there are numerous relations between different variables of processing information skill in task 2.

If the attention is focused on the correlations established between different students' variables of scanning information skill performance in task 2, it can be identified that the "time scanning useful information" is significantly and positively correlated with all the other variables of scanning information skill performance in task 2, the "time scrolling information" [r = 0.34, p<0.01] and "number of slides scrolled" [r = 0.32, p<0.01] being the correlations with the lowest correlated variables, whereas the relation with "number of slides lineally read" [r = 0.87, p<0.01] is the highest correlated variable. Nevertheless, the "time scanning useless information" has only been demonstrated to have a significant and positive correlation with "the number of slides lineally read" [r = 0.43, p<0.01] apart from with the amount of "time scanning useful information" [r = 0.50, p<0.01] as also has been demonstrated with task 1. Otherwise, the "time scrolling information" seem to be significant and positively correlated to the "number of slides scrolled" [r = 0.93, p<0.01] as has happened with task 1, "the number of slides lineally read" [r = 0.41, p<0.01] and "the number of slides scanned" [r = 0.35, p<0.01]. Likewise, the "number of slides lineally read" is significantly and positively correlated with all the variables of the scanning information skill. Contrary to what happens with the "number of slides scanned" and the "number of slides scrolled" which are positively correlated with all the different variables of scanning information skill except from the "time spent scanning useless information" which does not show a significant correlation with them. To summarize, all the variables of the scanning information skill performance in task 2 are significantly and positively correlated, except for the "time spent scrolling information", the "number of slides scanned" and the "number of slides scrolled", which are not correlated with the time spent scanning useless information, which may indicate that as students use more scanning techniques to scan information they also scan more useful information than useless information.

If the attention is focused on the relations between students' scanning information skill performance and students' processing information skill performance in task 2, several significant correlations can be identified. Firstly, the results show that there is a significant negative correlation between the “time scanning useful information” and the “number of incorrect answers non-consulted” [$r = -0.44$, $p<0.01$] but there are significant positive correlations between the “time scanning useful information” and three different variables of processing information skill which are the “time processing information” [$r = 0.36$, $p<0.01$], the “number of correct answers consulted” [$r = 0.23$, $p<0.05$] and the “number of incorrect answers consulted” [$r = 0.34$, $p<0.01$]. Secondly, the results also demonstrate that there are no significant correlations between the time scanning useless information and any of the variables that define the processing information skill. Thirdly, the results show that exist significant and positive correlations between the “time scrolling information” and two variables of processing information skill which are the “time processing information” [$r = 0.33$, $p<0.01$] and the “number of incorrect answers consulted” [$r = 0.30$, $p<0.01$] but there is a significant negative correlation between the “time scrolling information” and the “number of incorrect answers non-consulted” [$r = -0.40$, $p<0.01$]. Fourth, the results indicate that the same happens with the “number of slides lineally scanned”, which show a significant positive correlation with the “time processing information” [$r = 0.39$, $p<0.01$] and the “number of incorrect answers consulted” [$r = 0.35$, $p<0.01$] but there is a significant negative correlation with the “number of incorrect answers non-consulted” [$r = -0.458$, $p<0.01$]. Fifth, the results demonstrate that the “number of slides scanned” are significantly and positively correlated with the “time processing information” [$r = 0.30$, $p<0.01$] and the “number of correct answers consulted” [$r = 0.50$, $p<0.01$]. However, the “number of slides scanned” is negatively correlated with the “number of correct answers non-consulted” [$r = -0.25$, $p<0.05$] and the “number of incorrect answers non-consulted” [$r = -0.53$, $p<0.01$]. In addition, the results indicate that the “number of slides scrolled” is significantly positively related to the “time processing information” [$r = 0.33$, $p<0.01$] and the “number of correct answers consulted” [$r = 0.26$, $p<0.05$] while conversely the “number of slides scrolled” is significantly negatively related to the “number of incorrect answers non-consulted” [$r = -0.42$, $p<0.01$].

Finally, if the attention is focused on the relations established between different students’ variables of processing information skill performance in task 2, different significant positive and negative correlations can be identified. The “time processing information” presents a significant and positive relation to the “number of correct answers consulted” [$r = 0.25$, $p<0.05$] but presents a significant negative correlation with the “number of incorrect answers non-consulted” [$r = -0.49$, $p<0.01$]. The “number of correct answers consulted” also presents significant and negative correlations with the “number of correct answers non-consulted” [$r = -0.461$, $p<0.01$], the “number of incorrect answers consulted” [$r = -0.305$, $p<0.01$] and the “number of incorrect answers non-consulted” [$r = -0.64$, $p<0.01$].

These results may indicate that as has been shown in the results obtained for task 1, also in task 2 higher times scanning useful and useless information imply a higher number of slides read lineally which may mean that the students who do not use scanning techniques to scan information spent more time scanning information in order to achieve the aim of the activity. Additionally, in task 2 longer times of scanning useful information are related with longer time spent using scanning techniques and with a higher number of slides scanned using different scanning techniques such as scanning or scrolling. However, this does not happen with the time spent scanning useless information which is not significantly correlated to the “time spent scrolling information”, the “number of slides scanned” or the “number of slides scrolled”, which may indicate that as students use more scanning techniques to scan information they also scan more useful information rather than useless information.

According to the relation between the way in which the slides have been scanned and the way in which the information has been processed, it can be said that a higher number of slides scanned or scrolled through involve higher times of processing information and higher number of correct answers consulted but less incorrect answers non-consulted, and less correct answers non-consulted in the case of number of slides scanned, which may mean that the usage of scanning techniques leads to an increase of the correct answers consulted because students use the scanning techniques bearing in mind the purpose of the question to be answered, and when they answer they do it successfully. Conversely, the number of slides lineally read is significantly and positively correlated with the number of correct answers consulted but also with the number of incorrect answers consulted. This may indicate that when students read the slides in a lineal way they were able to take into consideration what they had been asked to solve. However, they do not always succeed when the question has to be answered, something that does not happen when they use scanning techniques to scan the slides. Understandably, as the time spent developing scanning techniques increases, so does the number of correct answers consulted, however, the number correct answers non-consulted decreases, which may indicate that students scan information bearing in mind the question to be answered.

Finally, in task 2 as the time is devoted by the students to processing information and the number of correct answers consulted increase, the number of incorrect answers non-consulted decreases, which may show that longer times of processing information be correlated to an improvement in students' achievement of mental map construction.

Thirdly, Table 28 shows the relations between the improvement of students' scanning information skill performance and students' processing skill development in task 3.

Table 28

Relations between students' scanning information skill performance and students' processing information skill performance in task 3 (N = 82)

	1	2	3	4	5	6	7	8	9	10	11
Scanning information skill performance for task 3											
1. Time scanning useful info	-										
2. Time scanning useless info	-0.18	-									
3.Time scrolling info	0.24[a]	-0.08	-								
4. Nº slides lineally read	0.73[b]	0.25[a]	0.21	-							
5. Nº slides scanned	0.45[b]	0.02	0.23[a]	0.27[a]	-						
6. Nº slides scrolled	0.25[a]	-0.06	0.91[b]	0.26[a]	0.23[a]	-					
Processing information skill performance for task 3											
7. Time processing info	0.54[b]	-0.13	0.04	0.48[b]	0.27[a]	0.08	-				
8. Nº correct answers consulted	0.70[b]	0.05	0.22[a]	0.67[b]	0.55[b]	0.25[a]	0.47[b]	-			
9. Nº correct answers non-consulted	-0.35[b]	-0.13	-0.24[a]	-0.41[b]	-0.27[a]	-0.26[a]	-0.08	-0.52[b]	-		
10. Nº incorrect answers consulted	-0.03	0.02	0.08	0.07	-0.10	0.10	0.07	-0.32[b]	-0.09	-	
11. Nº incorrect answers non-consulted	-0.55[b]	0.04	-0.10	-0.52[b]	-0.40[b]	-0.14	-0.56[b]	-0.64[b]	-0.20	-0.03	-

[a]p<0.05; [b]p<0.01

The results obtained from the analysis mainly demonstrate that there are numerous important correlations between students' scanning information skill performance and students' processing information skill performance in task 3. In addition, a considerable amount of relations exist between different variables of scanning information skill performance in task 3. Similarly, there are several correlations between the different variables of processing information skill in task 3.

If attention is focused on the relations established between different students' variables of scanning information skill performance in task 3, it can be identified that the "time scanning useful information" is significantly and positively correlated to all the other variables of scanning information skill performance in task 3 except for the "time scanning useless information". The relation with the "time scrolling information" [$r = 0.24$, $p<0.05$] and "number of slides scrolled" [$r = 0.25$, $p<0.05$] are the lowest related variables but they are still positively correlated as has happened with both previous tasks. The correlation with "number of slides lineally read" [$r = 0.73$, $p<0.01$] is the highest variable related as happened in task 2. Nevertheless, the "time scanning useless information" has only been demonstrated to have a significant and positive correlation with "the number of slides lineally read" [$r = 0.25$, $p<0.05$] which coincides with the previous results analyzed in tasks 1 and 2. The "time scrolling information" seems to be significantly and positively correlated with the "number of slides scrolled" [r = 0.91, p<0.01] and "the number of slides scanned" [r = 0.23, p<0.05]. Likewise, the "number of slides lineally read" is significantly and positively correlated with all the variables of the scanning information skill except for the "time scrolling information" which has shown no relations. Contrary to what happens with the variable "number of slides scanned" and "number of slides scrolled" which are positively correlated with all the different variables of the scanning information skill except for the "time spent scanning useless information" which does not show a significant correlation with them. This may indicate that as students use more scanning techniques to scan information they also scan more useful information than useless information.

If attention is focused on the relations between students' scanning information skill performance and students' processing information skill performance in task 3, numerous significant correlations can be recognized. Firstly, the results show that there is a significant negative correlation between the "time scanning useful information" and the variables which take into consideration the non-consulted answers, which are "number of correct answers non-consulted" [r = -0.35, p<0.01] and the "number of incorrect answers non-consulted" [r = -0.55, p<0.01]. However, there are significant positive correlations between the "time scanning useful information" and two different variables of processing information skill which are the "time processing information" [r = 0.54, p<0.01] and the "number of correct answers consulted" [r = 0.70, p<0.05] as happened in task 2.

Secondly, the results also demonstrate that there are no significant correlations between the time spent scanning useless information and any of the variables that define the processing information skill as happened in task 2. Thirdly, the results show that there is a significant and positive correlation between the "time scrolling information" and the "number of correct answers consulted" [r = 0.22, p<0.05] but there is a significant negative correlation between the “time scrolling information” and the “number of correct answers non-consulted” [$r = -0.24$, $p<0.05$]. Fourth, the results indicate that the “number of slides lineally scanned” show a significant positive correlation to the “time processing information” [$r = 0.48$, $p<0.01$] and the “number of correct answers consulted” [$r = 0.67$, $p<0.01$]. However, the “number of slides lineally scanned” present a significant negative correlation with the “number of correct answers non-consulted” [$r = -0.41$, $p<0.01$] and the “number of incorrect answers non-consulted” [$r = -0.52$, $p<0.01$]. Fifth, the results demonstrate that the same happens with the “number of slides scanned” which is shown to be significantly and positively correlated with the “time processing information” [$r = 0.27$, $p<0.05$] and the “number of correct answers consulted” [$r = 0.55$, $p<0.01$]. However, again the “number of slides scanned” is negatively correlated with the “number of correct answers non-consulted” [$r = -0.27$, $p<0.05$] and the “number of incorrect answers non-consulted” [$r = -0.40$, $p<0.01$]. Additionally, the results indicate that the “number of slides scrolled” is significantly positively related to the “number of correct answers consulted” [$r = 0.250$, $p<0.05$] while conversely the “number of slides scrolled” is significantly negatively related to the “number of correct answers non-consulted” [$r = -0.42$, $p<0.05$].

Finally, if attention is focused on the relations established between different students’ variables of processing information skill performance in task 3, different significant positive and negative correlations can be identified. As happens in task 2 the “time processing information” presents a significant and positive correlation with the “number of correct answers consulted” [$r = 0.47$, $p<0.01$] but presents a significant negative correlation with the “number of incorrect answers non-consulted” [$r = -0.56$, $p<0.01$]. The “number of correct answers consulted” is significantly and positively correlated with the “time processing information” [$r = 0.47$, $p<0.01$] but it is negatively correlated with the rest of variables of the processing information skill performance for task 2, which are the “number of correct answers non-consulted" [r = -0.52, p<0.01], the "number of incorrect answers consulted" [r = -0.32, p<0.01] and the "number of incorrect answers non-consulted" [r = -0.64, p<0.01].

These results may indicate that, as has been shown in the results obtained for task 1 and task 2, as well as in task 3 higher times scanning useful and useless information imply a higher number of slides read lineally which may mean that the students who do not use scanning techniques to scan information spent more time scanning information in order to achieve the aim of the activity. Additionally, as happened in task 2, in task 3 longer times of scanning useful information are related to longer time spent using scanning techniques and with a higher number of slides scanned by using different scanning techniques such as scanning or scrolling. However, this does not happen with the time spent scanning useless information which is not significantly related to the "time spent scrolling information", the "number of slides scanned" or the "number of slides scrolled", which may indicate that as students use more scanning techniques to scan information they also scan more useful information than useless information.

According to the relation between the way in which the slides have been scanned and the way in which the information has been processed, it can be said that as the time spent developing scanning techniques increases, so does the number of correct answers consulted However the number correct answers non-consulted decreases, which may indicate that students scan information bearing in mind the question to be answered in order to successfully achieve the aim of the task. Surprisingly in task 3, a higher number of slides lineally read, scanned or scrolled involve a higher number of correct answers consulted but less number of correct answers non-consulted, and less incorrect answers non-consulted in the case of number of slides lineally read and scanned, which may mean that as the students are familiarized with the information provided to achieve the tasks presented they scan the information having in mind the purpose of the question to be answered, independently from which is the technique used, something that has not happened before when the students read slides lineally in the previous tasks.

Finally, also in task 3 as more time is devoted by the students to process information the number of correct answers consulted increases and the number of incorrect answers non-consulted decreases, which may indicate that longer times of processing information are related to an improvement in students' achievement of specific writing development.

Based on the analysis of the results presented in the previous section, three main considerations can be discussed:

a) A high number of correlations between numerous categories of scanning information skill performance, and processing information skill performance have been found.

The results presented show that the students' performance of the scanning information skill is highly correlated with the different categories of the proper skill, as well as with the students' performance of the processing information skill. The same thing occurs with the students' performance of the processing information skill, which shows numerous correlations with the different categories of the proper skill as well as with the students' performance of the scanning information skill. From my point of view, the main explanation for this fact is that students' development of constituent skills is highly related to the way in which different constituent skills are developed according to the type of task.

Despite non-research studies which pursue to determine the correlations of different constituent skills of the IPS process have been found, the results may contribute to support the findings obtained by Badia & Becerril (2015). They suggest that the IPS skills can be used by the students according to the diverse necessities of the assignment and according to the requirements that the task demands. This emerging way of understanding the IPS process has also been suggested by other authors (Monereo & Badia, 2012; Şendurur & Yildirim, 2015).

b) There are certain categories which are correlated in the same way in two or in three types of tasks, while there are other categories which do not show correlations in any task or in only one task.

The results obtained demonstrated that certain correlations have been found in each of the three types of tasks. This leads us to state several common correlations that appear in the three different types of tasks.

Regarding correlations that deal with the categories of scanning information, two main correlations have been found. The first is that students that who did not use scanning techniques to scan information spent more time scanning information in order to find the right information for the goal of the proposed task. The second coherent statement is that students who present higher times of scrolling also present a higher number of slides scrolled. From my point of view, the main explanation for this fact is that students with higher times scanning useful and useless information also have a higher number of slides read lineally which may mean that the students who did not use scanning techniques to scan information spent more time scanning information in order to find the right information to achieve the aim of the task proposed.

The findings are consistent with previous literature on the topic, for instance, according to Salmerón, Naumann, García, and Fajardo (2017), students who use scanning techniques scanned more quickly and revisited segments of the hypertext that did not contain relevant information less often.

With regard to correlations among categories of the scanning information skill performance and categories of processing information skill performance, three main considerations have to be taken. The first reflection is that students who use scanning techniques to scan information obtain more correct answers consulted but less correct answers non-consulted. Additionally, the students who develop lineal reading to obtain information from the text obtain less incorrect answers non-consulted obtain. As well, the number of slides scrolled is positively related to the correct answers consulted.

With regard to correlations within the categories of processing information, one main consideration can be made. There is a coherent correlation which is that the students who have more correct answers consulted present less correct answers non-consulted and less incorrect answers non-consulted.

Surprisingly, while the results demonstrate that not many significant coincidences have been found among the correlations found in tasks 1 and task 2 or among the ones presented in task 1 and task 3, several coincidences have been in correlations from task 2 and task 3.

Regarding correlations that deal with the categories of scanning information, four main statements can be presented. Initially, students' who present long times of scanning useful information, also present a higher number of slides scanned by using different scanning techniques such as scanning or scrolling, which means that students who use scanning techniques scan more useful information than useless information. Additionally, the times of scrolling information seem to be positively correlated with the number of slides scanned, which means that students who scan information make a frequent use of the scrolling technique to discard and select pages of information, something proper of successful researchers of information. Moreover, the number of slides, lineally read, scanned, and scrolled are positively correlated between them, which may indicate that students who gather information tend to use different types of information according to tasks demands.

Regarding correlations among categories of scanning information skill performance and categories of processing information skill performance, three main considerations have to be taken. First, it can be stated that as the time that the students spent scanning useful information, so does the number of correct answers consulted, while is the number of incorrect answers non-consulted decreases, which may indicate that students who use scanning techniques to scan information, scan information appropriately to answer correctly the task given. Additionally, students who demonstrate longer times scanning useful information also spend more time processing information and reflecting about the task to give a proper answer.

However, it has also been demonstrated that high portion of lineally read information also shows high times of processing information as well as a high number of correct answers consulted, which may indicate that despite students who scan information using lineally reading present longer times of developing the whole task than the students who use scanning strategies, both succeed in properly completing the task.

Regarding correlations that deal with the categories of processing information, two explanations can be stated. The first state is that students with longer times of processing information show better learning outcomes when conceptual maps construction and specific writing are required. The second coherent statement is that students who present more correct answers consulted also present less incorrect answers consulted.

From my point of view, in more difficult tasks that require the students to connect concepts and ideas from more than one information source and to think about concepts in order to develop complex conceptual frameworks, which in our case are the proposed tasks 2 and 3, it has been shown that as the time the students dedicate to processing information increases so does the number of correct answers consulted, while the number of incorrect answers non-consulted decreases. This fact may indicate that students with longer times of processing information show better achievement when conceptual map construction and specific writing development is required.

The results presented may be connected with the results obtained by previous researchers who indicate that processing significant information to accomplish the task given could be associated with extended processing times (Hahnel, Goldhammer, Naumann, & Kröhne, 2016). Consistently, Walhout et al. (2015) mentioned in the results obtained from their study that deeper processing of information required the fulfillment of the information required in the task was reflected in longer viewing times of web pages.

Regarding task complexity, the results obtained are consistent with the ones presented by Becerril and Badia (2015) who mentioned that in a more cognitively complex task, the students showed higher performance levels in the information search, browsing, and development skills.

c) Students who do not use scanning techniques to scan information take longer to identify the information that must be found in order to successfully answer the tasks proposed.

Finally, despite the numerous similarities regarding the correlations highlighted in different types of task, some correlations have only stood out in singular tasks. The outstanding correlations can guide us to reflect that students who do not use scanning techniques to scan information take longer to identify the information that must be found in order to successfully answer the tasks proposed.

As the time that the students spend developing scanning techniques increases, so does the number of correct answers consulted, while the number of correct answers non-consulted decreases, which may indicate that students who use scanning techniques to scan information do so bearing in mind the question to be answered, something that does not happen with the students who read the slides lineally.

Students who use scanning techniques from the beginning of the proposed tasks are aware that in order to succeed in the resolution of the tasks, the information must be scanned with what is being asked to solve the task in mind, whereas students who use linear reading take longer to do so.

As students who do not use scanning techniques to scan information become familiar with the information provided to perform the various tasks proposed, they become aware of the need to bear in mind the aim of the task in order to scan the information effectively and consequently correctly develop the response to the task.

However, students who make higher use of scanning techniques instead of carrying out linear reading show significant positive correlations with the number of correct answers consulted from the first proposed task, which may indicate that these students are more efficient at the sperformance of scanning and processing information skills. Coherently, students who do not use scanning techniques to scan information and make use of linear reading do not present positive correlations with the number of correct and incorrect answers consulted until the second task proposed, while students who use scanning techniques still only present significant correlations with the correct answers consulted and do not show positive correlations with the incorrect answers consulted.

In fact, students who make use of linear reading do not present positive correlations with the number of correct answers consulted until the third task proposed, pushing aside the positive correlation with the incorrect answers consulted, an element that students who use scanning techniques use and maintain from the first task proposed.

This reasoning is consistent with previous research studies developed since, according to Salmerón, Naumann, García, and Fajardo (2017), students who use scanning techniques scan quicker and revisit segments of the hypertext that did not contain relevant information less often.

6.5. Research Question 5: Are there any differences between the students' initial and final learning performance?

The fifth research objective, which principally consisted in determining the effect that IPS instruction designed in an IWBL environment had on students' science knowledge on illnesses and health, provided us with useful information allowing us to describe in detail the students' learning performance on science knowledge. Table 29 shows the means and standard deviations of students' learning performance on science knowledge.

Table 29
Differences between initial and final students' learning achievements on science knowledge (N = 82)

Question	Initial M (SD)	Final M (SD)	t	p
Question 1	5.52 (1.59)	8.12 (1.53)	14.03	0.00
Question 2	2.71 (1.86)	5.00 (1.76)	11.11	0.00
Question 3	3.78 (2.17)	5.93 (2.02)	8.55	0.00
Total science knowledge	12.06 (4.03)	19.04 (3.84)	17.62	0.00

As shown in Table 29, from students' given responses in the individual assessments, it can be understood that students have improved in all the types of questions assessed, which means that students' science knowledge on illnesses and health has increased (M = 6.98) after having undertaken the instruction. Students' initial knowledge on illnesses and health was of 12.06 points out of 30, which means that the on average, students failed on the initial specific science knowledge assessment. Nevertheless, after the instruction period had been completed, students significantly improved their results achieving 19.04 points out of 30, which showed that students had higher science knowledge on illnesses and health after the instruction.

On the same lines, if we center our attention on each particular question of the assessment we can also affirm that students have increased their level of expertise on science knowledge on illnesses and health in each type of question. The results from question one reveal that the mean of students improved (from M = 5.52 to M = 8.12) in handling isolated content without transforming the content in any way, which shows that students successfully acquired the required contents. Moreover, the results from question two agree with question one that students showed important progress (from M = 2.71 to M = 5.00) in connecting concepts and ideas. Again in question three the results make it evident that the students performed better (from M = 3.78 to M = 5.93) in thinking about concepts and developing complex conceptual frameworks after the instruction.

The results analyzed in the next phase provide us with valuable information to determine in detail the effect that the IPS instruction designed in an IWBL environment has on the cognitive processes of scanning and processing information. Therefore, the tables below present the means and standard deviations derived from the results taken before and after the instruction received by the students.

With the intention of examining precisely the students' performance of the scanning information skill, six variables have been analyzed. These six variables can be grouped into two main groups: the time spent scanning information and the type of scanning information performed.

Firstly, considering the time spent scanning information, Table 30 shows the mean and standard deviations of the time spent by the students scanning useful information during the completion of each different task recorded before and after the instruction.

Table 30
Differences between initial and final time spent scanning useful information (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	235.54 (95.57)	99.96 (94.47)	-10.27	0.00
Task 2	228.59 (123.69)	98.83 (50.79)	-9.92	0.00
Task 3	46.98 (37.01)	39.56 (27.03)	-1.48	0.14

The results demonstrate that the time that students devoted to scanning useful information to complete the different tasks achievement has changed before and after the IPS instruction designed in an IWBL environment. In fact, the students considerably reduce the time spent scanning useful information in the three tasks proposed. In the first task completed the time spent scanning useful information is the most reduced, the first mean score was 235.54 (SD = 95.57) and the second one was 99.96 (SD = 94.47). In the second task completed the time spent scanning useful information was the second most reduced, the first mean score was 228.59 (SD = 123.69) and the second was 98.83 (SD = 50.79). Finally, despite the fact that in the third task completed, the time spent scanning useful information is the least reduced, the results also show that the time spent scanning useful information decreases again, the first mean score was 46.98 (SD = 37.01) and the second one was 39.56 (SD = 27.03). These results indicate that the students devote less to time scanning useful information to complete each task given after the instruction.

Table 31 shows the means and standard deviations of the time spent by the students scanning non-useful information during the completion of each different task recorded before and after the instruction.

Table 31
Differences between initial and final time spent scanning non-useful information (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	304.12 (130.47)	70.37 (80.15)	-15.01	0.00
Task 2	51.38 (55.65)	9.13 (11.63)	-6.91	0.00
Task 3	14.60 (38.73)	4.45 (10.90)	-2.57	0.01

The results reveal that the time that students devoted to scanning non-useful information to complete the different tasks achievement has changed dramatically before and after the IPS instruction designed in an IWBL environment. Indeed, the students noticeably reduced the time spent scanning non-useful information in the three tasks proposed. In the first task developed the time spent scanning non-useful information is the most reduced, the first mean score was 304.12 (SD = 130.47) and the second one was 70.37 (SD = 80.15). In the second task completed the time spent scanning useful information is the second most reduced, the first mean score was 51.38 (SD = 55.65) and the second one was 9.13 (SD = 11.63).

Finally, despite the fact that in the third task completed, the time spent scanning useful information is the least reduced, the results also show that the time spent scanning useful information decreases again, the first mean score was 14.60 (SD = 38.73) and the second one was 4.45 (SD = 10.90). These results indicate that the students devote less time to scanning fragments of text with non-useful information to complete the task given after the instruction.

Table 32 shows the means and standard deviations of the time spent by the students scrolling information during the development of each different task recorded before and after the instruction.

Table 32
Differences between initial and final time spent scrolling information (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	10.11 (11.38)	24.63 (15.95)	7.59	0.00
Task 2	47.20 (27.76)	34.87 (17.76)	-4.29	0.00
Task 3	11.48 (9.47)	12.39 (10.01)	0.61	0.54

The results show that the time that students devoted to scrolling through information to complete the different tasks achievement has changed dramatically depending on the demand of the task after the IPS instruction designed in an IWBL environment. Actually, the students increase the time spent scrolling information in two of the tasks proposed which are the first and the third task. In the first task completed the time devoted to scrolling through information is the most increased, the first mean score was 10.11 (SD = 11.38) and the second one was 24.63 (SD = 15.95). Accordingly, in the third task completed the time spent scrolling through information is slightly increased, the first mean score was 11.48 (SD = 9.47) and the second one was 12.39 (SD = 10.01). Conversely, in the second task completed, the time spent scrolling through information decreases, the first mean score was 47.20 (SD = 27.76) and the second one was 34.87 (SD = 17.76). These results indicate that depending on requirements of the tasks, the students devote more or less time scrolling through information to complete the task given.

Secondly, considering the type of scanning information, Table 33 shows the mean and standard deviations of the number of slides scanned through by the students using lineal reading during the development of each different task recorded before and after the instruction.

Table 33
Differences between initial and final scanned slides using lineal reading (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	12.27 (3.62)	6.39 (3.36)	-11.58	0.00
Task 2	17.54 (8.83)	7.12 (3.51)	-11.02	0.00
Task 3	4.23 (3.20)	2.89 (2.04)	-3.35	0.00

The results show that the number of slides scanned by the students using lineal reading changed before and after the IPS instruction designed in an IWBL environment. Undeniably, the students reduce the number of slides scanned using lineal reading in the three tasks proposed. In the first task completed the number of slides scanned using lineal reading is the second most reduced, the first mean score was 12.27 (SD = 3.62) and the second one was 6.39 (SD = 3.36). In the second task completed the number of slides scanned using lineal reading is the most reduced, the first mean score was 17.54 (SD = 8.83) and the second one was 7.12 (SD = 3.51). Finally, despite the fact that in the third task completed, the number of the scanned slides using lineal reading is the least reduced, the results also show that the number of scanned slides using lineal reading decreases again, the first mean score was 4.23 (SD = 3.20) and the second one was 2.89 (SD = 2.04). These results indicate that the students scanned less slides using lineal reading to complete the task given after the instruction.

Table 34 shows the mean and standard deviations of the number of slides scanned by the students using scanning reading during the completion of each different task recorded before and after the instruction.

Table 34
Differences between initial and final scanned slides using scanning reading (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	1.65 (1.68)	5.16 (3.12)	9.83	0.00
Task 2	7.74 (4.14)	9.88 (4.64)	3.44	0.00
Task 3	2.94 (2.38)	4.05 (2.82)	2.86	0.00

The results show that the number of slides scanned by the students using scanning reading has changed before and after the IPS instruction designed in an IWBL environment. Without a doubt, the students increase the number of slides scanned using scanning reading in the three tasks proposed. In the first task completed the number of slides scanned using scanning reading is the most increased, the first mean score was 1.65 (SD = 1.68) and the second one was 5.16 (SD = 3.12). In the second task completed the number of slides scanned using scanning reading is the second most increased, the first mean score was 7.74 (SD = 4.14) and the second one was 9.88 (SD = 4.64). Finally, despite the fact that in the third task completed, the number of the scanned slides using scanning reading is the least increased, the results also show that the number of scanned slides using scanning reading increases again, the first mean score was 2.94 (SD = 2.38) and the second one was 4.05 (SD = 2.82). These results indicate that the students scanned more slides using scanning reading to complete the task given after the instruction.

Table 35 shows the mean and standard deviations of the number of slides scrolled through by the students during the development of each different task recorded before and after the instruction.

Table 35
Differences between initial and final scrolled slides (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	8.96 (10.67)	22.82 (14.34)	7.79	0.00
Task 2	43.18 (25.34)	32.01 (16.82)	-4.12	0.00
Task 3	11.15 (8.70)	11.45 (8.40)	0.23	0.82

The results show that the number of slides scrolled through by the students to complete the different tasks achievement has particularly changed depending on the demand of the task after the IPS instruction designed in an IWBL environment. In fact, the students increase number of slides scrolled through in two of the tasks proposed which are the first and the third task. In the first task completed the number of slides scrolled through is the most increased, the first mean score was 8.96 (SD = 10.67) and the second one was 22.82 (SD = 14.34). Accordingly, in the third task completed the number of slides scrolled through is slightly increased, the first mean score was 11.15 (SD = 8.70) and the second one was 11.45 (SD = 8.40). Conversely, in the second task completed, the number of slides scrolled through decreases, the first mean score was 43.18 (SD = 25.34) and the second one was 32.01 (SD = 16.82). These results indicate that depending on the demands of the tasks the students scroll through more or less slides to complete the task given.

With the intention of precisely examining the students' performance of the processing information skill, five variables have been analyzed. These five variables can be grouped into two main groups: the time spent processing information and the type of answer given when processing information was performed.

Firstly, considering the time spent processing information, Table 36 shows the means and standard deviations of the time spent by the students processing information during the development of each different task recorded before and after the instruction.

Table 36
Differences between initial and final time spent processing information (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	97.63 (34.77)	65.34 (23.46)	-8.56	0.00
Task 2	333.76 (99.79)	244.57 (62.81)	-7.31	0.00
Task 3	217.98 (107.28)	171.09 (55.45)	-3.74	0.00

The results reveal that the time that students devoted to processing information to complete the different tasks achievement has particularly changed before and after the IPS instruction designed in an IWBL environment. The students noticeably reduce the time spent processing information in the three tasks proposed. In the first task completed the time spent processing information is the least reduced, the first mean score was 97.63 (SD = 34.77) and the second one was 65.34 (SD = 23.46). In the second task completed the time spent processing information is the most reduced, the first mean score was 333.76 (SD = 99.79) and the second one was 244.57 (SD = 62.81). Finally, the time spent processing information in the third task completed is the second most reduced, the first mean score was 217.98 (SD = 107.28) and the second one was 171.09 (SD = 55.45). These results indicate that the students devoted less time processing information to complete the task given after the instruction.

Secondly, considering the type of processing information, Table 37 shows the means and standard deviations of the number of correct answers consulted by the students during the completed of each different task recorded before and after the instruction.

Table 37
Differences between initial and final correct answers consulted (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	1.68 (1.72)	3.26 (1.44)	7.50	0.00
Task 2	5.91 (2.92)	9.18 (3.19)	7.78	0.00
Task 3	2.96 (1.74)	3.73 (1.34)	3.19	0.00

The results reveal that the number of correct answers consulted has changed before and after the IPS instruction designed in an IWBL environment. Actually, the students increased the number of correct answers consulted in the three tasks proposed. In the first task developed, the number of correct answers consulted is the second most increased, the first mean score was 1.68 (SD = 1.72) and the second one was 3.26 (SD = 1.44). In the second task completed the number of correct answers consulted is the most increased, the first mean score was 5.91 (SD = 2.92) and the second one was 9.18 (SD = 3.19). Finally, despite in the third task developed, the number of correct answers consulted is the less increased, the results also show that the number of correct answers consulted increases again, the first mean score was 2.96 (SD = 1.74) and the second one was 3.73 (SD = 1.34). These results indicate that the students answer correctly more answers consulted after the instruction.

Table 38 shows the mean and standard deviations of the number of correct answers non-consulted by the students during the completion of each different task recorded before and after the instruction.

Table 38
Differences between initial and final correct answers non-consulted (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	2.79 (1.73)	1.43 (1.29)	-6.86	0.00
Task 2	2.27 (1.86)	4.07 (2.70)	6.49	0.00
Task 3	0.71 (1.12)	0.94 (1.15)	1.36	0.18

The results reveal that the number of correct answers non-consulted has changed before and after the IPS instruction designed in an IWBL environment. In the first task completed the number of correct answers non-consulted decreases, the first mean score was 2.79 (SD = 1.73) and the second one was 1.43 (SD = 1.29). However, in the second and third tasks completed the results change and the number of correct answers non-consulted increase. From both tasks, the one in which the number of correct answers non-consulted is higher is task 1, the first mean score was 2.27 (SD = 1.86) and the second one was 4.07 (SD = 2.70). In task 2 the number of correct answers non-consulted increases again, the first mean score was 0.71 (SD = 1.12) and the second one was 0.94 (SD = 1.15). These results indicate that the students answer more correct answers non-consulted in tasks 2 and 3 after the instruction.

Table 39 shows the mean and standard deviations of the number of incorrect answers consulted by the students during the completion of each different task recorded before and after the instruction.

Table 39

Differences between initial and final incorrect answers consulted (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	0.18 (0.42)	0.10 (0.29)	-1.54	0.13
Task 2	4.09 (2.19)	1.07 (1.15)	-12.29	0.00
Task 3	0.50 (0.86)	0.01 (0.11)	-5.11	0.00

The results reveal that the number of incorrect answers consulted has changed before and after the IPS instruction designed in an IWBL environment. Actually, the students reduce the number of incorrect answers consulted in the three tasks proposed. In the first task completed the number of incorrect answers consulted is the third most reduced, the first mean score was 0.18 (SD = 0.42) and the second one was 0.10 (SD = 0.29). In the second task completed the number of incorrect answers consulted is the most reduced, the first mean score was 4.09 (SD = 2.19) and the second one was 1.07 (SD = 1.15). Finally, in the third task completed, the results also show that the number of incorrect answers consulted decreases again, the first mean score was 0.50 (SD = 0.86) and the second one was 0.01 (SD = 0.11). These results indicate that the students answer incorrectly less answers consulted after the instruction.

Table 40 shows the mean and standard deviations of the number of incorrect answers non-consulted by the students during the development of each different task recorded before and after the instruction.

Table 40

Differences between initial and final incorrect answers non-consulted (N = 82)

Task type	Initial M (SD)	Final M (SD)	t	p
Task 1	0.34 (0.57)	0.22 (0.49)	-1.79	0.08
Task 2	2.73 (2.85)	0.67 (1.35)	-6.04	0.00
Task 3	0.83 (1.50)	0.30 (0.78)	-2.76	0.01

The results show that the number of incorrect answers non-consulted has changed before and after the IPS instruction designed in an IWBL environment. In fact, the students decreased the number of incorrect answers non-consulted in the three tasks proposed. In the first task completed the number of incorrect answers non-consulted is the least decreased, the first mean score was 0.34 (SD = 0.57) and the second one was 0.22 (SD = 0.49). In the second task completed the number of incorrect answers non-consulted is the most decreased, the first mean score was 2.73 (SD = 2.85) and the second one was 0.67 (SD = 1.35). Finally, in the third task completed, the results also show that the number of incorrect answers non-consulted decreases again, the first mean score was 0.83 (SD = 1.50) and the second one was 0.30 (SD = 0.78). These results indicate that the students answer incorrectly less answers non-consulted after the instruction.

Based on the analysis of the results presented in the previous section, six main considerations can be discussed:

a) Students show higher knowledge on illnesses and health after the instruction.

As has been shown in the presentation of the results, students significantly increase the amount of knowledge on illnesses and health after the instruction developed in an IWBL environment. From the three activities that the students had to do in the final assessment of illnesses and health, the three of them were passed by the average of the students after the instruction, whereas before the instruction only the first activity could be considered to be passed by the average of the students. This demonstrates that students have increased their knowledge on illnesses and health after the instruction.

From my point of view, the main reason that can explain the successful results obtained is that thanks to the characteristics of the designed didactic sequence in the IWBL environment the students have achieved better learning outcomes.

The findings obtained are consistent with available literature about this topic in the sense that thanks to the instruction developed in an IWBL environment, students have increased their learning outcomes in scientific knowledge by showing a higher knowledge on illnesses and health after the instruction had been accomplished (Alfieri et al., 2011).

b) The time that students spent scanning and processing information after the instruction is less than before the instruction.

The results from the research completed make it evident that after the instruction the students reduced the time spent developing the two IPS skills for which they were trained which are scanning and processing information.

From my point of view, the main reason that can explain this fact is that after the instruction the students have become more skilled in the performance of scanning and processing information skills. The increase in the students' level of expertise when scanning for information means that they have used more efficient and selective reading strategies that have allowed them to directly locate the relevant information to solve the question given. Consequently the time spent developing scanning for information has decreased. Moreover, the students' higher knowledge on illnesses and health after the instruction could reinforce the results obtained for lower times of processing information skill.

The results obtained are consistent with the Şendurur and Yildirim (2015) results, which state that short scanning times are related with students' use of more efficient and selective scanning strategies allowing them to more directly find the appropriate information to rapidly answer the task proposed. However, the results differ in the skill of processing information from the ones obtained by Hahnel et al. (2016), which indicate that processing significant information to accomplish the task could be associated with extensive processing times.

c) Lineal reading is reduced when students scan information, while scanning technique usage is increased when students scan information after the instruction.

The results obtained in the present research clearly show that after the instruction provided, the students increased the use of scanning techniques to scan information while lineal reading decreases after the instruction received.

A possible explanation of the results obtained is be that because the students have been exposed to different digital texts during the didactic sequence, the students may have started to develop the so-called screen-reading behavior, which is mainly characterized by a growth of the time devoted to scrolling and scanning, while less time is devoted to linear reading (Liu, 2005).

Another possible explanation is that the characteristics of the didactic sequence designed had fostered the students' performance of strategic usage of scanning and processing information skills as was expected. As has been previously described, the didactic sequence wondered (sorry, not sure what you want to say here) to contain the four main features that previous research studies had demonstrated to be effective when teaching students IPS skills. Therefore, the initial session of the instruction was devoted to stimulate students to pay explicit attention to the various steps that had to be taken in IPS and to the way these steps could be used flexibly in different situations (Walraven et al., 2010). Simultaneously, students were asked to connect the organized knowledge base presented with similar representations that refer to personal experiences with representations in other domains. These connected and rich representations are what would make learning outcomes durable, flexible and generalizable in situations of other domains. After the first session, six different cases of IPS that dealt with illnesses and health were progressively presented to the students in order to offer them the possibility to apply the organized knowledge base on IPS in a flexible way. The six real case activities were inquiry-based activities to be solved by developing IPS skills. The way in which the activities were designed offered the students different prompts to scaffold their learning in order to help them to reflect on how to develop a certain IPS skills and construct their own learning. The development of the activities increased in freedom, offering the students less support as they progressed until they performed a whole IPS activity without any scaffolding.

The results obtained are consistent with previous research studies that mention that embedded instruction that promote IPS within inquiry activities is effective for teaching the highly interrelated constituent skills and sub-skills involved in IPS (Raes et al., 2012).

d) Students scroll through less or more information to complete the task given depending on the tasks demands.

The results presented show that the amount of scrolled through information varies depending on the task demands. After the instruction had been completed, students increased the time devoted to scrolling through information and the number of slides scrolled through in tasks one and three but this does not happen in task two where the numbers for scrolling through information decreases.

From my point of view, the main reason that can explain this fact is that after the development of the didactic sequence the students have changed the amount of scrolled through information depending on the demands of the tasks.

The first task presented required the students to answer five multiple choice questions with the help of the slides of information given. Before the instruction, the students generally decided to read all the slides of information in a lineal way before reading what exactly was demanded in each multiple-choice question. After having read all the slides of information, which meant no initial scrolling through of information, they started to read the demand of each multiple choice question and started to answer according to what they have already read. If students did not have a clear idea of was the right answer, they re-consulted the information offered and started to scroll through information. However, after the instruction provided, the strategy that the majority of the students used to answer multiple-choice question completely differed from the beginning.

When task one was presented to the students after the instruction they first carefully read what was demanded in each multiple-choice question and if they did not know the answer they then scanned the text scrolling through the slides of information they considered would not contain useful information to answer the question given. This students' change of strategy increased the amount of slides scrolled through as well as the amount of time spent scrolling through information during task one completion after the instruction.

The second task presented asked the students to fill in a conceptual map in order to relate sixteen concepts of the illness given with the help of the same slides of information given in task one. Before the instruction, the student showed several difficulties in locating the right information to be able to connect the concepts given, so the high incidence of students scrolling through information demonstrated how lost the students were when searching for the useful information. Nevertheless, after the instruction had been given, the students had a higher command of the different possible techniques to be used when scanning information and spent less time scrolling through information than before because the information required to complete the task was located more quickly according to the demands of the task.

Finally, task three required the students to write five specific preventive measures to avoid getting the illness with the help of the slides of information given at the beginning. In this third task, the majority of the students showed a slight increase of the scrolled through information after the instruction had been received. Before the instruction, in task three the students were familiarized enough with the slides of information because they had been working with them in the two previous tasks, so almost the majority of the students knew where they could locate the useful information to complete task three. On the same lines, after the instruction, the students were quite well familiarized with the slides of information. In addition, students' knowledge on illnesses and health had increased which led the students to rapidly scroll through the unnecessary information to answer task three, for this reason there is not a significant difference between the amount of information scrolled through before and after the instruction on task three.

The findings are consistent with available literature on the topic, which states that students usage of scanning information strategies is driven by task demands (Becerril & Badia, 2013; Boutet, Lemieux, Goulet, & Collin, 2017; Şendurur & Yildirim, 2015). In addition, it is important to mention that as the students' level of expertise on IPS increases, the way in which students develop IPS skills to complete different task demands may change.

e) The number of correct answers provided by the students in each task increases, while the number of incorrect answers given by the students in each task decreases after the instruction.

While the number of correct answers provided by the students in each task increased after the didactic sequence had been completed, the number of incorrect answers given by the students in each task decreased, which reveals that the students have better results on processing information after the completion of the didactic sequence.

The improvement between students' results when processing information in all the different tasks proposed after the completion of the didactic sequence means that students have a higher level of expertise in processing information skill when they have to face IPS activities. From my point of view, two main reasons can explain this. The first reason is that thanks to the fact that the teaching of IPS skills has been embedded in the students' curricular content, the skills practiced have become meaningful for students, which has led them to more successfully process the necessary information to solve a new informational problem (Kuiper et al., 2008). The second reason is that, because after the didactic sequence had been completed the students have also increased the amount of knowledge on illnesses and health; when they have had to process the scanned information to solve a new informational problem on illnesses and health, they have developed the skill more successfully than before the didactic sequence. This second reason could mean that students with more knowledge on the domain topic developed the processing skill more successfully.

The results obtained are consistent with Raes et al. (2012) who mentioned that promoting IPS learning within connected inquiry activities is effective for students' improvement of highly interrelated constituent skills and sub-skills involved in IPS. Moreover, further research findings demonstrate that web-based inquiry science environments increase students' learning success as well as on several inquiry skills that have several points in common with IPS skills, such as identifying problems, formulating questions and hypotheses, planning and carrying out experiments, collecting and analyzing data, presenting the results, and drawing conclusions (Mäeots et al., 2008).

f) On numerous occasions task 3 did not obtain significant results.

The results presented demonstrate that while task 1 and task 2 frequently showed significant results, task 3 did not always show noteworthy outcomes.

From my point of view, this fact can be explained by one main reason, which deals with the characteristics of each type of task. Task 1 required students to complete an information integration activity based on solving five different multiple-choice questions. In order to appropriately solve them, the students had to consult the information provided in order to properly answer the questions given. Consistently, task 2 asked students to establish relations between different concepts through a conceptual map construction, which drove students to identify how concepts where connected into the text offered, to later establish proper connections. Opposingly, task 3 did not require students to find specific information in the text since the task was mainly focused on asking students to write five specific preventive measures in order to avoid getting the illness previously described in the text given. The main reason students did not spend time scanning information was that this concrete information was not specifically given in the text. Therefore, they were expected to think about concepts and develop complex conceptual frameworks, instead of expecting them to find the preventive measures in the text.

The characteristics that shape task 3 could explain why this task does not present significant results in certain categories, such as: time spent scanning useful information, time spent scrolling information, number of correct answers non-consulted or number of scrolled slides.

6.6. Research Question 6: Are there any differences in the performance of students' scanning and processing information skills according to students' final science knowledge profile?

In the first step, a hierarchical cluster analysis was conducted to classify students using Ward's method. The analyzed data sets were extracted from the students' final science knowledge. Four final groups of students were selected based on the obtained results.

Table 41
Groups obtained from students' final science knowledge using Ward's method
Students (N=82, 100%)

	Cluster 1 N=37 (45.12%) M (SD)	Cluster 2 N=15 (18.29%) M (SD)	Cluster 3 N=17 (20.73%) M (SD)	Cluster 4 N=13 (15.85%) M (SD)	Significance level
SKA_F_01	8.35 (0.95)	9.67 (0.62)	8.00 (1.12)	5.85 (1.52)	C1 > C4[b]; C2 > C4[b]; C3 > C4[b]; C2 > C1[b]; C2 > C3[b]
SKA_F_02	4.76 (1.12)	7.33 (1.50)	5.18 (0.80)	2.77 (1.20)	C2 > C1[b]; C2 > C3[b]; C2 > C4[b]; C1 > C4[b]; C3 > C4[b]
SKA_F_03	6.97 (1.42)	7.33 (0.90)	3.47 (1.38)	4.54 (1.33)	C1 > C3[b]; C1 > C4[b]; C2 > C3[b]; C2 > C4[b];

[a] $p < 0.05$ [b] $p < 0.01$

Cluster 1 was composed of 37 (45.12%) students, cluster 2 was composed of 15 (18.29%) students while cluster 3 was composed of 17 (20.73%) students and cluster 4 was composed of 13 (15.85%) students. The results differentiating the four main clusters are presented below:

Cluster 1 was labeled as *intermediate level students in science knowledge with acceptable achievement in developing complex conceptual frameworks tasks*. The students that belong to this group are distinguished by having obtained median results when they are required to solve different types of tasks that deal with science content on illnesses and health. In tasks that require them to develop information integration they demonstrate to be much better than students from Cluster 4 but worse than students from Cluster 2. This also happens with tasks that ask them to establish relations between different concepts. Despite the fact of presenting quite similar results to students from Cluster 3 on the above mentioned tasks, when students from Cluster 1 have to think about concepts and develop complex conceptual frameworks, they make fewer mistakes than students from Cluster 3 and so obtain better results.

Cluster 2 was labeled as *high level students of science knowledge*. The students which are included in this group are characterized by being extremely competent students when required to solve different types of tasks that dealt with science content on illnesses and health. The results indicate that students from this group are proficient in developing information integration activities because they almost always correctly answer multiple-choice questions. In addition, during tasks that require students to establish relations between different concepts through a conceptual map construction, students with a high level of science knowledge stand out from the other groups of students. Accordingly, when they are asked to think about concepts and develop complex conceptual frameworks, they also demonstrate remarkable results compared to the other groups of students.

Cluster 3 was labeled as *intermediate level students of science knowledge with low achievement in developing complex conceptual framework tasks*. The students that belong to this group are distinguished by having demonstrated median results when they are required to solve different types of tasks that deal with science content on illnesses and health. In tasks that involve developing information integration activities they demonstrate to be much better than students from Cluster 4 but worse than students from Cluster 2. As also happens with tasks that ask them to establish relations between different concepts. Despite presenting quite similar results to students from Cluster 1 on the above mentioned tasks, when students from Cluster 3 have to think about concepts and develop complex conceptual frameworks, they make more mistakes than students from Cluster 1 and so obtain worse results.

Cluster 4 was labeled as *low level students of science knowledge*. The students which are included in this group are characterized by not having enough knowledge to satisfactory complete different types of tasks that deal with science content on illnesses and health. This fact leads them to be the worst group in completing tasks which require students to develop information integration activities such as answering multiple-choice questions related to illnesses and health. Consistent with it, this group of students also does not succeed establishing relations between different concepts when a conceptual map construction is asked, being again the group which presents lowest results. Finally, together with students from Cluster 3, *low leveled students of science knowledge* are also the ones who present the poorest results when asked to think about concepts and develop complex conceptual framework on the field of study of illnesses and health.

Then, the second step consisted of comparing those clusters of cases with data from the students' performance of scanning and processing information skills for each type of final task.

This first section provides a comparison of the students' profile in the performance of the scanning and processing information skills in the final task 1.

Table 42

Clusters solutions derived from students' performance on task 1

Students (N=82, 100%)

	Cluster 1 N=37 (45.12%) M (SD)	Cluster 2 N=15 (18.29%) M (SD)	Cluster 3 N=17 (20.73%) M (SD)	Cluster 4 N=13 (15.85%) M (SD)	Significance level
Time scanning useful information	103.73 (101.03)	58.33 (31.95)	104.41 (107.09)	131.46 (99.13)	C4 > C2[b]
Time scanning non-useful information	74.30 (81.78)	25.60 (21.75)	71.71 (90.92)	109.08 (86.93)	C1 > C2[a]; C4 > C2[b]
Time scrolling information	25.65 (16.91)	29.73 (15.99)	22.47 (14.38)	18.69 (14.31)	
Number of slides lineally read	6.70 (4.06)	5.67 (2.77)	5.94 (2.95)	6.92 (2.25)	
Number of slides scanned	5.16 (3.09)	5.47 (2.61)	4.71 (3.39)	5.38 (3.70)	
Number of slides scrolled	24.22 (14.27)	28.80 (16.55)	19.12 (11.73)	16.77 (12.85)	
Time processing information	65.92 (18.57)	52.60 (16.90)	72.24 (35.74)	69.38 (18.90)	C1 > C2[a] ; C3 > C2[a]; C4 > C2[a]
Number of correct answers consulted	3.57 (1.26)	3.93 (1.28)	2.65 (1.27)	2.38 (1.76)	C1 > C3[a] ; C1 > C4[a]; C2 > C3[b]; C2 > C4[a]
Number of correct answers non-consulted	1.14 (1.21)	1.07 (1.28)	1.82 (1.13)	2.15 (1.46)	C3 > C1[a] ; C4 > C1[a]; C3 > C2[a]; C4 > C2[a]
Number of incorrect answers consulted	0.14 (0.35)	0.00 (0.00)	0.12 (0.33)	0.08 (0.28)	
Number of incorrect answers non-consulted	0.16 (0.44)	0.00 (0.00)	0.41 (0.71)	0.38 (0.51)	C3 > C2[a] ; C4 > C2[b]

[a] $p < 0.05$ [b] $p < 0.01$

As Table 42 shows, the results state that students from cluster two are the ones who spent less time scanning information whether useful or non-useful in task one. According to the time spent scanning useful information in task one, the results show that students from cluster four spent much more time scanning non-useful information in task one (M = 131.46) than students from cluster two (M = 58.33). According to the time spent scanning non-useful information in task one, the results show that students from cluster two spent much less time scanning non-useful information in task one (M = 25.60) than students from cluster four (M = 109.08) or students from cluster one (M = 74.30).

In addition, the results reveal that student from cluster two are the ones who spent less time processing information in task one. While students from cluster two are the ones who spent less time processing information (M = 52.60), students from cluster one (M = 65.92), students from cluster four (M = 69.38) and students from cluster three (M = 72.24) spent longer times processing information.

Regarding the number of correct answers consulted, the students from cluster two present the highest number of correct answers consulted (M = 3.93) while students from cluster four present the lowest number of correct answers consulted (M = 2.38). However, the students from cluster four presented the highest number of correct answers non-consulted (M = 2.15) in task one as well as the highest number of incorrect answers non-consulted (M = 0.38), while the students from cluster two presented the lowest number of correct answers non-consulted (M = 1.07) in task one as well as the lowest number of incorrect answers non-consulted (M = 0.00).

This second section provides a comparison of the students' profile in the performance of the scanning and processing information skills in the final task 2.

Table 43

Clusters solutions derived from students' performance on task 2

Students (N=82, 100%)

	Cluster 1 N=37 (45.12%) M (SD)	Cluster 2 N=15 (18.29%) M (SD)	Cluster 3 N=17 (20.73%) M (SD)	Cluster 4 N=13 (15.85%) M (SD)	Significance level
Time scanning useful information	106.14 (56.67)	62.07 (23.53)	90.00 (46.71)	132.00 (32.72)	$C1 > C2^b$; $C4 > C1^a$; $C3 > C2^a$; $C4 > C2^b$; $C4 > C3^a$
Time scanning non-useful information	7.65 (9.98)	7.47 (10.84)	8.88 (12.07)	15.62 (15.10)	$C4 > C1^a$
Time scrolling information	36.81 (18.60)	32.20 (11.46)	33.53 (14.71)	34.15 (25.03)	
Number of slides lineally read	7.38 (3.68)	4.40 (1.68)	6.76 (2.80)	10.00 (3.22)	$C1 > C2^b$; $C3 > C2^b$; $C4 > C2^b$; $C4 > C3^b$
Number of slides scanned	10.78 (5.14)	8.33 (4.07)	7.71 (3.72)	11.92 (3.50)	$C1 > C3^a$; $C4 > C2^a$; $C4 > C3^b$
Number of slides scrolled	34.41 (17.86)	29.73 (11.75)	30.35 (14.30)	30.00 (22.10)	
Time processing information	246.11 (66.40)	221.20 (32.49)	252.35 (51.50)	257.00 (87.68)	
Number of correct answers consulted	9.32 (3.07)	9.87 (3.11)	8.53 (3.36)	8.85 (3.60)	
Number of correct answers non-consulted	4.11 (2.58)	4.40 (3.04)	4.65 (2.94)	2.85 (2.19)	
Number of incorrect answers consulted	0.89 (0.84)	0.67 (1.05)	1.18 (1.33)	1.92 (1.44)	$C4 > C1^a$; $C4 > C2^b$
Number of incorrect answers non-consulted	0.68 (1.03)	0.07 (0.26)	0.65 (1.17)	1.38 (2.50)	$C1 > C2^a$; $C3 > C2^a$; $C4 > C2^a$

^{a} $p < 0.05$ ^{b} $p < 0.01$

The results presented on Table 43 show that students from cluster two are the ones who spent the least time scanning useful information in task two (M = 23.53).

Regarding the number of slides lineally read, the results show that students from cluster one (M = 7.38) and cluster four (M = 10.00) scanned a higher amount of information in a lineal way than students from cluster two (M = 4.40) did in task two. As also happens with the amount of information scanned by using scanning techniques in task two, students from cluster one (M = 10.78) and cluster four (M = 11.92) also scanned a higher number of slides while students from cluster two (M = 8.33) and cluster three (M = 7.71) did not.

Regarding the number of incorrect answers given in task two, students from cluster two demonstrate less incorrect answers whether consulted or non-consulted than the other clusters. Regarding the incorrect answers consulted, the students from cluster four showed the highest number of incorrect answers consulted (M = 1.92) while students from cluster two showed the lowest number of incorrect answers consulted (M = 0.67). Regarding the incorrect answers non-consulted, the students from cluster two showed the lowest number of incorrect answers non-consulted (M = 0.07) in task two, while the students from cluster four presented the highest number of incorrect answers non-consulted (M = 1.38) in task two.

This third section provides a comparison of the students' profile in the performance of the scanning and processing information skills in the final task 3.

Table 44
Clusters solutions derived from students' performance on task 3
Students (N=82, 100%)

	Cluster 1 N=37 (45.12%) M (SD)	Cluster 2 N=15 (18.29%) M (SD)	Cluster 3 N=17 (20.73%) M (SD)	Cluster 4 N=13 (15.85%) M (SD)	Significance level
Time scanning useful information	40.81 (22.08)	39.13 (34.38)	42.29 (34.35)	32.92 (21.36)	
Time scanning non-useful information	4.00 (10.98)	5.73 (12.60)	4.65 (12.46)	4.00 (6.78)	
Time scrolling information	13.24 (11.32)	14.73 (11.90)	10.82 (7.56)	9.31 (5.30)	
Number of slides lineally read	3.05 (2.21)	2.47 (1.81)	2.94 (2.08)	2.85 (1.95)	
Number of slides scanned	4.30 (3.05)	4.13 (3.00)	4.06 (2.70)	3.23 (2.20)	
Number of slides scrolled	12.57 (9.57)	12.53 (9.67)	9.94 (6.47)	9.00 (4.69)	
Time processing information	163.49 (44.11)	193.27 (57.17)	182.24 (65.46)	152.54 (63.63)	
Number of correct answers consulted	3.84 (1.30)	3.67 (1.63)	3.94 (1.14)	3.23 (1.36)	
Number of correct answers non-consulted	0.92 (1.19)	1.20 (1.47)	0.76 (0.75)	0.92 (1.19)	
Number of incorrect answers consulted	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.08 (0.28)	
Number of incorrect answers non-consulted	0.22 (0.75)	0.13 (0.35)	0.29 (0.59)	0.77 (1.24)	

[a] $p < 0.05$ [b] $p < 0.01$

The analysis presented on Table 44 did not find significant relations between the different clusters according to the performance of the scanning information skill and processing information skill in task 3, which asks students to write five specific preventive measures to avoid getting the illness with the help of the slides of information given.

Based on the analysis of the results presented in the previous section, three main considerations can be discussed:

a) In task 1 performance students from cluster two demonstrate less scanning and processing times but more correct consulted answers and less incorrect non-consulted answers than other clusters.

The results demonstrate that students from cluster four, who are characterized by having lower average final science knowledge, spent much more time scanning non-useful information in task one than students from cluster two, who are characterized by being the students with the highest average final science knowledge. In addition, the students from cluster two showed the highest number of correct answers consulted while students from cluster four showed the lowest number of correct answers consulted.

From my point of view, this could be because students from cluster four have not developed the necessary abilities enough to find the appropriate information that they are searching four, while students from cluster two are efficient at scanning information to later answer properly the questions from task one.

Coherently, the students from cluster four presented the highest number of correct answers non-consulted in task one as well as the highest number of incorrect answers non-consulted, while the students from cluster two presented the lowest number of correct answers non-consulted in task one as well as the lowest number of incorrect answers non-consulted.

This fact could be explained due to the reason that students from cluster two did not consider answering task one, which required answering multiple choice questions, without scanning the proper information needed in order to be sure in the selection of the right question unless they already knew the answer from previous knowledge. However, students from cluster four, who had more difficulties when scanning the proper information to answer the questions, chose the possibility of answering the multiple choice questions from task one without knowing for certain if the answers are correct or not, which leads them to more non-consulted correct answers and non-consulted incorrect answers.

b) In task 2 performance students from cluster two demonstrate less scanning and less incorrect answers than other clusters.

The results demonstrate that students from cluster one and cluster four devoted more time to scanning useful information while students from cluster two did not, which could be explained by the fact that students from cluster two had scanned the useful information in the previous task and did not need to do it in the following tasks. Accordingly, the results show that students from cluster one and cluster four scanned a higher amount of information in a lineal way than students from cluster two did in task two. As also happens with the amount of information scanned by using scanning techniques in task two, students from cluster one and cluster four also needed to scan a higher number of slides while students from cluster two and cluster three did not.

From my point of view, this fact could be explained in first place due to the fact that students from cluster two know where to find the information since the text has been analyzed by them in the first task, or in second place due to the fact that students from cluster three did not find the need to do it because they had already found the information by using lineal reading.

Consistently with what has been said in task two, which required students to scan the proper information to fill in a conceptual map, students from cluster two are the students who showed the lowest number of incorrect answers consulted and non-consulted, while students from cluster four are the ones that present the highest number of incorrect answers consulted and non-consulted, which again reflects the problems they have when searching for the proper information.

c) Non-significant relations were found between the different clusters in task 3.

The analysis did not find significant relations between the different clusters according to the performance of the scanning information skill and processing information skill in task three, which asks students to write five specific preventive measures to avoid getting the illness with the help of the slides of information given.

This information could indicate that when students are required to complete task three, the students are familiarized enough with the slides of information because they have been working with them in the two previous tasks, so the majority of the students, even the weaker ones, know where they can locate the useful information to complete task three.

7. Conclusions

With the intention to expand further on academic knowledge available about students' IPS process development, the main aim of the present research has been to analyze the relation among certain students' individual characteristics and students' performance of scanning and processing information skills through an instruction developed in a science IWBL environment called WISE. Taking into account all the literature that has been presented above, as well as the results from the empirical analyses, this section will present the conclusions of this investigation according to the six specific objectives described before:

Objective 1: to determine if there are any differences between the two genders in relation to the different individual students' variables.

The results obtained in the research for this objective allow drawing two main conclusions that will be more carefully developed below.

The first conclusion is that slight differences exist between males and females in some individual aspects related to the learning of sciences through inquiry.

Specifically, male participants have demonstrated to be slightly better than female participants in three specific items of certain individual aspects obtained throughout the different measuring instruments. First, regarding the differences between students' reading skills, male participants have demonstrated to be better than female participants in one of the three items considered, which deals with answering reading questions that demanded text reflection of content and form of them. Secondly, regarding the differences between students' ICT skills, the male participants have demonstrated to be better than the female participants are in just two of the seventeen items considered, which deal with being able to use ICT to appropriately process the obtained information and with being able to set up a printer. Thirdly, regarding the differences between students' previous and final science knowledge, male participants have demonstrated to be better than female participants in the global results of assessment.

This conclusion is consistent with available literature on the topic which suggests that there might be certain differences among both genders in relation to certain individual characteristics. For instance, O'Reilly and McNamara (2007) who examined how well cognitive abilities predicted high school students' science achievement observed that male students scored higher on scientific knowledge and on reading comprehension. To be more specific, in terms of the format of questions and differences in gender on content-based assessments, males were shown to score higher on both multiple choice and open-ended questions than females.

In the same vein, Halpern et al. (2007) observed that females were found to have a tendency to do extremely well in verbal skills, while males did better than females on most measures of visuospatial skills. The authors concluded that females' advantage in verbal skills allows them to be successful in all educational domains, whereas males' advantage in visuospatial skills allows them to better complete standardized exams in mathematics and science. However, the authors concluded that early experience, educational policy, biological factors, and cultural context influence the amount of women and men who pursue higher studies in science and math and that these effects work together in complex ways, which may indicate that there are no single responses to the multifaceted questions about gender differences in science and mathematics.

In accordance with the reflection of previous authors, but in opposition to the results obtained from the current research, other recent research studies, which focused on gender differences and academic achievement, found female students to be better than male students in scientific and technological knowledge achievement despite the fact that the self-concept of their knowledge on the field of study was lower than male students (Sáinz & Martínez-Cantos, 2016; Schoon & Ng-Knight, 2017).

The second conclusion that has emerged from the previous objective is that both genders succeeded and passed the final science knowledge assessment after the instruction had been received.

Because both genders improved their final mark compared to the initial one and were able to pass the final science knowledge assessment with merit, this data may support the fact that the instruction received by the students about IPS embedded in science curricular content and developed in an IWBL environment, was effective for both groups of students independently of their gender.

The second conclusion drawn is consistent with available literature on the topic, which states that thanks to an IPS instruction embedded in science curricular content and developed in an IWBL environment, students have increased their learning outcomes in scientific knowledge by showing greater knowledge of the worked topic after the instruction has been accomplished. For instance, Alfieri et al. (2011) who compared the IBL model to different models of teaching and learning, such as the transmission or discovery models, revealed that students who had been instructed trough the IBL model achieved better learning outcomes at the end of the teaching and learning process. Consistently, Argelagós and Pifarré (2012) also confirmed that the teenagers in secondary education who received an IPS instruction embedded in the science curriculum had positive results when developing IPS skills. More precisely, the results determined that participants demonstrated to have greater marks on task performance than the participants who belonged to the control group.

Before closing the reflection point of this first objective, it is worth mentioning that the small differences presented between the two genders might be statistically but not practically meaningful, since both genders succeed satisfactorily and pass the science final knowledge assessment after the instruction received. This reasoning could be coherent with Halpern et al. (2007), who mentioned that previous experience, biological conditions, educational guidelines, and cultural background have effects, and these effects may interact in complex and occasionally unpredictable ways, as could have happened in the current research study.

Objective 2: to determine the relations established between students' individual characteristics and students' performance when scanning information.

The main conclusion to be taken from the objective pursued is that there are not numerous significant positive correlations between students' individual skills and their achievement when performing the scanning information skill.

Despite the lack of numerous significant correlations between students' scanning information skill performance and students' individual characteristics, three correlations can be highlighted.

Firstly, students' reading skill seems to be related with the way in which students develop scanning skill, when they are required to answer an activity which mainly asks them to connect concepts and ideas from a given text in order to create a partly constructed conceptual map. This statement is consistent with some previous investigations such as the one developed by Hahnel, Goldhammer, Naumann and Kröhne (2016) who mentioned that students who were skilled in reading linear texts were estimated to understand and relate important concepts presented on nodes in the hypertexts. Additionally, Salmerón et al. (2017) mentioned that expert readers scanned more rapidly and revisited sections of the hypertext that did not have relevant information fewer times, particularly in integrated questions. Nevertheless, Potocki et al. (2017) specify that in their research study the differences evidenced in students' strategies performance were not linked to the participants decoding of comprehension skills but rather to their knowledge of reading strategies.

Secondly, students' ICT skill is only correlated with students' scanning information skill performance, since only the students' information literacy category seems to be correlated to the amount of information scrolled through when students are required to handle isolated information without transforming the content in any way and when students had to connect concepts and ideas from more than one information source building a conceptual map. This fact indicates that from the different items which form the ICT skill the one which has a significant relationship with the IPS skills analyzed is the information literacy skill, because it deals with the ability of the students to identify information needs, assess information quality, manage information, use information effectively and ethically and create and communicate knowledge through the application of information (Lau & Yuen, 2014).

Coherent with this second relation, but opposite to the main conclusion drawn from the second objective, the results obtained by Coiro (2011) suggested that students reading skills and ICT skills were essential prerequisites for useful digital reading since data showed that skilled readers with ICT skills were better at locating information from hypertext. However, there are not enough research studies that focus their attention on the possible relationships between students' ICT skills and their IPS task performance to establish more relations or differences with previous research studies (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

Finally, students' previous knowledge seems to be correlated to the amount of information scrolled through and scanned by students when are asked to handle isolated information without transforming the content in any way, since students with excellent previous knowledge use more scanning strategies to develop the previously mentioned activity because they know where to locate the information they are searching for, and they do not need to read all the information given to solve the task in a linear way.

The findings drawn from this third relation agree with earlier investigations which state that there could be a close relation between students' previous knowledge and their decisions when selecting a particular piece of information (Rouet et al., 2011). For instance, Wood et al. (2016) examined how students' previous domain knowledge and students' level of expertise in search skills influenced the way in which students scanned information on the Internet. Data revealed that the combination of high search expertise and high previous domain knowledge produced the most effective searches since students with higher previous domain knowledge used the sites more thoroughly. Consistently, students who have less previous knowledge may be more limited to effectively performing a different problem-solving process which could mean that they do not use scanning strategies since they feel the need to linearly read each piece of information provided to solve the task suggested (Kim & Hannafin, 2011).

Before closing reflections on the second objective, it is relevant to remember that the main conclusion driven from this objective is that no significant positive correlations between students' individual skills and their achievement when performing the scanning information skill have been found.

Objective 3: to determine the relations established between students' individual characteristics and students' performance when processing information.

From the third specific objective, one main conclusion can be drawn, which is that there are not numerous significant relations between students' individual skills and their achievement when processing information skill performance. Despite the non-presence of numerous significant relations between students' processing information skill performance and students' individual characteristics, two primary relations can be concluded.

Firstly, students' reading skill and students' previous knowledge seem to be the individual skills that have most impact on the students' processing information skill performance especially when students are required to answer an activity which mainly asks them to connect concepts and ideas from a given text in order to create a conceptual map. Consistently, previous research studies have observed similar relations such as Hahnel, Goldhammer, Naumann, & Kröhne (2016) who observed that students who were skilled in reading linear texts were estimated to understand and relate significant concepts presented on nodes in the hypertexts. In addition, Rouet et al. (2011) affirmed that there could be a narrow relationship between students' previous knowledge and their time spent processing information since data revealed that the more previous knowledge participants had, the faster they processed the first search engine page. However, researchers revealed that participants who had higher previous knowledge also had less tendency to use keywords, extracted from the search problem statements in their initial search and during the following scanning of information.

Second, students' ICT skill only impacts on student' processing information skill performance, only students' information literacy seems to be related to the number of students' correct answers consulted when students are asked to answer a question that requires them to handle isolated information without transforming the content in any way and to connect concepts and ideas from more than one information source in a simple fashion such as a conceptual map. According to Lau and Yuen (2014), the fact that few relations have been found may happen because from the different items which form the ICT skill the one which has a major relation with the IPS skills analyzed is the information literacy skill which is closely related to IPS process because it deals with the capacity of the students to identify information needs, assess information quality, manage information, use information effectively and ethically and create and communicate knowledge through the application of information.

The conclusion drawn is consistent with previous empirical research studies which state that students with powerful, necessary computer skills were able to find, access, and relocate information in digital environments, indirectly supporting their comprehension of digital text (Goldhammer et al., 2014; Hahnel et al., 2016; Naumann, 2015). However, there are not sufficient research studies that centre their interest on the potential relationships between students' ICT skills and their IPS task development to establish more relations or differences with previous research studies (Hahnel, Goldhammer, Naumann, & Kröhne, 2016).

Contrary to the main conclusions derived from the last two objectives which state that no significant correlations have been found among students' individual skills and students' performance of scanning and processing information skills performances, Brand-Gruwel et al. (2005) mentioned the relevance of considering conditional skills and regulatory skills when developing an IPS process since they could influence the development of the central cognitive skills.

Coherently, one last reflection has to be made, which is that because no numerous significant relations between students' individual skills and their achievement when scanning and processing information skill performance emerged, the results may indicate that the difference in students' scanning and processing information skill performance between before and after the instruction received by the students is not influenced by the students' individual skills but seems to be influenced by the instruction received based on IBL environment. This reflection made, together with the ones that will be below presented, in relation to further research objectives, may reveal a relevant fact, which is that the instruction designed helps students to improve the performance of the scanning information skill regardless of the individual characteristics of the students.

Objective 4: to determine the relations established between students' scanning information skill performance and students' processing information skill performance in different types of tasks.

The main conclusion extracted from the fourth specific objective is that high correlations between numerous categories of scanning information skill performance and processing information skill performance have been found.

From my point of view, the main explanation for this fact is that students' development of constituent skills is highly related by the way in which different constituent skills are developed according to the type of task. This conclusion supports the findings obtained by previous researchers who suggest that the IPS skills can be used by the students according to the diverse necessities of the assignment and according to the requirements that the task demands (Monereo & Badia, 2012; Şendurur & Yildirim, 2015).

Additionally, another conclusion driven from this objective is that certain categories have shown to be correlated in the same way in two or in three types of tasks, while there are other categories which do not show correlations in any task or just in one task. From them, three main outstanding correlations have been discussed.

The first correlation found revealed that students who do not use scanning techniques to scan information spend more time scanning information in order to find the right information to achieve the aim of the task proposed. In the present investigation the main reason that can explain this fact is that students with higher times scanning useful and useless information also have a higher number of slides lineally read which may mean that the students who do not use scanning techniques to scan information spend more time scanning information in order to find the right information to achieve the purpose of the task proposed. This reasoning is consistent with previous research studies developed, since according to Salmerón, Naumann, García, and Fajardo (2017), students who use scanning techniques scan quicker and revisit segments of the hypertext that did not contain relevant information less often.

The second correlation found was that students who do not use scanning techniques to scan information take longer to understand what the information that has to be found in order to successfully answer the tasks proposed is, which means that as the amount of time that the students spend developing scanning techniques increases, so does the number of correct answers consulted, but the number of correct answers non-consulted decreases. This fact may indicate that students, who use scanning techniques to scan information, scan information bearing in mind the question to be answered, something that does not happen with the students who read the slides lineally who start scanning the information given without bearing in mind what they need to find. After reviewing the literature, it was found that this relationship did not appear before in any other investigation.

The third correlation to be highlighted is that students with longer times of processing information show better outcomes when conceptual maps construction and specific writing are required. In more complicated tasks that require the students to connect concepts and ideas from more than one information source and to think about concepts in order to develop complex conceptual frameworks, it has been shown that as the students dedicate more time to processing information the number of correct answers consulted increases and the number of incorrect answers non-consulted decreases. This fact indicates that students with longer times of processing information show better achievement when conceptual map construction and specific writing development is required, which is connected with the results obtained by previous researchers who indicate that processing significant information to accomplish the task given could be associated with extensive processing times (Hahnel, Goldhammer, Naumann, & Kröhne, 2016). Consistently, Walhout et al. (2015) mentioned in the results obtained from their study that deeper processing of information needed for the fulfillment of the information required in task was reflected in longer viewing times of web pages.

Regarding task complexity, the results obtained are consistent with the ones presented by Becerril and Badia (2015) who mentioned that in a more cognitively complex task, the students showed higher performance levels in the information search, browsing and development skills.

Objective 5: to identify the difference between the students' initial and final learning performance.

The main conclusion that can be extracted from the established objective is that there are numerous significant differences between students' initial and final learning performance. The students' improvement shown through data collected allows us to confirm that the instruction designed to improve students' IPS skills embedded in science curricular content and designed in an IWBL environment has been tremendously successful since all the students have improved the learning performance of both, science knowledge on illnesses and health, and IPS skills performance.

The results obtained from the fifth specific objective initially established in the investigation were classified into two main branches. The first branch included the results that stated the difference between students' initial and final science knowledge on illnesses and health, while the second branch included the results that stated the difference between students' initial and final IPS performance.

Considering this division on students' learning outcomes, the general conclusion can give place to two more specific conclusions. The first is that, thanks to the instruction developed in an IWBL environment, students increase their learning outcomes in scientific knowledge by showing a higher knowledge of scientific content, which confirms the results obtained by other researchers who stated that inquiry learning was a successful methodology to promote students learning of scientific content (Alfieri et al., 2011).

Simultaneously, the results obtained are consistent with the results that Thoron and Myers (2012) presented, which stated that students who had been taught with IBL environments scored higher on content knowledge assessments as compared to students who were taught through traditional methods. Zhang and Quintana (2012), who also examined the differences between students that learned sciences through a regular method and other who learned through an IWBL environment, revealed that the inquiry strategies implemented in the software were effective to improve students' learning performance.

Consistently, Becker, Klein, Gößling and Kuhn (2019) also highlighted the participants' improvement in science learning after participating in the instruction designed. More concretely, the authors investigated, in real classroom settings, how mobile devices could be used to augment inquiry-based learning processes in science content, the results revealed that students had greater conceptual knowledge on the field of study which dealt with physical experiments.

The results obtained in the Buckner and Kim (2014) research study also coincided with the previous results found. The purpose of their research was to integrate ICT and inquiry-based pedagogies in classroom settings by using a software called: Stanford Mobile Inquiry-based Learning Environment (SMILE). The data collected demonstrated that the integration of ICT and inquiry based pedagogies effectively encouraged student questioning and changed student-teacher dynamics in class. However, they also found out that school and country contexts influenced students' initial abilities to form profound inquiries, and SMILE was more complicated to apply in regions where memorization pedagogies were common.

The second specific conclusion that emerges from the results is that students improve their performance of IPS skills after the instruction developed on an IWBL environment, which demonstrates that the results derived from the investigation are consistent with the results presented by Raes et al. (2012) who mention that promoting IPS learning within connected inquiry activities is useful for students' improvement of highly interrelated constituent skills and sub-skills involved in IPS. As well, Mäeots et al. (2008) earlier supported the idea that web-based inquiry science environments increase students' learning achievement as well as on several inquiry skills that have several points in common with IPS skills.

One of the most outstanding indicators of students' IPS skills improvement, that confirm the previously drawn conclusion, were the results which revealed that the time that students spent scanning and processing information after the instruction was less than before the instruction, since as Şendurur and Yildirim (2015) stated, short scanning times are related with students use of more efficient and selective scanning strategies allowing them to find the appropriate information straightaway, and to answer the task proposed more quickly. Conversely, the results differ in the skill of processing information from the ones obtained by Hahnel et al. (2016), which state that processing significant information to accomplish the task could be associated with long processing times.

Another group of results to be highlighted that support the previous conclusion were the ones that demonstrate that students had a higher level of expertise after the instruction because lineal reading was reduced when students scan information, while scanning techniques usage was increased when students scanned information. This indicator coincides with the explanation made by Liu (2005), who mentions that when students are exposed to different digital texts, such as has happened during the instruction, the students start to develop the so-called screen-reading behavior, which is mainly characterized by a growth of the time devoted to scrolling and scanning, while less time is devoted to linear reading demonstrating in this way a higher domain of IPS skills usage.

Furthermore, the last strong sign that supports the conclusion established is the fact that students increase the number of correct answers given in each task and also they decrease the number of incorrect answers given, which is what Argelagós and Pifarré (2012) also found in their investigation, since it was concluded that the experimental students who had been instructed through an IWBL environment displayed better task performance than control students who were not. Mason et al. (2014) also demonstrated that students who received an IPS based on inquiry tasks development performed better than the others in the inquiry task of the instructional context and in the transfer inquiry task, since they showed more suitable navigation behavior and better source assessment, in addition to higher surface and more profound comprehension of the consulted information.

Consistent with the conclusions derived from this point, Frerejean et al. (2019) mention that participants who had received the instruction searched for and selected information more systematically in the short term. However their search query sources and answers were not significantly higher than the ones obtained from the participants who did not take the specific instruction and attended the regular course. In addition, participants' progress was not noticeable after five weeks since the instruction ended.

Objective 6: to describe the main differences in students' scanning and processing information skills performance in each type of final task, according to students' final science knowledge profile.

This investigation found the appearance of four differentiated students' profiles regarding students' science final knowledge. The four profiles obtained were given a name according to the students' level domain of science final knowledge on illnesses and health.

If the clusters are presented according to an ascending graduation of students' level domain of science final knowledge on illnesses and health, the first cluster to be mentioned is the cluster 4, which was labeled as *low level students of science knowledge*. Then, students from cluster 3 were labeled as intermediate *level students of science knowledge with low achievement in developing complex conceptual framework tasks*. After them, students from cluster 1 were labeled as *intermediate level students of science knowledge with acceptable achievement in developing complex conceptual framework tasks*. Finally, students from cluster 2 were labeled as *high level students of science knowledge*.

Considering the previous ascending graduation, the first students' profile described were *low level students of science knowledge*. These students are characterized by being students that do not have enough knowledge to satisfactorily complete different types of tasks that deal with science content on illnesses and health.

The second students' profile can be placed above previous students' level and thus be named *intermediate level students of science knowledge with low achievement in developing complex conceptual framework tasks*, since they are characterized by being students who have demonstrated average results when they are required to solve different types of tasks that deal with science content on illnesses and health. They make numerous mistakes when they have to develop a task which requires them to think about concepts and develop complex conceptual framework.

The third students' profile is named *intermediate level students of science knowledge with acceptable achievement in developing complex conceptual framework tasks* and they are characterized by being students who have demonstrated medium results when they are required to solve different types of tasks that deal with science content on illnesses and health.

The last students' profile of the graduation, which includes the students with a higher level of expertise, is named *high level students of science knowledge*. Students belonging to this profile are characterized by being extremely competent students when required to solve different types of tasks that dealt with science content on illnesses and health.

Once having specified the main differences between students belonging to different profiles, the attention is focused on how students from different profiles, perform scanning and processing information skills on each type of final task.

In task 1 performance, which consisted in handling isolated information without transforming the content in any way, *high level students of science knowledge* demonstrated lower scanning and processing times but more correct consulted answers and less incorrect non-consulted answers than students from other profiles. However, *low level students of science knowledge* spent much more time scanning non-useful information in task one than advanced domain students. In addition, *high level students of science knowledge* present the highest number of correct answers consulted, while *low level students of science knowledge* present the lowest number of correct answers consulted.

In task 2 performance, which dealt with connecting concepts and ideas from more than one information source in a simple fashion and had a form of a conceptual map with specific concepts, *high level students of science knowledge* demonstrated less scanning and less incorrect answers than other students, while *low level students of science knowledge* and *intermediate level students of science knowledge with acceptable achievement in developing complex conceptual framework tasks* devoted more time to scanning useful information while *high level students of science knowledge* did not. Accordingly, while *low level students of science knowledge* and *intermediate level students of science knowledge with acceptable achievement in developing complex conceptual framework tasks* scanned a higher amount of information in a linear way than *high level students of science knowledge* did. As also happens with the amount of information scanned by using scanning techniques in task two, *low level students of science knowledge* and *intermediate level students of science knowledge with acceptable achievement in developing complex conceptual framework tasks* also needed to scan a higher number of slides while *high level students of science knowledge* and *intermediate level students of science knowledge with low achievement in developing complex conceptual framework tasks*.

In task 3 performance, which required students to think about concepts and develop complex conceptual frameworks, non-significant relations were found between the different students profiles, from which it was concluded that it may be like this because all the students were familiarized enough with the slides of information because they had been working with them in the two previous tasks, so the majority of the students, even the weaker ones, know where they can locate the useful information to complete task three.

After reviewing the literature, it was found that profiles characterizing students' performance of scanning information and processing information skills performance had not appeared before in any other investigation. However, previous research studies have aimed to determine different profiles for other constituent skills of the IPS process. For instance, Castañeda-Peña, Barbosa-Chaccón, Marciales and Barreto (2015) sought to understand university students' information-literacy profiles when searching for information. The results found that three main profiles could be identified in order to differentiate the way in which students searched for information.

Firstly, the Information-Collector Profile included students who were mainly characterized by believing that the truth lies on the Internet and who had an important lack of task planning which leads them to frequently "cut and paste" information. Secondly, Information-Checker Profile included students who were characterized by understanding that the knowledge is not fixed and searched for information on consistent databases. The last profile, named Reflexive Student Profile, included students who assumed that academic tasks were a part of their professional development and carefully started searching for information after previous planning.

The profiles obtained in the previous study mentioned helped researchers to better understand how university students could be helped to improve their searching strategies when information was needed to fulfill a task given, as also happens in the present research study, in which the birth of the different profiles established may allow for the design of future IPS instruction focused on each students' profile.

Generally, the conclusions presented in relation to each one of the learning objectives allow us to state two main conclusions from the present research study.

The first general conclusion is that the instruction designed in an IWBL environment seems to be effective since the students' knowledge on illnesses and health is greater than the students had before the instruction had been received, as well as the students' performance of scanning information and processing information skills performance. Consistently, the fact that the difference in students' scanning and processing information skills performance between the before and after the instruction received is not influenced by the students' individual skills, may demonstrate that the instruction received by the students is the one that has influenced on this difference. This fact may indicate that the instruction designed is valid for the improvement of students scanning and processing information skills regardless of the individual characteristics of the students.

Coherently, the second general conclusion is that data obtained as a whole, may act like opening a door to a new way of understanding and thinking about the processes of IPS. Surprisingly, contrary to what the IPS model suggested by Brand-Gruwel et al. (2005), characterized by describing a sequence of cognitive processes defined by the central cognitive skills as well as the regulatory and conditional skills both involved in the process, we would venture to think that the process is more dynamic and the phases should not be strictly sequential. This emerging way of understanding the IPS process has also been suggested by other authors who say that the IPS skills can be used by the students according to the diverse necessities of the assignment and according to the requirements that the task demands (Badia & Becerril, 2015; Becerril & Badia, 2015; Monereo & Badia, 2012; Şendurur & Yildirim, 2015). Therefore, we might conclude that a good execution of the IPS process could be more influenced by how various constitutive abilities are applied than by the possible individual abilities that could affect the process itself.

8. Limitations

After the conclusions of the investigation have been detailed, the current section aims to collect all the limitations of the research study, considering both the theoretical framework as well as the empirical features.

This study has some limitations. In the first place, it has to be considered that one of the main purposes of the current research study has been to determine how certain individual characteristics of the students are related to students' development of concrete IPS skills. In the current research study the following individual characteristics have been considered: students' reading skills, students' ICT skills, and students' previous knowledge, although there may be other individual factors not considered in the current study that might affect the students' performance when developing IPS processes. Therefore, it could have been interesting to have measured more individual characteristics of the students susceptible of being related to the IPS process despite their not being included in figure 1.

The second limitation to mention is that the research investigation developed has been highly contextualized since the type of task developed by the students; the curricular content and the technology used have been carefully chosen. This is the reason why it could be interesting to develop a larger investigation to apply the study with students from other centers and ages and with other curricular contents to confirm the obtained results in other educational conditions.

Another limitation that might appear is related with the instruments used to collect information. Primarily, the data has been collected using different tests for each student's individual characteristics and non- participant observation for analyzing the scanning information skill development and the processing information skill development. For this reason, a qualitative approach based on interviews and participant observations could have extended the current knowledge beyond the statistical significance obtained and generated a deepness of understanding about the field of study. Additionally, a few recent research studies have begun to use other, perhaps more accurate, data collection tools such as Eye-Tracking technology, which could possibly have brought us more precise information about students' development of scanning and processing information skills performance.

Furthermore, one of the specific objectives presented in the first section of the empirical framework pursued was to determine if there were any differences between the two genders in relation to the different individual students’ variables. However, this objective did not compare students’ performance of scanning and processing information skills with students’ gender, which could have brought to the study additional information regarding the possible relations established between the influence of students individual characteristics and students’ performance when developing scanning and processing information skills as Walhout et al. (2015) did. Nevertheless, their results demonstrated that neither navigational support nor gender was associated with differences in task performance.

Finally, it could have been interesting to develop a new data collection system after a prudential time after the instruction has passed to deeply check if the knowledge achieved by the students lasts or not in time. By this way, it could have been demonstrated if the students had been able to transform the knowledge and skills acquired during the instruction developed, into competencies for acting different authentic contexts even outside the academic one. Frerejean et al. (2019), for instance, demonstrated that carrying out an investigation after the instruction received may demonstrate if the knowledge initially acquired by the students after the instruction lasts or not in time.

9. Future Research Lines

After having considered all the limitations derived from this study, the following paragraphs aim to put forward various future lines of research that may be considered in further investigations.

One primary research line in the field of study of IPS process, should investigate how other individual factors not considered in the current study, might affect the students' performance of each concrete skill of the IPS. Since the results have demonstrated that there are not many relations between the analyzed students' individual characteristics and their performance on certain constituent skills of the process, there might be other individual characteristics of the students that could have an effect on how students develop the IPS process. For instance, it could be interesting to pay special attention to the students' emotions before, during and after solving an IPS task, to find out how these emotions could affect the IPS task fulfillment. In addition, it could also be interesting to consider how the students' familiar background might influence their performance when they are required to solve an IPS task.

Considering the possible relevance that students' individual characteristics may have on their IPS skills performance, a second research line could focus its attention on designing adapted instructional methods to work on IPS process development according to students' individualities. This concreteness could help, on the one hand, students to improve their mastering of the IPS skills considering their specific needs. On the other hand, the results obtained from similar future studies could also provide researchers with valuable data to better adjust the teaching and learning process of IPS skills, which undoubtedly would help teachers to better attend to diversity in the schools.

Despite the fact that in the current research no attention has been paid to the teachers' role in the students' IPS process, it is crucial to highlight the important responsibility that teachers have for the students teaching and learning process. For this reason, a third research line could pay attention to how teachers' performances might influence the whole teaching and learning process of IPS skills development. Analyzing how teachers might provide different strategies to support the process of acquisition of IPS skills by students could be relevant to the teachers' influence on students' performance when executing IPS tasks.

Moreover, since the globalized world we live in is constantly changing and nowadays numerous technologies for teaching and learning processes are frequently emerging, a fourth research line could focus its attention on discovering how students' acquisition of scientific contents might be fostered by using new information and communication technologies. Additionally, it now becomes crucial to identify what works properly with each type of student to better help them in the teaching and learning process, because a specific way of teaching and learning is not valid for all students since they present numerous differences. Considering both, it can be thought that using different emerging educational tools in the teaching and learning process of the students will become crucial to adapt the teaching and learning process to the target student in each case. These emerging tools can also bring us different learning models that would probably fit better with the current society where students have to coexist.

Last of all, a fifth research line that could stem from the current research study is to focus attention on determining relations between the different constituent skills of the IPS processes expected to be employed by students, in order to know how the performance of each constituent skill may affect the execution of another one. If researchers find how students may develop IPS process in a dynamic way without expecting them to follow a sequence of constituent skills to complete the IPS task suggested, it might be possible to learn how to develop a more strategic and efficient IPS task, focused on the specific requirements of the task.

10. Educational implications

After presenting the conclusions, the limitations of this work and the future research lines, it also becomes essential to mention in a few words the various educational implications that originate from the results achieved and the reflections made in the present research. The educational implications are presented considering two main levels: teaching and learning IPS skills, and teaching and learning science in IWBL environments.

- First of all, it has to be considered that one of the main goals of present education is to help students become future citizens who are able to coexist in the society where we live and who are capable of facing the future problems that humanity might have to overcome. Considering this state of affairs, training students in solving different informational problems should be one of the greatest concerns of educators, because being able to solve IPS problems, even outside of the academic context, will make students more proficient at successfully participating in the current civilization. In fact, there are currently many job positions where students are required to solve informational problems satisfactorily. For this reason, proficiency at solving different informational problems will open a new path for students in choosing a job of their choice in the current globalized society.
- Secondly, the results have proven that teaching and learning IPS skills embedded in curricular science content has been a complete success. Therefore, considering previous research studies as well as the data obtained in the present research, teachers have to bear in mind that IPS skills should not be taught as a single content, but rather as a set of skills that support students when learning different curricular contents. For this reason, it is important not only to pay attention to IPS skills in an isolated way, but also to consider

embedding IPS skills instruction in other curricular contents to obtain benefits from the combination of both. By this way, students will acquire a more grounded knowledge since the content will have been acquired in a meaningful context for them.

- Thirdly, data obtained has suggested the possibility of considering IPS process as a dynamic process influenced by the various constituent skills that are applied, rather than a sequential process influenced by the different regulatory and conditional skills. Therefore, it might be interesting to instruct students on how different IPS skills can be employed according to the different tasks requirements in order to better achieve the purpose of the assignment.
- In addition, despite the fact that students' individual characteristics have not been highly correlated with their development of certain constituent skills of the IPS process, there might be other individual characteristics that could affect the students' resolution of IPS process. That is why, in order to attend to diversity in the classrooms, it becomes crucial that teachers take into account the individualities that students might present, because each student is special and unique and what can be valid for some may not be the most appropriate way of learning for others.
- A further important issue that has been considered in this research is teaching and learning science in IWBL environments. The results obtained have demonstrated that teaching and learning science using an IWBL environment is successful for students' learning of science contents that deal with illnesses and health. For this reason it would be of special interest to promote the use of IWBL environments in schools. However, to do so, it becomes crucial to properly instruct teachers on how to design IWBL environments to be used by

their students. Therefore, it could be interesting to offer IWBL courses to teachers to provide them with the possibility of being appropriately instructed on designing and using IWBL environments. These courses might allow teachers to feel more secure when using the digital environment in their classrooms and hence increase their usage.

- Undoubtedly, in relation to what has previously been mentioned before about providing teachers proper instruction to succeed in the design of IWBL environments, making teachers more competent in solving informational problems will allow them to better develop IPS instruction. Therefore, providing current teachers with specific training on the field of study of the IPS is crucial to improve our students' resolution of IPS process. If we do not have expert teachers in IPS resolution, it will be harder to make students more proficient in IPS process resolution.
- Lastly, it has been proven that technology use is highly present in the contemporary world and thus among teachers and students at schools. For this reason it would be of special interest to continue consideration of the implementation of new emerging technologies on teaching and learning IPS skills embedded in science curricular content through inquiry, and even promoting their usage among other teachers that are more reticent to its implementation.

From our perspective, this section has reflected the more significant aspects that might contribute to effectively integrating IPS skills instruction in schools to provide secondary education students with the necessary tools to participate in the changing society in which they live. Additionally, it has also given an overview to the benefits of teaching science in

IWBL environments in order to convert science students into real investigators of the surrounding world.

11. References

Abdi, A. (2014). The Effect of Inquiry-Based Learning Method on Students' Academic Achievement in Science Course. *Universal journal of educational Research*, *2*(1), 37-41. https://doi.org/10.13189/ujer.2014.020104

Alexander, J., & Cockburn, A. (2008, May). An Empirical Characterisation of Electronic Document Navigation. In Proceedings of *Graphics Interface Conference 2008* (pp. 123–130). Windsor: Canadian Information Processing Society.

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does Discovery-Based Instruction Enhance Learning? *Journal of Educational Psychology*, *103*(1), 1–18. https://doi.org/10.1037/a0021017

American Psychological Association. (2010). *Publication manual of the American Psychological Association Sixth Edition*. Washington: American Psychological Association.

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research?. *Educational researcher*, *41*(1), 16-25. https://doi.org/10.3102/0013189X11428813

Argelagós, E. (2012). *Information-problem solving in Secondary Education: analyses of cognitive processes using Web information and their improvement through embedded instruction* (Doctoral dissertation, University of Lleida). Retrived from https://www.tdx.cat/handle/10803/80749.

Argelagós, E., & Pifarré, M. (2012). Improving Information Problem Solving skills in Secondary Education through embedded instruction. *Computers in Human Behavior*, *28*(2), 515–526. https://doi.org/10.1016/j.chb.2011.10.024

Argelagós, E., & Pifarré, M. (2016a). Key information-problem solving skills to learn in secondary education: A qualitative, multi-case study. *Journal of Education and Learning*, *5*(4), 1–14. https://doi.org/10.5539/jel.v5n4p1

Argelagós, E., & Pifarré, M. (2016b). Unravelling Secondary Students' Challenges in Digital Literacy: a Gender Perspective. *Journal of Education and Training Studies*, *5*(1), 42. https://doi.org/10.11114/jets.v5i1.1517

Badia, A., & Becerril, L. (2015). Resolución colaborativa de problemas informacionales y resultados de aprendizaje grupal en la educación secundaria. *Infancia y Aprendizaje*, *38*(1), 67–101. https://doi.org/10.1080/02103702.2014.996403

Badilla Quintana, M. G., Pujol, M. C., & Romani, J. R. (2012). Internet navigation and information search strategies: How do children are influenced by their participation in an intensive ICT project. *International Journal of Technology and Design Education*, *22*(4), 513–529. https://doi.org/10.1007/s10798-011-9158-4

Banchi, H., & Bell, R. (2008). The Many Levels of Inquiry. *Science and Children*, *46*(2), 26–29. https://doi.org/10.1111/j.1600-065X.2008.00760.x.SHP-1

Bar-Ilan, J., & Belous, Y. (2007). Children as architects of web directories: An exploratory study. *Journal of the American Society for Information Science and Technology*, *58*(6), 895–907. https://doi.org/10.1002/asi.20566

Becerril, L., & Badia, A. (2013). La competencia informacional en la Educación Secundaria. Demanda de aprendizaje y resolución colaborativa de problemas relativos a la información con apoyo de las TIC. *Revista de Educacion*, (362), 659–689. https://doi.org/10.4438/1988-592X-RE-2013-362-245

Becerril, L., & Badia, A. (2015). Information problem-solving skills and the shared knowledge construction process: a comparison of two learning tasks with differing levels of cognitive complexity / Habilidades de resolución de problemas informacionales y proceso de construcción compartid. *Cultura y Educación*, *27*(4), 766–801. https://doi.org/10.1080/11356405.2015.1092265

Becker, S., Klein, P., Gößling, A., & Kuhn, J. (2019). Using Mobile Devices to Augment Inquiry-Based Learning Processes with Multiple Representations. *arXiv preprint arXiv:1908.11281.*

Behrens, S. J. (1994). A conceptual analysis and historical overview of information literacy. *College & Research Libraries, 55*(4), 309-322. https://doi.org/10.5860/crl_55_04_309

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational psychologist*, *26*(3-4), 369-398. https://doi.org/10.1080/00461520.1991.9653139

Boutet, I., Lemieux, C. L., Goulet, M. A., & Collin, C. A. (2017). Faces elicit different scanning patterns depending on task demands. *Attention, Perception, and Psychophysics*, *79*(4), 1050–1063. https://doi.org/10.3758/s13414-017-1284-y

Brand-Gruwel, S., Kammerer, Y., van Meeuwen, L., & van Gog, T. (2017). Source evaluation of domain experts and novices during Web search. *Journal of Computer Assisted Learning*, *33*(3), 234–251. https://doi.org/10.1111/jcal.12162

Brand-Gruwel, Saskia, & Stadtler, M. (2011). Solving information-based problems: Evaluating sources and information. *Learning and Instruction*, *21*(2), 175–179.

https://doi.org/10.1016/j.learninstruc.2010.02.008

Brand-Gruwel, S., Wopereis, I., & Vermetten, Y. (2005). Information problem solving by experts and novices: Analysis of a complex cognitive skill. *Computers in Human Behavior*, *21*(3), 487-508. https://doi.org/10.1016/j.chb.2004.10.005

Brand-Gruwel, Saskia, Wopereis, I., & Walraven, A. (2009). A descriptive model of information problem solving while using internet. *Computers and Education*, *53*(4), 1207–1217. https://doi.org/10.1016/j.compedu.2009.06.004

Bråten, I., Strømsø, H. I., & Salmerón, L. (2011). Trust and mistrust when students read multiple information sources about climate change. *Learning and Instruction*, *21*(2), 180–192. https://doi.org/10.1016/j.learninstruc.2010.02.002

Britt, M. A., & Aglinskas, C. (2002). Improving students' ability to identify and use source information. *Cognition and instruction*, *20*(4), 485-522. https://doi.org/10.1207/S1532690XCI2004_2

Bruce, B. C., & Casey, L. (2012). The Practice of Inquiry: A Pedagogical “Sweet Spot” for Digital Literacy? *Computers in the Schools*, *29*(1–2), 191–206. https://doi.org/10.1080/07380569.2012.657994

Bruce, C. (2011). Information literacy programs and research: An international review. *Australian Library Journal, 60* (4), 326–333. https://doi.org/10.1080/00049670.2011.10722652

Buckner, E., & Kim, P. (2014). Integrating technology and pedagogy for inquiry-based learning: The Stanford Mobile Inquiry-based Learning Environment (SMILE). *Prospects*, *44*(1), 99-118. https://doi.org/10.1007/s11125-013-9269-7

Bulu, S. T., & Pedersen, S. (2012). Supporting problem-solving performance in a hypermedia learning environment: The role of students’ prior knowledge and metacognitive skills. *Computers in Human Behavior*, *28*(4), 1162–1169. https://doi.org/10.1016/j.chb.2012.01.026

Campanario, J. M., & Moya, A. (1999). ¿Cómo enseñar ciencias? *Ensenanza de Las Ciencias*, *17*(2), 179–192.

Castañeda-Peña, H., Barbosa-Chacón, J. W., Marciales, G., & Barreto, I. (2015). Profiling information literacy in higher education: traces of a local longitudinal study. *Universitas Psychologica*, *14*(2), 445-458. https://doi.org/10.11144/Javeriana.upsy14-2.pilh

Chevalier, A., Dommes, A., & Marquié, J. C. (2015). Strategy and accuracy during information search on the Web: Effects of age and complexity of the search questions. *Computers in Human Behavior*, *53*, 305–315. https://doi.org/10.1016/j.chb.2015.07.017

Chiu, J. L., & Linn, M. C. (2014). Supporting knowledge integration in chemistry with a visualization-enhanced inquiry unit. *Journal of Science Education and Technology*, *23*(1), 37-58. https://doi.org/10.1007/s10956-013-9449-5

Chu, K. W. S. (2009). Inquiry project-based learning with a partnership of three types of teachers and the school librarian. *Journal of the American Society for Information Science and Technology*, *60*(8), 1671-1686. https://doi.org/10.1002/asi.21084

Chu, S. K. W., Tse, S. K., & Chow, K. (2011). Using collaborative teaching and inquiry project-based learning to help primary school students develop information literacy and information skills. *Library and Information Science Research*, *33*(2), 132–143. https://doi.org/10.1016/j.lisr.2010.07.017

Coiro, J. (2011). Predicting Reading Comprehension on the Internet. *Journal of Literacy Research*, *43*(4), 352–392. https://doi.org/10.1177/1086296X11421979

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative*. Upper Saddle River: Prentice Hall.

Csapó, B., & Funke, J. (2017). *The Nature of Problem Solving: Using Research to Inspire 21st Century Learning Centre for Educational Research and Innovation.* https://doi.org/10.1787/9789264273955-en

De Jong, T., Van Joolingen, W. R., Giemza, A., Girault, I., Hoppe, U., Kindermann, J., ... & Weinbrenner, S. (2010). Learning by creating and exchanging objects: The SCY experience. *British Journal of Educational Technology*, *41*(6), 909-921. https://doi.org/10.1111/j.1467-8535.2010.01121.x

De Jong, T., Weinberger, A., Girault, I., Kluge, A., Lazonder, A. W., Pedaste, M., ... & Geraedts, C. (2012). Using scenarios to design complex technology-enhanced learning environments. *Educational technology research and development*, *60*(5), 883-901. https://doi.org/10.1007/s11423-012-9258-1

De Vries, B., van der Meij, H., & Lazonder, A. W. (2008). Supporting reflective web searching in elementary schools. *Computers in Human Behavior*, *24*(3), 649–665. https://doi.org/10.1016/j.chb.2007.01.021

Dean Jr, D., & Kuhn, D. (2007). Direct instruction vs. discovery: The long view. *Science Education*, *91*(3), 384-397. https://doi.org/10.1002/sce.20194

Demir Kaymak, Z., & Horzum, M. B. (2013). Relationship between online learning readiness and structure and interaction of online learning students. *Kuram ve Uygulamada Egitim Bilimleri*, *13*(3), 1792–1797. https://doi.org/10.12738/estp.2013.3.1580

Dorier, J. L., & García, F. J. (2013). Challenges and opportunities for the implementation of inquiry-based learning in day-to-day teaching. *ZDM*, *45*(6), 837-849. https://doi.org/10.1007/s11858-013-0512-8

Eisenberg, M. B., & Berkowitz, R. E. (1990). *Information Problem Solving: The Big Six Skills Approach to Library & Information Skills Instruction.* Norwood: Ablex.

Francom, G. (2018). Ten Steps to Complex Learning: a Systematic Approach to Four-Component Instructional Design, by Jeroen JG van Merriënboer and Paul A. Kirschner. *TechTrends*, *62*(2), 204-205. https://doi.org/10.1007/s11528-018-0254-0

Frerejean, J., Van Strien, J. L. H., Kirschner, P. A., & Brand-Gruwel, S. (2016). Completion strategy or emphasis manipulation? Task support for teaching information problem solving. *Computers in Human Behavior*, *62*, 90–104. https://doi.org/10.1016/j.chb.2016.03.048

Frerejean, J., Velthorst, G. J., van Strien, J. L., Kirschner, P. A., & Brand-Gruwel, S. (2019). Embedded instruction to learn information problem solving: Effects of a whole task approach. *Computers in Human Behavior*, *90*, 117-130. https://doi.org/10.1016/j.chb.2018.08.043

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis. *Review of educational research*, *82*(3), 300-329. https://doi.org/10.3102/0034654312457206

Gasque, K. (2016). Information literacy for inquiry-based learning. *Transinformação*, *28*(3), 253–262. https://doi.org/10.1590/2318-08892016000300001

Gehring, K. M., & Eastman, D. A. (2008). Information fluency for undergraduate biology majors: applications of inquiry-based learning in a developmental biology course. *CBE Life Sciences Education*, *7*(1), 54-63. https://doi.org/10.1187/cbe.07-10-0091

Gerard, L. F., Varma, K., Corliss, S. B., & Linn, M. C. (2011). Professional development for technology-enhanced inquiry science. *Review of educational research*, *81*(3), 408-448. https://doi.org/10.3102/0034654311415121

Gerjets, P., & Hellenthal-Schorr, T. (2008). Competent information search in the World Wide Web: Development and evaluation of a web training for pupils. *Computers in Human Behavior*, *24*(3), 693–715. https://doi.org/10.1016/j.chb.2007.01.029

Gil Pérez, D. (1986). La metodología científica y la enseñanza de las ciencias: unas relaciones controvertidas. *Enseñanza de Las Ciencias: Revista de Investigación y Experiencias Didácticas*, *4*(2), 111–121. https://doi.org/10.4067/S0718-07052008000100011

Goldhammer, F., Naumann, J., Stelter, A., Tóth, K., Rölke, H., & Klieme, E. (2014). The time on task effect in reading and problem solving is moderated by task difficulty and skill: Insights from a computer-based large-scale assessment. *Journal of Educational Psychology*, *106*(3), 608–626. https://doi.org/10.1037/a0034716

Gómez, M., & Badia, A. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom. *Computers in Human Behavior, 56*, 21-28. https://doi.org/10.1016/j.chb.2015.11.023

Green, A. (1998). *Verbal protocol analysis in language testing research: A handbook. Studies in Language Testing.*Cambridge: Cambridge University Press.

Griffin, P., McGaw, B., & Care, E. (2012). *Assessment and teaching of 21st century skills*. https://doi.org/10.1007/978-94-007-2324-5

Hahnel, C., Goldhammer, F., Naumann, J., & Kröhne, U. (2016). Effects of linear reading, basic computer skills, evaluating online information, and navigation on reading digital text. *Computers in Human Behavior*, *55*, 486–500. https://doi.org/10.1016/j.chb.2015.09.042

Hairida, H. (2016). The effectiveness using inquiry based natural science module with authentic assessment to improve the critical thinking and inquiry skills of junior high school students. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 209-215. https://doi.org/10.15294/jpii.v5i2.7681

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological science in the public interest*, *8*(1), 1-51. https://doi.org/10.1111/j.1529-1006.2007.00032.x

Hanrahan, M. (1998). The effect of learning environment factors on students' motivation and learning. *International Journal of Science Education*, *20*(6), 737–753. https://doi.org/10.1080/0950069980200609

Hassard, J. (2013). *The Art of Teaching Science: Inquiry and Innovation in Middle School and High School*. https://doi.org/10.4324/9780203892961

Head, A. J.; Eisenberg, M. B. (2010). *How college students evaluate and use information in the digital age. Project Information Literacy, progress report: Truth be told.* Seattle, Washington: The Information School, University of Washington.

Hepworth, M., & Walton, G. (2009). *Teaching Information Literacy for Inquiry-based Learning*. https://doi.org/10.1533/9781780630175

Hewson, P. W. (1992, June). Conceptual change in science teaching and teacher education.

In *Research and Curriculum Development in Science Teaching*. (pp. 1-15). Madrid: National Center for Educational Research, Documentation, and Assessment.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to Kirschner, Sweller, and Clark. *Educational psychologist*, *42*(2), 99-107.https://doi.org/10.1080/00461520701263368

Huang, Y. M., Liu, M. C., Chen, N. S., Kinshuk, & Wen, D. (2014). Facilitating learners' web-based information problem-solving by query expansion-based concept mapping. *Australasian Journal of Educational Technology*, *30*(5), 517–532. https://doi.org/10.14742/ajet.613

Hutchison, A. C., & Colwell, J. (2014). The Potential of Digital Technologies to Support Literacy Instruction Relevant to the Common Core State Standards. *Journal of Adolescent & Adult Literacy*, *58*(2), 147–156. https://doi.org/10.1002/jaal.335

INFOhio (1998). *DIALOGUE Model for Information Literacy Skills.* Ohio: The Information Network for Ohio School.

Irving, A. (1985). *Study and Information Skills Across the Curriculum.* London: Heinemann Educational Books.

Joyce, B., Weil, M., & Calhoun, E. (2011). *Models of Teaching*. *Models of teaching*.

Joyce, M. Z., & Tallman, J. I. (1997). *Making the Writing and Research Connection with the I-Search Process: A How-To-Do-It Manual for Teachers and Librarians.* New York: Neal-Schuman Publishers.

Jukes, I., Dosat, A., & Matheson, K. (1997). *Net Savvy: Information Literacy for the Communication Age.* Coimbatore: NetSavvy Group.

Julien, H., & Barker, S. (2009). How high-school students find and evaluate scientific information: A basis for information literacy skills development. *Library and Information Science Research*, *31*(1), 12–17. https://doi.org/10.1016/j.lisr.2008.10.008

Kerawalla, L., Littleton, K., Scanlon, E., Jones, A., Gaved, M., Collins, T., ... & Petrou, M. (2013). Personal inquiry learning trajectories in geography: Technological support across contexts. *Interactive learning environments*, *21*(6), 497-515. https://doi.org/10.1080/10494820.2011.604036

Ketelhut, D. J., Nelson, B. C., Clarke, J., & Dede, C. (2010). A multi-user virtual environment for building and assessing higher order inquiry skills in science. *British Journal of Educational Technology*, *41*(1), 56-68. https://doi.org/10.1111/j.1467-8535.2009.01036.x

Kim, M. C., & Hannafin, M. J. (2011). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers and Education*, *56*(2), 403–417. https://doi.org/10.1016/j.compedu.2010.08.024

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational psychologist*, *41*(2), 75-86. https://doi.org/10.1207/s15326985ep4102_1

Kubicek, J. P. (2005). Inquiry-Based Learning, the Nature of Science, and Computer Technology: New Possibilities in Science Education. *Canadian Journal of Learning and Technology*, *31*(1), 13. https://doi.org/10.21432/T29C77

Kuhlthau, C. C. (1988). Meeting the information needs of children and young adults: Basing library media programs on developmental states. *Journal of Youth Services in Libraries*, 2(1), 51-57.

Kuhlthau, C. C. (1993). A principle of uncertainty for information seeking. *Journal of documentation*, *49*(4), 339-355. https://doi.org/10.1108/eb026918

Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2015). *Guided inquiry: Learning in the 21st century (2nd ed.)*. Santa Barbara: Libraries Unlimited.

Kuhn, D. (2001). How do people know? *Psychological Science*, *12*(1), 1–8. https://doi.org/10.1111/1467-9280.00302

Kuiper, E., Volman, M., & Terwel, J. (2008). Integrating critical Web skills and content knowledge: Development and evaluation of a 5th grade educational program. *Computers in Human Behavior*, *24*(3), 666–692. https://doi.org/10.1016/j.chb.2007.01.022

Kyza, E. A., Golan, R., Reiser, B. J., & Edelson, D. C. (2002, January). Reflective inquiry: Enabling group self-regulation in inquiry-based science using the Progress Portfolio tool. In *Proceedings of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL Community* (pp. 227-236). Boulder: International Society of the Learning Sciences.

Lamb, A., Smith, N., & Johnson, L. (1997). Wondering, Wiggling, and Weaving: A new model for porject and community based learning on the Web. *Learning and Leading With Technology, 24*(7), 6-13.

Large, A., & Beheshti, J. (2000). The Web as a classroom resource: Reactions from the users. *Journal of the American Society for Information Science*, *51*(12), 1069-1080. https://doi.org/10.1002/1097-4571(2000)9999:9999<::AID-ASI1017>3.3.CO;2-N

Lau, W. W. F., Lui, V., & Chu, S. K. W. (2017). The use of wikis in a science inquiry-based project in a primary school. *Educational Technology Research and Development*, *65*(3), 533–553. https://doi.org/10.1007/s11423-016-9479-9

Lau, W. W. F., & Yuen, A. H. K. (2014). Developing and validating of a perceived ICT literacy scale for junior secondary school students: Pedagogical and educational contributions. *Computers and Education*, *78*, 1–9. https://doi.org/10.1016/j.compedu.2014.04.016

Lazonder, A. W. (2001). Minimalist instruction for learning to search the World Wide Web. *Education and Information Technologies*, *6*, 161–176. https://doi.org/10.1023/a:1012756223618

Lazonder, A. W., & Rouet, J. F. (2008). Information problem solving instruction: Some cognitive and metacognitive issues. *Computers in Human Behavior*, *24*(3), 753–765. https://doi.org/10.1016/j.chb.2007.01.025

Li, D. D., & Lim, C. P. (2008). Scaffolding online historical inquiry tasks: A case study of two secondary school classrooms. *Computers and Education*, *50*(4), 1394–1410. https://doi.org/10.1016/j.compedu.2006.12.013

Li, L. Y., Tseng, S. T., & Chen, G. D. (2016). Effect of hypertext highlighting on browsing, reading, and navigational performance. *Computers in Human Behavior*, *54*, 318–325. https://doi.org/10.1016/j.chb.2015.08.012

Linn, M. C., Davis, E. A., & Bell, P. (2004). *Internet Environments for Science Education*. https://doi.org/10.4324/9781410610393

Linn, M. C., Eylon, B. S., Rafferty, A., & Vitale, J. M. (2015). Designing Instruction to Improve Lifelong Inquiry Learning. *Eurasia Journal of Mathematics, Science & Technology Education*, *11*(2). https://doi.org/10.12973/eurasia.2015.1317a

Liu, Z. (2005). Reading behavior in the digital environment. *Journal of Documentation*, *61*(6), 700–712. https://doi.org/10.1108/00220410510632040

Loh, B, Radinsky, J., Reiser, B. J., Gomez, L. M., Edelson, D. C., & Russell, E. (1997, December). The progress portfolio: promoting reflective inquiry in complex investigation environments. In *Proceedings of the 2nd international conference on Computer Support for Collaborative Leraning*. (pp. 176-185). Toronto: International Society of the Learning Sciences. https://doi.org/10.3115/1599773.1599795

Loh, Ben, Radinsky, J., Russell, E., & Gomez, L. (1998, April). The progress portfolio: Designing reflective tools for a classroom context. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. (pp. 627-634). Los Angeles: ACM Press. https://doi.org/10.1145/274644.274728

Loh, B., Reiser, B. J., Radinsky, J., Edelson, D. C., Gomez, L. M., & Marshall, S. (2001). Developing reflective inquiry practices: A case study of software, the teacher, and students. *Designing for science: Implications from everyday, classroom, and professional settings*, (pp. 279-323). Mahwah: Lawrence Erlbaum Associates. https://doi.org/10.1002/nml

Macedo-Rouet, M., Rouet, J. F., Epstein, I., & Fayard, P. (2003). Effects of online reading on popular science comprehension. *Science Communication*, *25*(2), 99-128. https://doi.org/10.1177/1075547003259209

Mäeots, M., Pedaste, M., & Sarapuu, T. (2008, July). Transforming students' inquiry skills with computer-based simulations. In *Proceedings - The 8th IEEE International Conference on Advanced Learning Technologies, ICALT 2008* (pp. 938–942). Santander: IEEE. https://doi.org/10.1109/ICALT.2008.239

Maldonado, H., Perone, B., Datoo, M., Franz, P., & Pea, R. D. (2013, June). Designing Soil Quality Mobile Inquiry For Middle School. In *To appear in the Proceedings of the 10th International Conference on Computer Supported Collaborative Learning* (pp. 85-88). Madison: University of Wisconsin.

Mangen, A., Walgermo, B. R., & Brønnick, K. (2013). Reading linear texts on paper versus computer screen: Effects on reading comprehension. *International Journal of Educational Research*, *58*, 61–68. https://doi.org/10.1016/j.ijer.2012.12.002

Mason, L., Junyent, A. A., & Tornatora, M. C. (2014). Epistemic evaluation and comprehension of web-source information on controversial science-related topics: Effects of a short-term instructional intervention. *Computers and Education*, *76*, 143–157. https://doi.org/10.1016/j.compedu.2014.03.016

Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning?. *American psychologist*, *59*(1), 14. https://doi.org/10.1037/0003-066X.59.1.14

Mazella, D., & Grob, J. (2011). Collaborations between faculty and special collections librarians in inquiry-driven classes. *portal: Libraries and the Academy*, *11*(1), 467-487. https://doi.org/10.1353/pla.2011.0012

McKenzie, J. (2000). *Beyond Technology: Questioning, Research and the Information Literate School.* Bellingham: FNO Press.

Mikroyannidis, A., Okada, A., Scott, P., Rusman, E., Specht, M., Stefanov, K., … Chaimala, F. (2013). WeSPOT: A personal and social approach to inquiry-based learning. *Journal of Universal Computer Science*. https://doi.org/10.3217/jucs-019-14-2093

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *47*(4), 474-496. https://doi.org/10.1002/tea.20347

Monereo, C., & Badia, A. (2012). La competencia informacional desde una perspectiva psicoeducativa: enseñanza basada en la resolución de problemas prototípicos y emergentes. *Revista Española de Documentación Científica*, *35*, 75–99. https://doi.org/10.3989/redc.2012.mono.978

Monroe-Gulick, A., & Petr, J. (2012). Incoming Graduate Students in the Social Sciences: How Much Do They Really Know About Library Research? *Portal: Libraries and the Academy*, *12*(3), 315–335. https://doi.org/10.1353/pla.2012.0032

Morris, R., Hadwin, A. F., Gress, C. L., Miller, M., Fior, M., Church, H., & Winne, P. H. (2010). Designing roles, scripts, and prompts to support CSCL in gStudy. *Computers in Human Behavior*, *26*(5), 815-824. https://doi.org/10.1016/j.chb.2008.12.001

Mosher, A. (2011). Setting Performance Standards in Europe: The Judges' Contribution to Relating Language Examinations to the Common European Framework of Reference by PAPAGEORGIOU, SPIROS. *The Modern Language Journal*. *95*(2), 335-337. https://doi.org/10.1111/j.1540-4781.2011.01201.x

Mulholland, P., Anastopoulou, S., Collins, T., Feisst, M., Gaved, M., Kerawalla, L., ... & Wright, M. (2011). nQuire: technological support for personal inquiry learning. *IEEE Transactions on Learning Technologies*, *5*(2), 157-169. https://doi.org/10.1109/TLT.2011.32

National Research Council (NRC). (2000). *Inquiry and the National Science Education Standards*: *A guide for teaching and learning*. https://doi.org/10.17226/9596

Naumann, J. (2015). A model of online reading engagement: Linking engagement, navigation, and performance in digital reading. *Computers in Human Behavior*, *53*, 263-277. https://doi.org/10.1016/j.chb.2015.06.051

Nielsen, M. (2011). Reinventing Discovery: The New Age of Networked Science. *Media*, 1–280. https://doi.org/10.1515/9781400839452

Novak, J. D. (2002). Meaningful Learning: The Essential Factor for Conceptual Change in Limited or Inappropriate Propositional Hierarchies Leading to Empowerment of Learners. *Science Education*, *86*(4), 548-571. https://doi.org/10.1002/sce.10032

Novak, J., & Gowin, B. (1988). Aprendiendo a aprender. *Barcelona Martínez Roca*, *194*, 12–15.

O'Reilly, T., & McNamara, D. S. (2007). The impact of science knowledge, reading skill, and reading strategy knowledge on more traditional "high-stakes" measures of high school students' science achievement. *American educational research journal*, *44*(1), 161-196. https://doi.org/10.3102/0002831206298171

Okada, A., Serra, A., Ribeiro, S., & Pinto, S. (2015). Key skills for co-learning and co-inquiry in two open platforms: a massive portal (EDUCARED) and a personal environment (weSPOT). *Open Praxis*, *7*(1), 83-102. https://doi.org/10.5944/openpraxis.7.1.174

Osborne, J. (2007). Science education for the twenty first century. *Eurasia Journal of Mathematics, Science and Technology Education*, *3*(3), 173-184. https://doi.org/10.1080/13586840903194748

Pappas, M. L., & Tepe, A. E. (1995). Preparing the Information Educator for the Future. *School Library Media Annual (SLMA)*, 13, 37-44.

Pea, R., Milrad, M., Maldonado, H., Vogel, B., Kurti, A., & Spikol, D. (2012). *Orchestrating Inquiry Learning: Learning and technological designs for mobile science inquiry collaboratories*. https://doi.org/10.4324/9780203136195

Pedaste, M., & Sarapuu, T. (2006). Developing an effective support system for inquiry learning in a Web-based environment. *Journal of Computer Assisted Learning*, *22*(1), 47–62. https://doi.org/10.1111/j.1365-2729.2006.00159.x

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational research review*, *14*, 47-61. https://doi.org/10.1016/j.edurev.2015.02.003

Penner, A. M. (2003). International gender× item difficulty interactions in mathematics and science achievement tests. *Journal of Educational Psychology*, *95*(3), 650. https://doi.org/10.1037/0022-0663.95.3.650

Perin, D. (2011). Facilitating student learning through contextualization: A review of evidence. *Community College Review*, *39*(3), 268-295. https://doi.org/10.1177/0091552111416227

Pifarré, M., Cobos, R., & Argelagós, E. (2014). Incidence of group awareness information on students' collaborative learning processes. *Journal of Computer Assisted Learning*, *30*(4), 300–317. https://doi.org/10.1111/jcal.12043

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, *66*(2), 211–227. https://doi.org/10.1002/sce.3730660207

Potocki, A., Ros, C., Vibert, N., & Rouet, J.-F. (2017). Children's Visual Scanning of Textual Documents: Effects of Document Organization, Search Goals, and Metatextual Knowledge. *Scientific Studies of Reading*, *00*(00), 1-18. https://doi.org/10.1080/10888438.2017.1334060

Pozo, J. I. (1999). Más allá del cambio conceptual: el aprendizaje de la ciencia como cambio representacional. *Enseñanza de las ciencias: revista de investigación y experiencias didácticas*, *17*(3), 513-520.

Probert, E. (2009). Information literacy skills: Teacher understandings and practice. *Computers and Education*, *53*(1), 24-33. https://doi.org/10.1016/j.compedu.2008.12.018

Protopsaltis, A., Seitlinger, P., Chaimala, F., Firssova, O., Hetzner, S., Kikis-Papadakis, K., & Boytchev, P. (2014). Working environment with social and personal open tools for inquiry based learning: Pedagogic and Diagnostic Frameworks. *The International Journal of Science, Mathematics and Technology Learning*, *20*(4), 51-63.

Pujol, M. C., Quintana, M. G. B., Romaní, J. R., & Gibson, J. D. (2009, June). Students' informational and technological competencies in an ICT school project. In *Proceedings of the IADIS International Conference e-Learning.* Algarve: MCCSIS.

Puustinen, M., & Rouet, J. F. (2009). Learning with new technologies: Help seeking and information searching revisited. *Computers and Education*, *53*(4), 1014–1019. https://doi.org/10.1016/j.compedu.2008.07.002

Raes, A., Schellens, T., De Wever, B., & Vanderhoven, E. (2012). Scaffolding information problem solving in web-based collaborative inquiry learning. *Computers & Education*, *59*(1), 82-94. https://doi.org/10.1016/j.compedu.2011.11.010

Ray, W. E. (1961). Pupil discovery vs. direct instruction. *The Journal of Experimental Education*, *29*(3), 271-280. https://doi.org/10.1080/00220973.1961.11010692

Reiser, B. J., Tabak, I., Sandoval, W. A., Smith, B. K., Steinmuller, F., & Leone, A. J. (2001). BGuILE: Strategic and conceptual scaffolds for scientific inquiry in biology classrooms. *Cognition and instruction: Twenty-five years of progress*, 263-305. https://doi.org/10.1038/jcbfm.2014.253

European Commission. (2007). Science education now: A renewed pedagogy for the future of Europe. Brussels: Office for Official Publications of the European Communities.

Rohatgi, A., Scherer, R., & Hatlevik, O. E. (2016). The role of ICT self-efficacy for students' ICT use and their achievement in a computer and information literacy test. *Computers and Education*, *102*, 103–116. https://doi.org/10.1016/j.compedu.2016.08.001

Rotherham, A., & Willingham, D. (2010). " 21st-Century" Skills: Not New, but a Worthy

Challenge. *American Educator*, 17–20. https://doi.org/10.1145/1719292.1730970

Rouet, J. F., Ros, C., Goumi, A., Macedo-Rouet, M., & Dinet, J. (2011). The influence of surface and deep cues on primary and secondary school students' assessment of relevance in Web menus. *Learning and Instruction*, *21*(2), 205–219. https://doi.org/10.1016/j.learninstruc.2010.02.007

Ryan, K. E., Willingham, W. W., & Cole, N. S. (1999). Gender and Fair Assessment. *Educational Researcher. 28*(5), 30-32. https://doi.org/10.2307/1176371

Sáinz, M., & Martínez-Cantos, J. L. (2016). Desigualdades de género en la percepción social de la ciencia y la tecnología en función de la edad y el nivel educativo. *Percepción Social de la Ciencia y la Tecnología 2016, 235.*

Salmerón, L., Naumann, J., García, V., & Fajardo, I. (2017). Scanning and deep processing of information in hypertext: an eye tracking and cued retrospective think-aloud study. *Journal of Computer Assisted Learning*, *33*(3), 222–233. https://doi.org/10.1111/jcal.12152

Sanchiz, M., Chevalier, A., & Amadieu, F. (2017). How do older and young adults start searching for information? Impact of age, domain knowledge and problem complexity on the different steps of information searching. *Computers in Human Behavior*, *72*, 67–78. https://doi.org/10.1016/j.chb.2017.02.038

Sanchiz, M., Chin, J., Chevalier, A., Fu, W. T., Amadieu, F., & He, J. (2017). Searching for information on the web: Impact of cognitive aging, prior domain knowledge and complexity of the search problems. *Information Processing and Management*, *53*(1), 281–294. https://doi.org/10.1016/j.ipm.2016.09.003

Sandoval, W. A., & Reiser, B. J. (1997, April). Evolving Explanations in High School Biology. In *Annual Meeting of the American Educational Research Association.* (pp. 244-253). Chicago: AERA.

Scanlon, E., Anastopoulou, S., Kerawalla, L., & Mulholland, P. (2011). How technology resources can be used to represent personal inquiry and support students' understanding of it across contexts. *Journal of Computer Assisted Learning*, *27*(6), 516–529. https://doi.org/10.1111/j.1365-2729.2011.00414.x

Schoon, I., & Ng-Knight, T. (2017). Co-development of educational expectations and effort: Their antecedents and role as predictors of academic success. *Research in Human Development, 14*(2), 161-176. https://doi.org/10.1080/15427609.2017.1305808

Şendurur, E., & Yildirim, Z. (2015). Students' web search strategies with different task types: An eye-tracking study. *International Journal of Human-Computer Interaction*, *31*(2), 101–111. https://doi.org/10.1080/10447318.2014.959105

Settlage, J. (2011). Derek Hodson: Teaching and learning about science: Language, theories, methods, history, traditions and value. *Science & Education, 20*, 393-396. https://doi.org/10.1007/s11191-010-9266-7

Shih, J., Chuang, C.W., & Hwang, G.J. (2010). An inquiry-based mobile learning approach to enhancing social science learning effectiveness. *Educational Technology & Society*, *13*(4), 50–62.

Slotta, J. D., & Aleahmad, T. (2009). WISE technology lessons: Moving from a local proprietary system to a global open source framework. *Research and Practice in Technology Enhanced Learning*, *4*(02), 169-189. https://doi.org/10.1142/S1793206809000684

Smith, B K, & Reiser, B. J. (1997, November). What should a wildebeest say? Interactive nature films for high school classrooms. In *Multimedia '97 Proceedings of the fitfth ACM international conference on Multimedia* (pp. 193-201). Seattle: Proceeding. https://doi.org/10.1145/266180.266365

Smith, B. K., & Reiser, B. J. (1998). National Geographic unplugged: Designing interactive nature films for classrooms. *Proceedings of CHI*, 98, 424-431. https://doi.org/10.1145/274644.274702

Spikol, D., Milrad, M., Maldonado, H., & Pea, R. (2009, July). Integrating co-design practices into the development of mobile science collaboratories. In *2009 Ninth IEEE International Conference on Advanced Learning Technologies* (pp. 393-397). Riga: IEEE. https://doi.org/10.1109/ICALT.2009.175

Spink, A., Danby, S., Mallan, K., & Butler, C. (2010). Exploring young children's web searching and technoliteracy. *Journal of documentation*, *66*(2), 191-206. https://doi.org/10.1108/00220411011023616

Stadtler, M., & Bromme, R. (2008). Effects of the metacognitive computer-tool met.a.ware on the web search of laypersons. *Computers in Human Behavior*, *24*(3), 716–737. https://doi.org/10.1016/j.chb.2007.01.023

Stripling, B. K., & Pitts, J. M. (1988). *Brainstorms and blueprints: Teaching library research as a thinking process.* Englewood: Libraries Unlimited.

Tabak, I., Sandoval, W. A., Smith, B. K., Agganis, A., Baumgartner, E., & Reiser, B. J. (1995, October). Supporting collaborative guided inquiry in a learning environment for biology. In *Computer-Supported Collaborative Learning* (pp. 362-366). Bloomington: University of Indiana Press. https://doi.org/10.3115/222020.222830

Tabak, I., Smith, B. K., Sandoval, W. A., & Reiser, B. J. (1996, June). Combining general and domain-specific strategic support for biological inquiry. In *International Conference on Intelligent Tutoring Systems* (pp. 288-296). Berlin: Springer. https://doi.org/10.1007/3-540-61327-7_126

Tatay, A. C. L., Pelluch, L. G., Gámez, E. V. A., Giménez, T. M., Lloriá, A. M., & Pérez, R. G. (2011). Prueba de competencia lectora para educación secundaria (CompLEC). *Psicothema*, *23*(4), 808–817. https://doi.org/0214-9915

Taub, M., Azevedo, R., Bouchet, F., & Khosravifar, B. (2014). Can the use of cognitive and metacognitive self-regulated learning strategies be predicted by learners' levels of prior knowledge in hypermedia-learning environments? *Computers in Human Behavior*, *39*, 356–367. https://doi.org/10.1016/j.chb.2014.07.018

Thoron, A. C., & Myers, B. E. (2012). Effects of Inquiry-based Agriscience Instruction on Student Scientific Reasoning. *Journal of Agricultural Education*, *53*(4). https://doi.org/10.5032/jae.2012.04156

Timmers, C. F., Walraven, A., & Veldkamp, B. P. (2015). The effect of regulation feedback in a computer-based formative assessment on information problem solving. *Computers and Education*, *87*, 1–9. https://doi.org/10.1016/j.compedu.2015.03.012

Tricot, A., & Sweller, J. (2014). Domain-specific knowledge and why teaching generic skills does not work. *Educational psychology review*, *26*(2), 265-283. https://doi.org/10.1007/s10648-013-9243-1

Trigwell, K., Prosser, M., & Waterhouse, F. (1999). Relations between teachers' approaches to teaching and students' approaches to learning. *Higher education*, *37*(1), 57-70. https://doi.org/10.1023/A:1003548313194

Varma, K., & Linn, M. C. (2012). Using interactive technology to support students' understanding of the greenhouse effect and global warming. *Journal of Science Education and Technology*, *21*(4), 453-464. https://doi.org/10.1007/s10956-011-9337-9

Vidal-Abarca, E., Mañá, A., & Gil, L. (2010). Individual differences for self-regulating task-oriented reading activities. *Journal of Educational Psychology*, *102*(4), 817–826. https://doi.org/10.1037/a0020062

Villasclaras-Fernandez, E. D., Sharples, M., Kelley, S., & Scanlon, E. (2013, September). Supporting citizen inquiry: An investigation of Moon rock. In *European Conference on Technology Enhanced Learning* (pp. 383-395). Berlin: Springer. https://doi.org/10.1007/978-3-642-40814-4_30

Virkus, S. (2003). Information literacy in Europe: a literature. *Inf. Res*, *8*(4), 1-56.

https://doi.org/159 Artn 159

Vitale, D. C., Armenakis, A. A., & Feild, H. S. (2008). Integrating qualitative and quantitative methods for organizational diagnosis: Possible priming effects?. *Journal of Mixed Methods Research*, *2*(1), 87-105. https://doi.org/10.1177/1558689807309968

Vogel, B., Spikol, D., Kurti, A., & Milrad, M. (2010, April). Integrating mobile, web and sensory technologies to support inquiry-based science learning. In *2010 6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education* (pp. 65-72). Kaohsiung: IEEE. https://doi.org/10.1109/WMUTE.2010.41

Walhout, J., Brand-Gruwel, S., Jarodzka, H., Van Dijk, M., De Groot, R., & Kirschner, P. A. (2015). Learning and navigating in hypertext: Navigational support by hierarchical menu or tag cloud? *Computers in Human Behavior*, *46*, 218–227. https://doi.org/10.1016/j.chb.2015.01.025

Walhout, J., Oomen, P., Jarodzka, H., & Brand-Gruwel, S. (2017). Effects of task complexity on online search behavior of adolescents. *Journal of the Association for Information Science and Technology*, *68*(6), 1449–1461. https://doi.org/10.1002/asi.23782

Wallace, R. M., Kupperman, J., Krajcik, J., & Soloway, E. (2000). Science on the Web: Students Online in a Sixth-Grade Classroom. *Journal of the Learning Sciences*, *9*(1), 75–104. https://doi.org/10.1207/s15327809jls0901_5

Walraven, A., Brand-Gruwel, S., & Boshuizen, H. P. A. (2008). Information-problem solving: A review of problems students encounter and instructional solutions. *Computers in Human Behavior*, *24*(3), 623–648. https://doi.org/10.1016/j.chb.2007.01.030

Walraven, A., Brand-Gruwel, S., & Boshuizen, H. P. A. (2010). Fostering transfer of websearchers' evaluation skills: A field test of two transfer theories. *Computers in Human Behavior*, *26*(4), 716–728. https://doi.org/10.1016/j.chb.2010.01.008

Wang, C., Ke, Y.T., Wu, J.T., & Hsu, W.H. (2012). Collaborative Action Research on Technology Integration for Science Learning. *Journal of Science Education and Technology*, *21*(1), 125–132. https://doi.org/10.1007/s10956-011-9289-0

Wenning, C. J. (2011). The Levels of Inquiry Model of Science Teaching. *Journal of Physics Teacher Education Online*, *6*(2), 9–16.

Williams, M., DeBarger, A. H., Montgomery, B. L., Zhou, X., & Tate, E. (2012). Exploring middle school students' conceptions of the relationship between genetic inheritance and cell division. *Science Education*, *96*(1), 78-103. https://doi.org/10.1002/sce.20465

Wilson, C. D., Reichsman, F., Mutch-Jones, K., Gardner, A., Marchi, L., Kowalski, S., ... &

Dorsey, C. (2018). Teacher Implementation and the Impact of Game-Based Science Curriculum Materials. *Journal of Science Education and Technology*, *27*(4), 285-305. https://doi.org/10.1007/s10956-017-9724-y

Wood, E., De Pasquale, D., Mueller, J. L., Archer, K., Zivcakova, L., Walkey, K., & Willoughby, T. (2016). Exploration of the Relative Contributions of Domain Knowledge and Search Expertise for Conducting Internet Searches. *The Reference Librarian*, *57*(3), 182–204. https://doi.org/10.1080/02763877.2015.1122559

Wopereis, I., Brand-Gruwel, S., & Vermetten, Y. (2008). The effect of embedded instruction on solving information problems. *Computers in Human Behavior*, *24*(3), 738–752. https://doi.org/10.1016/j.chb.2007.01.024

Wopereis, I. G. J. H., & van Merriënboer, J. J. G. (2011). Evaluating text-based information on the World Wide Web. *Learning and Instruction*, *21*(2), 232-237. https://doi.org/10.1016/j.learninstruc.2010.02.003

Yeh, Y. F., Hsu, Y. S., Chuang, F. T., & Hwang, F. K. (2014). Middle-school students' online information problem solving behaviors on the information retrieval interface. *Australasian Journal of Educational Technology*, *30*(2), 245–260. https://doi.org/10.14742/ajet.478

Yucht, A. H. (1997). *Flip It! An Information Skills Strategy for Student Researchers.* Worthington: Linworth Publishing.

Zhang, M., & Quintana, C. (2012). Scaffolding strategies for supporting middle school students' online inquiry processes. *Computers and Education*, *58*(1), 181-196. https://doi.org/10.1016/j.compedu.2011.07.016

12. Annexes

12.1. Annex 1. E-mail sent to the headmasters of the high schools

Translated from Catalan

Dear members of the management team,

After contacting the Institute through a telephone call, I have been instructed to contact you via email.

My name is Marta Gómez Domingo with DNI XXXXXXXX-X, I'm a PhD student at the Universitat Oberta de Catalunya and resident in Manacor.

Under the approval of my PhD thesis director, Dr. Antoni Badia Garganté, I contact you, to formally present the interest of collaborating with your center to develop this research.

The characteristics of the collaboration would be the following:

- Training for participating teachers on how to carry out the efficient development of the teaching-learning process in the resolution of informational problems.
- Collection of data through the participation of second cycle students of Secondary Education in the development of 11 sessions with each group, focused on learning content related to the area of natural sciences and the acquisition of skills for the resolution of informational problems.
- Coordination among the members of the natural sciences department and the researcher of the research for the elaboration of the material that will be used in the sessions with the students.
- Being able to have, for the realization of said sessions, a computer for each student.

Finally, I would appreciate that you give me the opportunity to speak better through a meeting with the professors of the area of natural sciences of 3rd year of ESO, in which to expose in detail the characteristics of the research, to open this way the possibility of establishing a collection of data in your centre, if you deem it appropriate.

Thank you very much for the attention received,

Marta Gómez Domingo.

12.2. Annex 2. Educational intervention protocol (for teachers)

Translated from Catalan

PROTOCOL OF THE EDUCATIONAL INTERVENTION

❖ **BEFORE THE INSTRUCTION SESSIONS:**

Before the start of the instruction sessions it will be necessary that ALL students have completed "The online test" and "The initial paper assessment test":

1. **The online test (http://goo.gl/forms/zSVLkT0plb).**

Students must access this link from the computers / laptops and complete the test of reading comprehension and digital skills individually. It is suggested to carry out the test during one hour of whole class group.

2. **The initial paper assessment test.**

To carry out this test, all students will have to be available individually in the classroom (exam format) so that the responsible teacher will then submit the initial assessment test (photocopies attached). Once the students finish the test, the teacher will make sure that all the tests have the student's last names and photocopies will be introduced in the envelope. It is suggested to carry out the test during one hour of whole class group.

** If for any reason the day on which the test was carried out one of the students has not been able to attend, they will have to be carried out in another space of time. But it is essential that all students take the test before Friday, May 6, 2016.*

❖ **DEVELOPMENT OF THE INSTRUCTION SESSIONS:**

Before the completion of the training, the researcher will have accessed half an hour before in the students' classroom to turn on the computers, distribute the headphones to each one of them and open the WISE portal so that students can access it.

When the time comes, the teacher responsible for the subject will take the students to the computer room and they will be placed by list book on the assigned computer, where they will find the username and password of Access to the WISE portal (which will have to be saved for the next sessions).

SESSION 0 - 60min:

1. Students sit on the adjudicated computers (by order of the list) and the headphones are placed.
2. The students open the Camtasia Studio 8.6 software and they begin to record the activity after the indications of the researcher.
3. Students enter the WISE website (with the user and password delivered).
4. Students are instructed to access the first activity called "Zika virus disease", to perform the task assigned to them. They are reminded that they must put on their headsets and continually verbalize what they are doing and why.
5. After completing the task, they are asked to stop recording the screen and save the file to the USB by writing: name of the highschool_group_name and surnames_0, for example: paucasesnoves_A_martagómezdomingo_0

SESSION 1 - 60min:

1. The students sit on the adjudicated computers (by order of the list, the same as the last session) and the headphones are placed.
2. The students open the Camtasia Studio 8.6 software and they start recording the activity.
3. Students enter the WISE website (with the user and password delivered).
4. Students access the second activity called "How to solve a problem?", To perform the task assigned to them. They are reminded that they must put on their headsets and continually verbalize what they are doing and why.
7. Once the task is completed, they are asked to stop recording the screen and save the file to USB by writing: name of the highschool_group_name and surnames_1, for example: paucasesnoves_A_martagómezdomingo_1
8. The last minutes of the class manifest the written questions and are put in common in the class group.

SESSIONS 2, 3, 4 - 60min per session:

1. Students sit on the adjudicated computers (by order of the list, the same as the last session) and the headphones are placed.
2. The students open the Camtasia Studio 8.6 software and they start recording the activity.

3. Students enter the WISE website (with the user and password delivered).
4. Students access the third activity called "Resolve several problems I" to perform the task assigned to them. The teacher reminds them that they must put on their headsets and continually verbalize what they are doing and why.
5. Once the task is completed, they are required to stop recording the screen and save the file to USB by writing the name of the highschool_group_name and surnames_2,3,4, for example: paucasesnoves_A_martagómezdomingo_2,3,4 (respectively).

SESSIONS 5, 6, 7 - 60min per session:

1. The students sit on the adjudicated computers (by order of the list, the same as the last session) and the headphones are placed.
2. The students open the Camtasia Studio 8.6 software and they start recording the activity.
3. Students enter the WISE website (with the user and password delivered).
4. Students access the different third activity "Solve several problems II", to carry out the task assigned to them each day. The teacher reminds them that they must put on their headsets and continually verbalize what they are doing and why.

After finishing the task, they are asked to stop recording the screen and save the file to the USB by writing: name of the highschool_group_name and surnames_5,6,7, for example: paucasesnoves_A_martagómezdomingo_5.6,7 (respectively).

SESSION 8 - 60min:

1. The students sit on the adjudicated computers (by order of the list, the same as the last session) and the headphones are placed.
2. The students open the Camtasia Studio 8.6 software and they start recording the activity.
3. Students enter the WISE website (with the user and password delivered).
4. The students access the third activity called "The Syphilis", to carry out the task assigned to them “Syphilis disease”. They are reminded that the headsets must be put in place and they will be continually verbalizing what they are doing and why.
5. After completing the task, they are asked to stop recording the screen and save the file to USB by writing: name of the highschool_group_name and surnames_8, for example: paucasesnoves_A_martagómezdomingo_8

** During all the sessions the teacher and the researcher will verify that all the recording softwares are being recorded correctly. At the same time, students will be reminded of the importance of constantly verifying what they are doing.*

- **<u>AFTER THE INSTRUCTION SESSIONS:</u>**

After completing the sessions, ALL students will be required to complete "The Final Evaluation Test in paper format." For the completion of this test, all students will have to be available individually in the classroom (format exam) so that the responsible teacher will then submit the final evaluation test (photocopies attached). Once the students complete the test, the teacher will make sure that all the tests have the student's names and lineages and the photocopies will be introduced in the envelope. It is suggested to carry out the test during one hour of whole class group.

** If for any reason the day on which the test was carried out one of the students has not been able to attend, they will have to be carried out in another space of time.*

.

12.3. Annex 3. Computer technicians' logistic survey

Translated from Catalan

LOGISTIC QUESTIONNAIRE FOR THE PREPARATION OF INTERVENTION	
Name of the participating high school:	
Name of the teachers responsible of the activity:	
Name of the computer technician of the high school:	
Will laptops or desktop computers be used?	
How many laptops or desktop computers are available?	
Are there enough computers for each student?	
Should computer material be reserved in advance?	
What days will the sessions be held?	
Are there headphones for each laptop or desktop computer?	
Are there microphones for every laptop or desktop computer?	
Has the Camtasia Studio 8.6 software installed on all the computers that will be used?	
Has the compatibility between computers and the Internet portal that will be used been checked? * Check compatibility using this link: **https://wise.berkeley.edu/pages/check.html**	
Which browser is usually used in the computers of the high school?	

12.4. Annex 4. Science knowledge test on illnesses and health

Translated from Catalan

TEST OF CONTENTS OF THE AREA OF SCIENCES

ACTIVITY 1. Below you will find 10 questions with multiple choice answers. Choose the answer you think is correct in each case.

1. Health is defined as:

a) The state of the human being when there is no pain.
b) State of complete physical, mental and social well-being.
c) Absent state of infectious diseases.
d) A state that does not present symptoms of physical illnesses.

2. Depending on its cause the diseases can be classified in:

a) Physical illnesses, mental illnesses and social illnesses.
b) Chronic diseases, accidental illnesses.
c) Exotic diseases, common diseases and frequent illnesses.
d) Degenerative diseases, static illnesses and evolutionary illnesses.

3. Infectious diseases are:

a) Caused by a malfunction of the brain, which causes a decrease in mental capacity, or some alteration of the behavior.
b) Caused by a pathogen that is reproduced within our body.
c) Caused by the existence of a violent social environment or with serious economic or educational deficiencies, and, therefore, it is hostile to people.
d) Caused by a chronic injury of the device.

4. The pathogenic microorganisms that cause infectious diseases are:

a) Viruses, fungi, insects, germs.
b) Bacteria, Insects, Protozoa.
c) Protozoa, Virus, Bacteria, Mushrooms.
d) Viruses.

5. Pathogenic microorganisms are transmitted through:

a) Concrete route, abstract route.
b) Inland way, outer route.
c) Fast way, slow route.
d) Direct route, indirect route.

6. For the prevention of an infectious disease, you must:

a) Perform daily physical exercise, food hygiene but the proper vaccination is not necessary.
b) Personal and environmental hygiene, food hygiene, sexual health, adequate vaccination, preventative measures in travel and pet care.

c) Personal hygiene, food hygiene, sexual health, but no preventive measures are required in travel.
d) Perform a physical exercise, do not eat gritty products and drink blood.

7. Non-infectious diseases:

a) They are not transmitted, since they are not provoked by pathogenic microorganisms.
b) They are not easily contracted since only some pathogenic microorganisms are responsible.
c) They are not the most common ones because they are only transmitted through animals.
d) They are not transmitted quickly because they are caused by weak pathogenic microorganisms.

8. The indirect transmission of an infectious disease occurs:

a) through contaminated elements such as: water, air, food, etc.
b) through contact with the sick person.
c) only through contact with infected animals.
d) through non-polluting elements such as: water, air, food, etc.

9. The immune response can be of two types:

a) Specific or diverse.
b) Specific or acquired.
c) Innate or nonspecific.
d) Specific or non-specific.

10. Vaccines:

a) Cure infectious diseases.
b) They are only put on children and the elderly.
c) They trigger a nonspecific immune response.
d) They are prepared for virus and dead or attenuated bacteria.

<u>ACTIVITY 2.</u> Given the following 25 words, develop a conceptual map where they appear related:

HEALTH – WELFARE STATE - HEALTHY HABITS - REST - HYGIENE - DIET - PHYSICAL EXERCISE - DISEASES - MENTAL DISEASES - SOCIAL DISEASES - PHYSICAL DISEASES - INFECTIOUS - NON-INFECTIOUS - PATHOGENS MICROORGANISMS - DIRECT VIA - INDIRECT VIA - BACTERIA - FUNGUS - PROTOZOUS - VIRUS - PREVENTION MEASURES - VACCINES - IMMUNITARY RESPONSE - INSPECIFIC - SPECIFIC.

<u>ACTIVITY 3.</u> Write a Decalogue of prevention measures to avoid infectious disease:

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

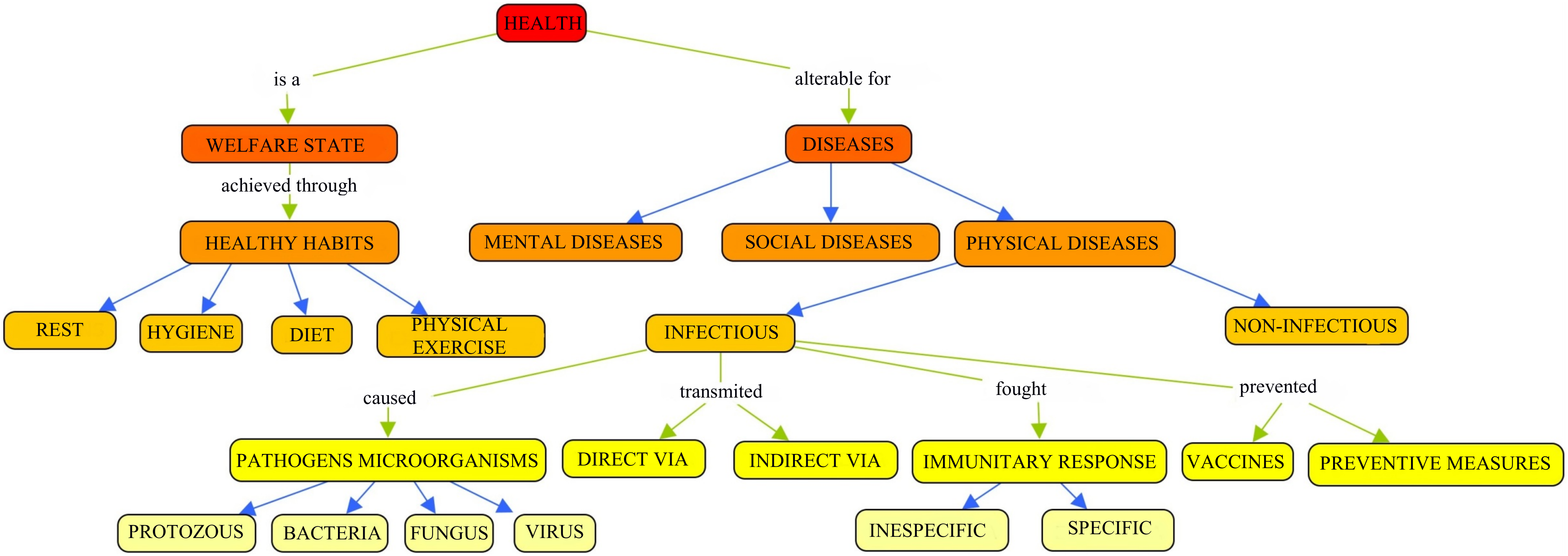
7. ____

8. ____

9. ____

10. ____

12.5. Annex 5. Extern model of the conceptual map



12.6. Annex 6. Table of answers examples

	CORRECT CONCEPTS	INCORRECT CONCEPTS
HAVE HYGIENE	Take care of personal hygiene: - Have a shower once a day to remove sweat and dead skin cells. - Change underwear clothes and socks every day, that is, use clean clothes. - Disinfect/cure any wound or burn by applying a disinfectant (iodine, alcohol, soap, oxygenated water). - Take the appropriate vaccines. - Wash your teeth after each meal. - Live in an hygienic place, that is to say clean.	- Do physical exercise. - Do not smoke. - Do not take drugs. - Visit the doctor if you are not well.
	Take care of food hygiene: - Wash your hands before cooking or eating. - Wash raw food such as fruits and vegetables before being ingested. - Check the good condition of the food to be ingested. - Use clean kitchen utensils. - Drink potable water. - Avoid raw meat or fish consumption.	- Drink a lot of water. - Maintain a balanced diet. - Eat lots of fruits and vegetables. - Do not drink alcohol. - Drink healthy liquids (orange juice). - Eat quality foods. - Take vitamin supplements.
AVOID THE CONTACT	Take preventive measures when contacting other people (mask, gloves, etc.): - Use protection in sexual relationships (condom). - Do not share utensils of personal use such as toothbrushes, shavings, cutlery, glasses, syringes, tissues, etc. - Avoid contact with infected people. Avoid contact with pathogenic microorganisms: - Use flip flops in swimming pools and changing rooms. - Avoid contact with dirty or unknown objects. - Avoid contact with unknown animals. - Take care of pets properly.	- Use contraceptive methods which are not condoms. - Sexual health. - Do not breathe the same air.
TRAVEL WITH CAUTION	Take preventive measures while traveling to tropical areas: - Use insect repellents. - Use long trousers, long-sleeved shirts, socks and closed shoes to cover the maximum body surface area. - Use mosquito nets in beds, cots and strollers. - Choose an accommodation with air conditioning because insects avoid cool climates. - Install mesh nets in the windows to prevent the entry of insects. - Avoid visiting areas with poor sanitation where the risk of being crushed by an insect is higher. - Apply recommended vaccines when traveling to tropical areas. - Avoid traveling to areas with a risk of infection.	- Environmental health. - Avoid sites with pollution. - Environmental hygiene. - Handle toxic waste.

12.7. Annex 7. Answers' correctness sheet

Translated from Catalan

INITIAL PERFORMANCE ANSWERS

Table 45

Initial performance answers of Task 1 (Handling isolated information)

Questions	Correct answers
Question 1: Which of the following symptoms is proper to a person suffering from the Zika virus disease?	b) Fever.
Question 2: What kind of illness is Zika virus disease?	a) Physical illness (infectious).
Question 3: What medical tests can detect that a person suffers from the Zika virus disease?	a) Analysis of blood or other body fluids.
Question 4: How is Zika virus disease transmitted?	a) Indirectly, through the bite of mosquitoes that act as vectors.
Question 5: What is the treatment to be taken by a patient infected with the Zika virus?	b) There is no specific treatment for the infection caused by the Zika virus.
TOTAL SCORE TASK 1	5

Table 46

Initial performance answers of Task 2 (Connecting concepts)

Word	Correct answers
Word 1	physical
Word 2	infectious
Word 3	virus
Word 4	Zika
Word 5	indirect
Word 6	mosquito
Word 7	Preventive measures
Word 8	use repellents / put mosquito nets / wear clothes that cover the body / sleep in places with air conditioning
Word 9	use repellents / put mosquito nets / wear clothes that cover the body / sleep in places with air conditioning
Word 10	use repellents / put mosquito nets / wear clothes that cover the body / sleep in places with air conditioning
Word 11	fever / rash / joint or muscular pain / conjunctivitis / headache / tiredness
Word 12	fever / rash / joint or muscular pain / conjunctivitis / headache / tiredness
Word 13	fever / rash / joint or muscular pain / conjunctivitis / headache / tiredness
Word 14	treatment
Word 15	laboratory tests
TOTAL SCORE TASK 2	15

Table 47

Initial performance answers of Task 3 (Thinking about concepts)

Categories	Score
Students do not give an answer.	0
Students to give an answer copy and paste information.	1
Students to give an answer paraphrase or write with their own words an answer.	2
TOTAL SCORE TASK 3	10

Translated from Catalan

FINAL PERFORMANCE ANSWERS

Table 48

Final performance answers of Task 1 (Handling isolated information)

Questions	Correct answers	
Question 1: If Syphilis is not treated, what are the 3 stages of the disease?	c)	Primary syphilis, secondary syphilis, tertiary syphilis.
Question 2: What kind of illness is Syphilis?	a)	Physical illness (infectious).
Question 3: What medical tests can detect that a person suffers from syphilis?	b)	Blood tests.
Question 4: Which pathogen causes Syphilis?	a)	Bacteria.
Question 5: What is the treatment to be taken by a patient infected with Syphilis?	a)	Antibiotic.
TOTAL SCORE TASK 1	5	

Table 49

Final performance answers of Task 2 (Connecting concepts)

Word	Correct answers
Word 1	physical
Word 2	infectious
Word 3	bacteria
Word 4	Treponema pallidum
Word 5	direct
Word 6	Sexual relations
Word 7	Preventive measures
Word 8	use condoms / avoid contact with skin lesions / use oral barrier / do not share needles or syringes / follow prophylaxis protocols
Word 9	use condoms / avoid contact with skin lesions / use oral barrier / do not share needles or syringes / follow prophylaxis protocols
Word 10	use condoms / avoid contact with skin lesions / use oral barrier / do not share needles or syringes / follow prophylaxis protocols
Word 11	primary
Word 12	secondary
Word 13	tertiary
Word 14	antibiotics
Word 15	Blood tests
TOTAL SCORE TASK 2	15

Table 50

Final performance answers of Task 3 (Thinking about concepts)

Categories	Score
Students do not give an answer.	0
Students to give an answer copy and paste information.	1
Students to give an answer paraphrase or write with their own words an answer.	2
TOTAL SCORE TASK 3	10

12.8. Annex 8. Answers' correctness sheet

INITIAL TASKS PERFORMANCES

4

SCANNING INFORMATION

T1 time scanning useful information	T1 time scanning non-useful information	T1 Time scrolling	T1 Nº of slides lineal reading	T1 Nº of slides scanning reading	T1 Nº of slides scrolling	T2 time scanning useful information	T2 time scanning non-useful information	T2 Time scrolling
187	296	05	15	1	4	262	54	38

T2 Nº of slides lineal reading	T2 Nº of slides scanning reading	T2 Nº of slides scrolling	T3 time scanning useful information	T3 time scanning non-useful information	T3 Time scrolling	T3 Nº of slides lineal reading	T3 Nº of slides scanning reading	T3 Nº of slides scrolling
20	13	33	103	59	01	5	1	2

PROCESSING INFORMATION

T1 time processing information	T1 Nº correct answers consulted	T1 Nº correct answers non-consulted	T1 Nº incorrect answers consulted	T1 Nº incorrect answers non-consulted	T2 time processing information	T2 Nº correct answers consulted	T2 Nº correct answers non-consulted	T2 Nº incorrect answers consulted
94	0	3	1	1	396	7	2	4

T2 Nº incorrect answers non-consulted	T3 time processing information	T1 Nº correct answers consulted	T1 Nº correct answers non-consulted	T1 Nº incorrect answers consulted	T1 Nº incorrect answers non-consulted
0	213	3	2	0	0

3

Scanning information (time)			
Slide numbe	Task 1	Task 2	Task 3
Slide 01	12	20	22
Slide 02	49	149	00
Slide 03	76	17	00
Slide 04	56	33	37
Slide 05	45	05	00
Slide 06	21	09	00
Slide 07	35	47	00
Slide 08	58	14	00
Slide 09	26	14	00
Slide 10	34	16	03
Slide 11	35	00	100
Slide 12	36	10	00
Time per tasl	187	269	103
Time per tasl	296	65	59

1

STUDENT'S PERFORMANCE				
CODE	START	END	Duration	Scrollings
t1s01	0:02:58	0:03:10	12	
t1s02	0:03:10	0:03:48	38	
t1s03	0:03:48	0:04:42	54	
t1s04	0:04:42	0:05:32	50	
t1s05	0:05:32	0:06:13	41	
t1d	0:06:13	0:06:17	04	3
t1s05	0:06:17	0:06:21	04	
t1s06	0:06:21	0:06:42	21	
t1s07	0:06:42	0:07:17	35	
t1s08	0:07:17	0:08:15	58	
t1s09	0:08:15	0:08:41	26	
t1s10	0:08:41	0:09:15	34	
t1s11	0:09:15	0:09:50	35	
t1s12	0:09:50	0:10:26	36	
t1q01	0:10:26	0:10:38	12	
t1q02	0:10:38	0:10:52	14	
t1d	0:10:52	0:10:53	01	1
t1s02	0:10:53	0:11:04	11	
t1s03	0:11:04	0:11:26	22	
t1s04	0:11:26	0:11:32	06	
t1q02	0:11:32	0:11:36	04	
t1q03	0:11:36	0:11:50	14	
t1q04	0:11:50	0:12:22	32	
t1q05	0:12:22	0:12:40	18	
t2s01	0:12:54	0:13:11	17	
t2s02	0:13:11	0:13:38	27	
t2q01	0:13:38	0:13:46	08	

2

Processing information				
Question	Time	orrectnes	Type	Queries
T1Q01	12	1	0	0
T1Q02	18	0	1	1
T1Q03	14	1	0	0
T1Q04	32	1	0	0
T1Q05	18	0	0	0
T2Q01	51	0	1	4
T2Q02	12	0	1	1
T2Q03	10	0	0	0
T2Q04	12	1	1	1
T2Q05	96	0	1	4
T2Q06	20	0	1	1
T2Q07	09	1	0	0
T2Q08	29	1	1	3
T2Q09	16	1	1	1
T2Q10	48	1	1	1
T2Q11	12	1	1	1
T2Q12	08	1	1	2
T2Q13	26	1	0	0
T2Q14	24	0	0	0
T2Q15	23	1	1	1
T3Q01	109	1	1	1
T3Q02	27	1	1	1
T3Q03	61	0	1	1
T3Q04	65	1	1	1
T3Q05	72	1	1	1

12.9. Annex 9. Descriptive statistics

Table 51

Descriptive statistics of students' reading skills (N = 82)

	M	SD
Information retrieval.	3.10	1.59
Information integration.	5.45	2.09
Text reflection of content and form.	2.99	1.24
Global reading skill	11.54	4.12

Table 52

Descriptive statistics of students' Information and Communication Technology skills (N = 82).

	M	SD
I am able to identify appropriately the needed information from question.	3.67	0.93
I am able to collect/retrieve information in digital environments.	3.83	0.95
I am able to use ICT to process appropriately the obtained information.	3.68	1.07
I am able to interpret and represent information, such as using ICT to synthesize.	3.57	1.05
I am able to use ICT to design or create new information from information already acquired.	3.57	0.98
I am able to use ICT to convey correct information to appropriate targets.	3.78	0.96
I am able to judge the degree to which information is practical or satisfies the needs of the task.	3.74	0.76
Information Literacy	3.71	0.82
I am able to set a homepage for an internet browser.	4.33	1.19
I am able to search for information on the internet using a search engine (e.g. Yahoo, Google, Baidu).	4.48	0.95
I am able to use email to communicate	4.38	1.02
I am able to use instant messaging software (e.g. MSN, QQ) to chat with friends.	4.54	0.98
I am able to download files from the internet.	4.40	0.98
Internet literacy	4.45	0.91
I am able to set header/footer in word processor software (e.g. Microsoft Word).	3.93	1.08
I am able to plot a graph and chart using spreadsheet software (e.g. Microsoft Excel).	3.79	1.11
I am able to insert an animation in presentation software (e.g. Microsoft PowerPoint).	4.09	1.03
I am able to edit a photo using image-processing software (e.g. Photo Editor, Photo Impact, and Photo Shop).	4.11	1.01
I am able to set up a printer (e.g. installing printer drivers).	3.77	1.20
Computer literacy	3.99	0.90
Global ICT skill	3.97	0.68

Table 53

Descriptive statistics of students' previous science knowledge (N = 82)

	M	SD
Handling isolated information without transforming the content in any way.	5.52	1.59
Connecting concepts and ideas from more than one information source.	2.71	1.86
Thinking about concepts and developing complex conceptual frameworks.	3.78	2.17
Total initial science knowledge	12.06	4.03

The information and knowledge society of this century expects students to manage the excess of information successfully, but this does not mean that they have the necessary skills to deal with Information Problem Solving (IPS). This study expands further on academic knowledge available about students' IPS process development, by exploring in depth the relation among certain students' individual characteristics and students' performance of scanning and processing information skills through an instruction developed in a scientific Inquiry Web Based Learning environment. The data collected from a total of 82 secondary students suggest that the instruction used to improve students' IPS skills embedded in science curricular content was successful since all the students improved the learning performance of both, science knowledge on illnesses and health, and IPS skills performance. Findings also show that there are not numerous significant correlations between students' individual skills and their achievement when performing scanning and processing information skills, but highlight several significant correlations between both constituent skills. The work could help teachers to plan, implement, and evaluate IPS instruction in schools.

Universitat
Oberta
de Catalunya