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Los cuadernos inteligentes en la enseñanza-aprendizaje de las ciencias naturales. Una investigación desde la percepción docente

Interactive notebooks in the teaching-learning of natural sciences. A research from teaching perception

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Resumen

Los cuadernos inteligentes son una herramienta novedosa que actualmente se está utilizando en la enseñanza de las ciencias en Educación Infantil, Primaria y Secundaria en algunos centros españoles. Hasta el momento, se ha investigado sobre las percepciones de investigadores y familias sobre los beneficios del uso de los cuadernos en el aprendizaje de las ciencias. Consideramos que analizar las percepciones del profesorado, formado específicamente para el uso de dicha herramienta, en el contexto del modelo bilingüe de enseñanza de las ciencias, completa las investigaciones publicadas hasta el momento. Para ello, se ha desarrollado un estudio selectivo descriptivo mediante una encuesta transversal con una muestra de 36 docentes de ciencias de Educación Infantil, Primaria y Secundaria. El instrumento utilizado para la recogida de la información es un cuestionario adaptado y validado por expertos en el campo de investigación. Los resultados muestran que los docentes encuestados coinciden en que los cuadernos inteligentes son una herramienta metodológica efectiva tanto para el alumnado como para los docentes, considerando una incidencia positiva en el aprendizaje de ciencias, en concreto destacan los beneficios sobre el desarrollo del pensamiento crítico, la motivación, organización, planificación y evaluación de contenidos y procedimientos científicos.

Palabras clave: *Cuadernos inteligentes; educación científica; percepción del profesorado; educación obligatoria*

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Abstract

Interactive notebooks are a novel tool that is currently being used in science teaching in Early Childhood, Primary and Secondary Education in some Spanish centers. To date, research has been conducted on the perceptions of researchers and families about the benefits of using notebooks in science learning. We consider that analyzing the perceptions of teachers, specifically trained for the use of this tool, in the context of the bilingual science teaching model, completes the research published to date. To this end, a selective descriptive study has been developed through a cross-sectional survey with a sample of 36 science teachers from Early Childhood, Primary and Secondary Education. The instrument used to collect information is a questionnaire adapted and validated by experts in the research field. The results show that the teachers surveyed agree that smart notebooks are an effective methodological tool for both students and teachers, considering a positive impact on science learning, specifically they highlight the benefits on the development of critical thinking, motivation, organization, planning and evaluation of scientific content and procedures.

Keywords: *Interactive notebook; science education; teacher perception; Mandatory education*

Introduction

Interest in learning foreign languages has been steadily increasing in recent years. There are several factors that contribute to this fact. The process of globalization, increasing commercial, cultural and tourist relations between countries; the constant development of technology and adaptability to the new 'Age of Knowledge' make mastery of more than one language essential. This means that the better access to language learning and new learning methods are now crucial in many educational contexts (Aragón, 2007; Coyle et al., 2010).

To achieve these goals, Content and Language Integrated Learning (CLIL) is currently shaping the educational system in Spain. Specifically, in the Autonomous Community of Aragon, a bilingual project was implemented under this methodological approach known as 'BRIT', established in the Order of May 18th, 2018 (BOA, 2018). This model defines that the foreign language will be used as a means of learning the content of the subjects. Among them, one of the most demanded and object of study of this research, Natural Sciences in Primary Education.

The current challenge of the Science class is not so much to transmit information as to teach how to use it, to establish relationships and connections between information and to communicate our ideas. It is necessary to write ideas and also to structure, illustrate them with graphs, evaluate or compare them (Sanmartí & Izquierdo, 1997). The CLIL educational approach increases the difficulty of the subject by having to overcome the language barrier to approach the content and internalize the learning, so a methodological change is necessary, one that includes tools that ensure learning in Science. In this context of methodological change, the 'interactive notebooks' emerged in 2014 (Embid, 2018).

The interactive notebook is an educational tool that shows a student's work throughout the academic year, capturing both the content learned (right page of the notebook or 'input') and the reflective knowledge (left page or 'output') acquired and produced by the student. These notebooks provide a means to communicate, record, evaluate, and reflect their work (Marcarelli, 2010). Currently, several studies have been published, all of them based on students' improvements in Science learning through the tool (Bravo-Torija et al., 2016) or on the perceptions of researchers (Westfall, 2018). This makes this study consider the possibility of expanding the field of research by counting on one of the educational agents that collects the most information about the teaching-learning process: teachers.

Therefore, the main objective of this study is to analyze how interactive notebooks intervene in science learning in the bilingual model of Aragon from the teachers' point of view. The specific objectives that will guide this research are:

- To design an instrument and validate it to analyze the teachers' perception of interactive notebooks in the teaching-learning of Science in Primary Education.
- To study how and to what extent interactive notebooks facilitate Science learning according to teachers' perceptions.
- To identify and describe the pedagogical and didactic benefits of interactive notebooks in Science for teachers from the teacher's point of view.
- Identify and describe the difficulties and proposals for improvement towards interactive notebooks in Science from the teacher's point of view.

Next, we proceed to delimit interactive notebooks as an object of study and the numerous didactic and pedagogical benefits evidenced in previous studies.

Interactive notebook. Definition and characteristics.

Interactive notebooks originated in the 1970s by a California teacher, Lee Swenson, in the field of social studies. The interactive notebook was later adopted by the Teacher's Curriculum Institute (TCI) as part of the 'History Alive' Program (Mallozzi, 2013). Over the years, interactive notebooks have been used in numerous classrooms across the U.S. in social studies instruction and have recently expanded around the world to other disciplines such as mathematics or experimental sciences, the area of study of this research.

In the publications related to this tool, several meanings of interactive notebooks are defined, all of which coincide. According to Young (2003), 'smart' or 'interactive' science notebooks are a tool used to strengthen curriculum learning ('input') through greater student engagement ('output'). It is the culmination of a student's performance throughout the year that demonstrates both the content learned ('input') and the reflective knowledge acquired ('output') (Yaylak, 2020). Marcarelli (2010) adds that a interactive notebook provides a space where students can make connections before new learning, review their thinking, apply it, and share it with their classmates, families and teachers.

Using the interactive notebook as a tool for teaching Science involves structuring the content through an organization by thematic units, each of which includes the following pages (Marcarelli, 2010):

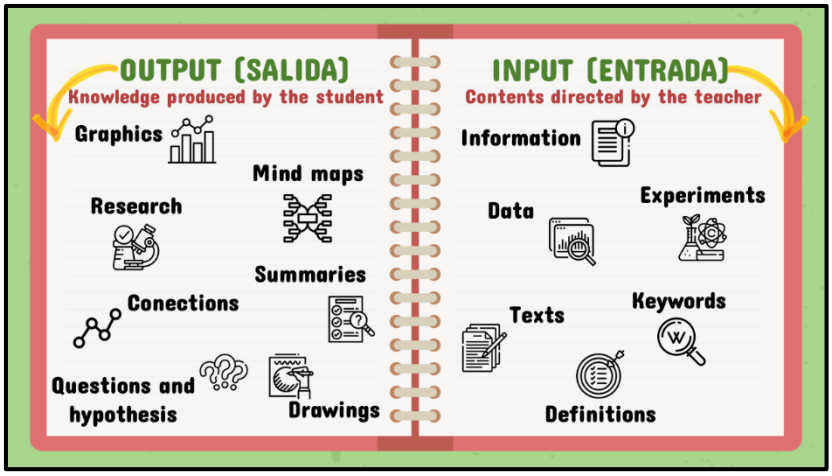
- The cover of the unit, including the title and possible illustrations.
- The 'Aha Connections' pages, which provide a place to record key questions and important concepts you learn throughout the unit.
- The input and output pages. As can be seen in Figure 1, the right side of the interactive notebook is an area dedicated to explanations (texts, words, definitions, etc.) given by teachers or notes taken by students. This information is called 'input'. In contrast, the left side is an area used to process, visualize, and interact with new information using various metacognitive strategies such as drawings, concept maps, reflections, or summaries. The student's interaction with information is called 'output' (Robinson, 2018; Yaylak, 2020). In this way, the right side of the notebook contains the teacher-directed content (Westfall, 2018), while the left side contains activities to engage students with the new information; emphasizing their thinking about acquired knowledge (metacognition); and demonstrate their learning (Waldman & Crippen, 2009).
- The self-reflection page, at the end of each unit, where students write about their performance and the scientific skills acquired (Marcarelli, 2010).

Pedagogical and didactic benefits of the use of interactive notebooks

According to Kellie Marcarelli (2010), interactive notebooks provide an open door into students' minds to reveal their understanding of scientific concepts. However, according to Young (2003), the benefits that interactive Science notebooks bring to the classroom for teachers are also abundant and varied. Below, we present a detailed literature review on both.

Figure 1

Graphical representation of the organization of an interactive notebook.



Pedagogical and didactic benefits of the use of interactive notebooks

According to Kellie Marcarelli (2010), interactive notebooks provide an open door into students' minds to reveal their understanding of scientific concepts. However, according to Young (2003), the benefits that interactive Science notebooks bring to the classroom for teachers are also abundant and varied. Below, we present a detailed literature review on both.

Benefits of interactive notebooks for students

First, interactive notebooks have been shown to improve student learning and academic performance in Science. Floria Mallozi (2013) studied whether the use of interactive notebooks would affect the scientific skills of 194 students at two schools in the Northeastern United States. The results revealed that students who used this methodology scored significantly higher. Similar results were obtained with students of Algebra (Drew, 2018) and Physics (Fajardo et al., 2019). Interactive notebooks are characterized by working specifically on the development of scientific skills, allowing students the opportunity to connect their thinking and experiences with scientific concepts, deepen and refine their scientific ideas, and reflect on their learning (Bravo-Torija et al., 2016; Marcarelli, 2010).

However, interactive notebooks seek to promote not only the acquisition of scientific knowledge but also the skills and abilities that characterize the work of scientists (Marcarelli, 2010). Scientists use laboratory notebooks to record data and observations, to draw models to represent their ideas, to ask questions and draw conclusions (Nesbit et al., 2004). Interactive notebooks engage students in authentic scientific language and processes such as data recording or analysis (Fulton, 2017; Mallozzi, 2013; Mason and Bohl, 2017; Young, 2003).

In addition, it has been proven that these notebooks encourage active and personal learning. They provide students with autonomy in their learning, a space in which students construct the meaning of the information transmitted in class in a creative and independent way (Gilbert & Kotelman, 2005; Jaladanki and Bhattacharyya, 2014).

Interactive notebooks have also been shown to be tools for thinking and metacognition. First, it allows them to create a record of reflection, evaluation, and connections with previous ideas (Marcarelli, 2010; Mason & Bohl, 2017) and in addition, this tool enhances students' critical thinking to obtain, analyze and process information (Embid, 2018). The interactive notebook can be used to construct their own knowledge, enhancing metacognitive strategies or knowledge of their own cognitive processes in learning (Chesbro, 2006; Gilbert and Kotelman, 2005; Waldman & Crippen, 2009). When students explain what they have learned in writing, they are forced to

organize their ideas and thoughts so that other people can understand them (Young, 2003).

On the other hand, it can be examined how interactive notebooks promote effective learning strategies. Kellie Marcarelli (2010) highlights that this tool helps students develop strategies as diverse as setting objectives, generating and testing hypotheses before starting their explorations, identifying similarities and differences when establishing connections between concepts, or making graphical representations. Other studies add that students also develop their note-taking skills (Westfall, 2018) or formulating questions (Bravo et al., 2016).

In addition, they offer numerous opportunities to develop and improve students' written, visual, and oral communication skills, thereby connecting Science with other areas (Gilbert & Kotelman, 2005; Young, 2003). Interactive notebooks also support the integration of reading within scientific content (Westfall, 2018).

Another relevant development is the improvement of students' organisational skills (Embid, 2018). Over time, students demonstrate better organization in both thinking and work habits (Marcarelli, 2010). The notebooks provide a study reference as well as a resource for consulting information (Young, 2003).

In addition, interactive notebooks support differentiated and inclusive learning, helping all students achieve their goals and attending to their individual needs (Amaral et al., 2002; Gilbert and Kotelman, 2005). Students can work successfully at their own pace and their use can even facilitate the development of intervention measures for students with special needs (Marcarelli, 2010).

Several studies also highlight the high levels of acceptance of interactive notebooks and the effects they have on student motivation (Marcarelli, 2010). Erham Yaylak (2020) revealed the opinions of students at a Secondary school in Ixmir, Turkey, about the interactive notebook. The findings indicated that the participants mostly defined them as an entertaining, instructive tool that could be extrapolated to other subjects.

Another reason to use interactive notebooks is that they serve as formative assessment tools as they provide the teacher with a record of each student's thinking and level of understanding throughout the teaching-learning process (Gilbert & Kotelman, 2005; Nesbit et al., 2004). In addition, their own self-knowledge and their capacity for self-evaluation (metacognition) are enhanced (Embid, 2018; Marcarelli, 2010).

Finally, they facilitate communication between students, teachers and families. Contributions in the notebook provide teachers and families with evidence of a student's conceptual understanding, reflections, and personal growth (Nesbit et al., 2004; Young, 2003).

Benefits of interactive notebooks for teachers

Many experts highlight that interactive notebooks improve teachers' programming and planning by providing a clear structure of lessons (Marcarelli, 2010). The notebooks give access to students' thinking, what misconceptions they have, and the organizational skills they are using. All of this information can guide teachers in their instruction (Gilbert & Kotelman, 2005; Marcarelli, 2010).

One of the most valuable aspects of this tool is the wealth of assessment information it can gather to conduct a comprehensive assessment. Westfall (2018) showed that teachers can collect data on students' level of comprehension, connections, identify misconceptions, or discover the questions they ask. The smart notebook provides the teacher with a means to assess student progress and provide continuous and specific feedback on their learning (Marcarelli, 2010; Young, 2003).

Finally, several studies show the effects they have on classroom management, since all student work is organized in this notebook (Marcarelli, 2010); and communication and collaboration between teachers and with families (Gilbert & Kotelman, 2005).

Throughout this section, evidence has been presented of the numerous benefits that interactive Science notebooks bring to the classroom, becoming real evidence of student learning and thinking and an adequate and effective teacher tool (Marcarelli, 2010; Young, 2003). All the research has

analyzed the benefits of interactive notebooks from the perceptions of students, families or researchers. To complete this theoretical field, it is necessary for this study to address and collect the perceptions and evidence that can be provided by teachers who use this tool as the main educational agent. To this end, it is considered necessary to contextualize the current teaching of Science in the Autonomous Community of Aragon, adapted to the bilingual model and the educational legislation that regulates it.

Contextualization of Bilingual Science Education in the Autonomous Community of Aragon

The mastery of foreign languages, an essential skill for the society of the 21st century, is one of the aims of current educational projects, hence the great momentum that bilingual education is gaining (Aragón, 2007). Content and Language Integrated Learning (CLIL) is one of the benchmarks of the current educational context in Spain. It is a two-way educational proposal in which a foreign language is used for learning and teaching of both content and language. This approach is based on four fundamental pillars: content, communication, culture and cognition (Coyle et al., 2010).

Among the different areas of knowledge, the Natural Sciences have usually been chosen as one of the contexts to develop this integrated curriculum in a foreign language (Embid, 2018). Numerous studies show that the inclusion of Experimental Sciences in bilingualism projects, in addition to improving language skills, can promote Science learning (Archila, 2013; Bravo-Torija et al., 2016). Aragón (2007) postulates that the bilingual Science project potentially improves students' attitudes and performance, can enhance the development of scientific discourse by favoring meaningful learning, and opens new paths for students.

The context of this study is located in the bilingual model of the Autonomous Community of Aragon. This model, known as 'BRIT', emerged from the publication of the Order of 18th May 2018 (BOA, 2018). This order generates the principles for schools to implement bilingual education, establishing that the foreign language will be used as a means of learning the content of the subject.

The CLIL educational approach requires a methodological change that helps students to overcome the language barrier in order to be able to approach the content and internalize and reflect on their own learning. In this context, interactive notebooks emerge as a methodological proposal to this new educational model (Embid, 2018). In Aragon, in its first year of implementation, in the 2014-15 academic year, interactive notebooks substantially improved student results, as shown by two studies carried out by the 'Beagle' research group at the University of Zaragoza (Bravo et al., 2016).

In the first study, the performance of scientific skills of 72 students in the 4th year of Primary Education from two schools in Zaragoza was compared, one that works on Science with the CLIL approach, and another that combines this approach with the interactive notebooks. The results showed that the performance of students reaches greater complexity in the school that uses the interactive notebooks, especially in the formulation of questions, the identification of similarities and differences and the ability to design research (Bravo-Torija et al., 2016).

In the second study, scientific questions asked by 131 elementary school students in Science while working with interactive notebooks were analyzed. The results suggest that there is an increase in causal and predictive questions in the students who use these notebooks. These findings could indicate that its use promotes an improvement in the type of questions students ask (Bravo et al., 2016).

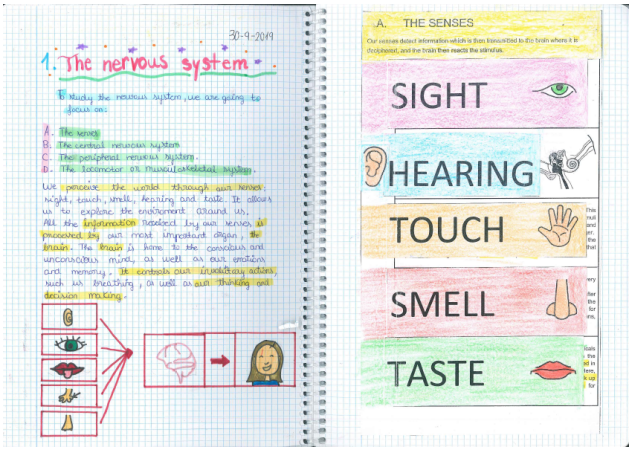
These studies show that interactive notebooks are also suitable for learning Science in the bilingual model of Aragon. In fact, they are recognized as 'Exemplary teaching performance' by the Government of Aragon (BOA, 2015) and there are several educational centres that are implementing this methodology (18 in total), in the three provinces and in the different educational stages from Infant Education to Secondary Education. Figure 2 shows several examples of interactive notebooks made by students in an Aragonese school.

Once the theoretical foundation and context of this research were examined, it was evident that there is little presence of studies that analyze the benefits of this tool from the perception of teachers, who can observe daily the changes produced by its implementation and the progress achieved by students in the Science knowledge. This line of research leads the study presented

into the following sections, detailing the methodology and the process of collecting and analyzing results.

Figure 2

Photographs of the interactive notebooks of an educational centre in the province of Zaragoza.



Method

To achieve the objectives set out in this research, a selective descriptive methodology has been used, through the survey technique, by cross-sectional sampling thanks to a questionnaire adapted and validated for the survey. This methodological choice is justified by the aim of collecting information from a very specific population of teachers at a single time and over a short period of time.

The survey method allows us to obtain information on aspects that have already happened and that are difficult to observe, such as, in this case, the teachers' perception of a certain methodology. This method establishes rules to be able to scientifically access teachers' thoughts, opinions and experiences regarding interactive notebooks (León & Montero, 1997). In addition, it makes it possible to describe a given reality, identify regularities in the data and existing relationships between the variables of interest (Fontes de Gracia et al., 2010).

The survey presented in this research is sample-based because it aims to collect information from a subset of the population or sample, descriptive since its objective is to know and have an approximation to the population's perception of interactive notebooks; and transversal because it collects information in a single moment in time (Fontes de Gracia et al., 2010).

Characteristics and Sample Selection

The target population is all teachers who implement or have implemented interactive notebooks in bilingual Science classrooms in Aragon in their professional careers. The selection of the subjects was carried out by a non-probabilistic, intentional and convenience sampling technique based on the criteria of accessibility and interest. In this case, it has not been possible to draw a random sample since the total number of units that make up the population is unknown. Teaching staff, due to their interim regime, move continuously from school to school, so accessibility and contact with all teachers who have used the interactive notebooks is complicated (Fontes de Gracia et al., 2010). Thus, the final sample (Table 1) that participated in the survey was made up of 36 teachers, 81% of whom were women. It should be noted that 48% of teachers have been implementing interactive notebooks for more than three years.

Table 1
Sample description (n=36)

Gender	Number of teachers	Educational stage		
		Early Childhood and Primary Education	Primary Education	Secondary Education
Male	6 (16,67%)	1	5	
Female	29 (80,55%)	1	27	1
I'd rather not say	1 (2,78%)		1	
	36	2 (5,55%)	33 (91,67%)	1 (2,78%)

Note. Sample number n = 36

Instrument: adaptation and validation

The instrument designed and used to collect the information is a questionnaire (Appendix A) adapted from the one used by Ana García-Valcárcel et. al. (2012) and validated by three experts in the field of research in the Didactics of Experimental Sciences. It consists of three distinct sections:

1) In the first section, there is a part linked to the respondent's profile with sociodemographic variables such as gender, age or educational stage of their teaching.

2) The second part corresponds to the assessment of the interactive notebooks as a methodological tool through 24 items formulated with a 5-point Likert category scale, which allows each item to be assessed from 'strongly disagree' (1) to 'strongly agree' (5). Based on the literature consulted, the items in this section are divided into nine blocks that correspond to the variables of interest in this study: academic and scientific performance, bilingual teaching, learning, learning to learn, motivation, organization, attention to diversity, evaluation, and relationships.

3) The third section discusses the advantages and disadvantages of interactive notebooks. It consists of two closed-ended binary choice questions and five open-ended questions about their experiences in the classroom in relation to smart notebooks and the advantages and disadvantages they can have for both students and teachers.

The adaptation of this questionnaire was chosen for its reliability and overall internal consistency with a Cronbach's α coefficient of 0.946 and for the combination of closed and open questions that offer the possibility of both knowing the degree of agreement or disagreement with the different variables and delving into the benefits, weaknesses and needs of interactive notebooks (García-Valcárcel et. al., 2012). On the one hand, the Likert scale represents a valuable alternative for data collection in research that aims to obtain information about the evaluations and opinions that a population has on a particular issue (Fabila et al., 2012). On the other hand, there was a need to include open-ended questions, considering that their answers could offer more information about how teachers experience a process of change such as the implementation of a new methodology.

Despite having a previous validation, the instrument was validated again through the expert judgement procedure in which they participated [Anonymous for review]. These experts assessed the relevance, pertinence and uniqueness of the questionnaire and made the relevant assessments and observations (Appendix B). From the result of this validation, the modifications to the instrument were applied that have led to its final presentation for its subsequent administration to the educational centres. Appendix A shows the instrument after validation and the code by which all responses have been identified.

Planning the data collection process

Once the instrument was designed and validated, it was decided to adapt it to an online format (https://forms.office.com/e/gF2WFAr2Wm) using the Microsoft Forms web application. Surveys via e-mail or the Internet have the advantage of immediacy in the recording and coding of data and faster and more attractive completion for the respondent (Fontes de Gracia et al., 2010). The main problem is the restriction of access, counteracted by the possibility of being able to answer from any mobile device.

The questionnaire was sent on January 24th 2023 to the corporate emails of twenty schools in Aragon, included in the list of schools that had received training in interactive notebooks through CARLEE. A total of 11 centres in the province of Zaragoza, 8 in Huesca and 1 in Teruel. Through these emails, schools were asked to collaborate in the research by sharing the questionnaire with as many teachers as there were or were implementing the interactive notebooks. The questionnaire closed on February 15th 2023 with 36 responses. Subsequently, the coding and recording process was carried out, taking into account all the possibilities of response, which leads in the following sections to analyze the information obtained and the conclusions of this study.

Results

The analysis of the data collected through the questionnaire has been carried out in two clearly differentiated ways, according to the type of questions and the nature of the data:

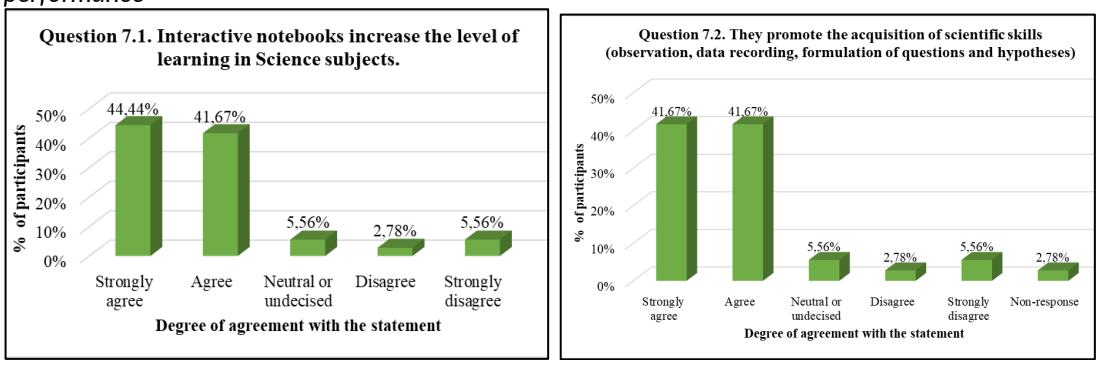
1) The second section (questions 7-15) corresponding to the assessment of the interactive notebooks as a methodological tool, has been analyzed through graphs (Figure 3 to 11), through the percentage of responses for each of the items of the questions. It should be noted that the first section is linked to sociodemographic variables, so it is not included in this analysis.

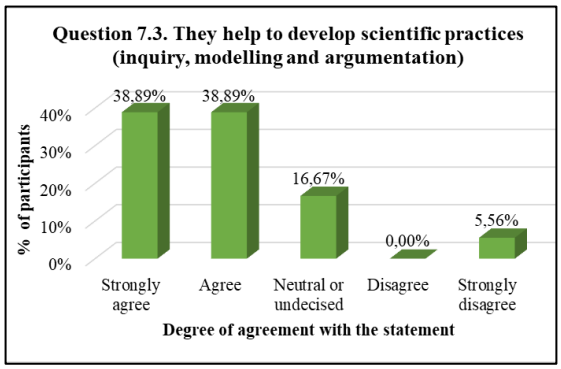
2) The third section (questions 16-21), focusing on the advantages and disadvantages of interactive notebooks, has been analysed through graphs (Figure 12) and analysis of emerging categories of the most recurrent terms (Figure 13).

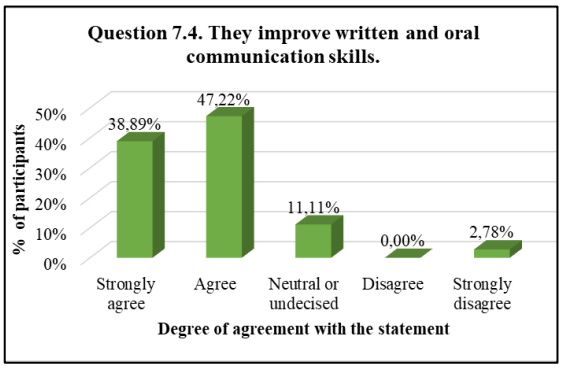
First of all, Figure 3 shows that 86.11% of the teachers surveyed agree or strongly agree that interactive notebooks increase the level of learning in Science subjects. In addition, 83.34% and 77.78% of the sample consider that they promote the acquisition of scientific skills and practices, respectively. Respondents also believe (86.11%) that they improve students' written and oral communication skills.

Figure 3

Graphs of the assessment of the impact of interactive notebooks on academic and scientific performance



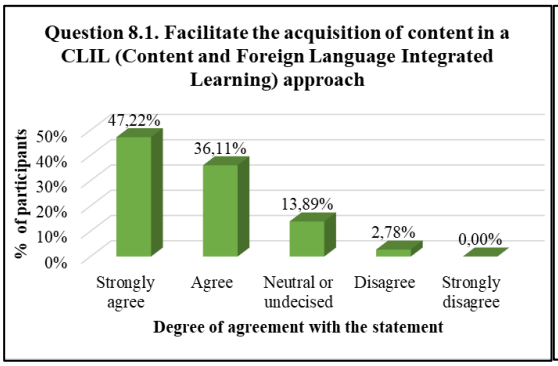


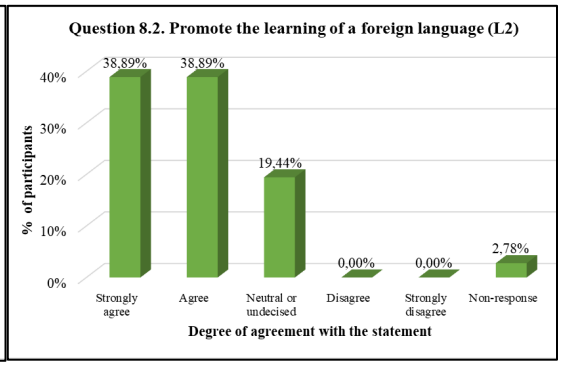


Regarding bilingual education, Figure 4 shows that 83.33% agree or strongly agree that interactive notebooks facilitate the acquisition of CLIL content and 77.78% believe that they favor the learning of a foreign language (L2).

Figure 4

Graphs of the assessment of the impact of interactive notebooks on bilingual education

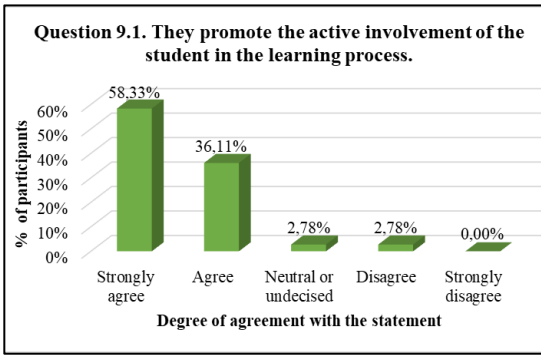


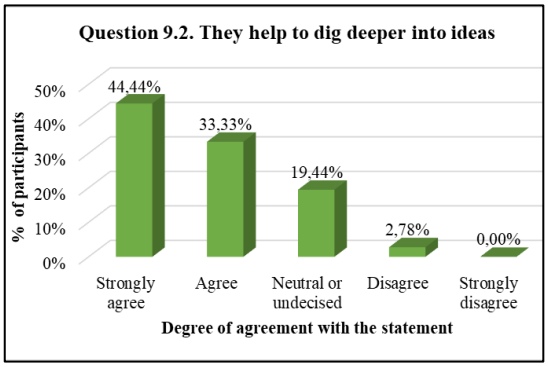


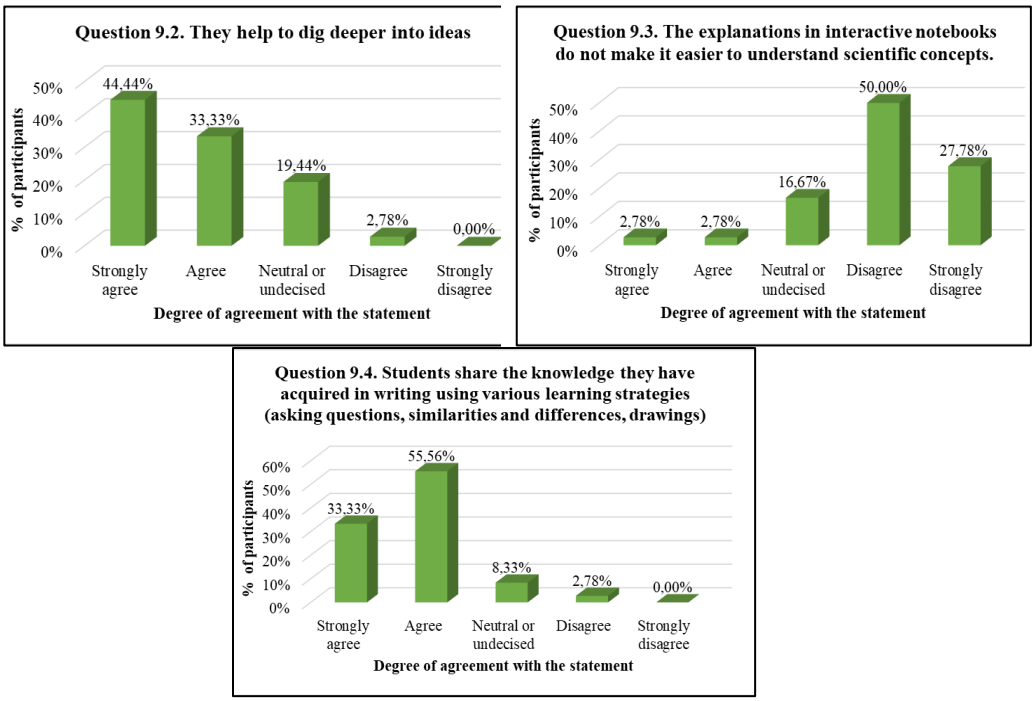
Gilbert and Kotelman (2005) showed that these notebooks encourage active and personal learning. The teachers surveyed, as can be seen in Figure 5, consider that they promote the active involvement of the student (94.44%), help to deepen ideas (77.77%) and facilitate the understanding of scientific concepts (77.78%). The sample states that 88.89% of students use various learning strategies with interactive notebooks.

Figure 5

Graphs of the assessment of the impact of interactive notebooks on learning



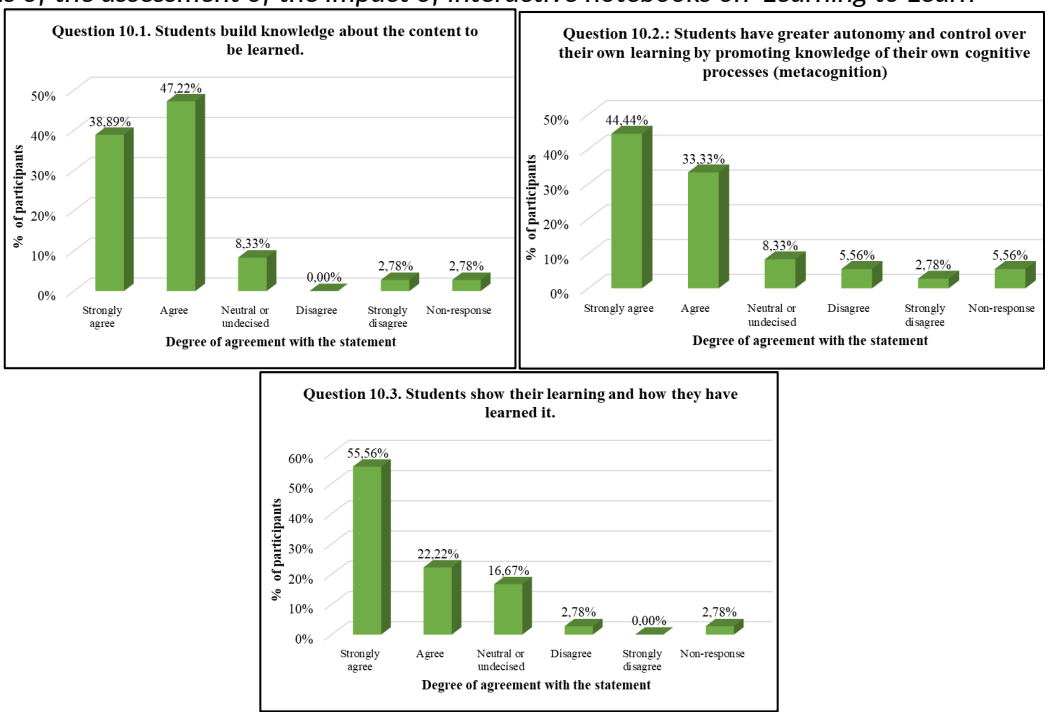




Teachers surveyed also believe that interactive notebooks have a strong impact on the competence of 'Learning to Learn' (Figure 6). 86.11% agree or strongly agree that it favors the construction of their own knowledge; 77.77% believe that with these notebooks they have greater autonomy and control over their own learning; and 77.78% believe that, with this methodological tool, students demonstrate their learning by favoring metacognition.

Figure 6

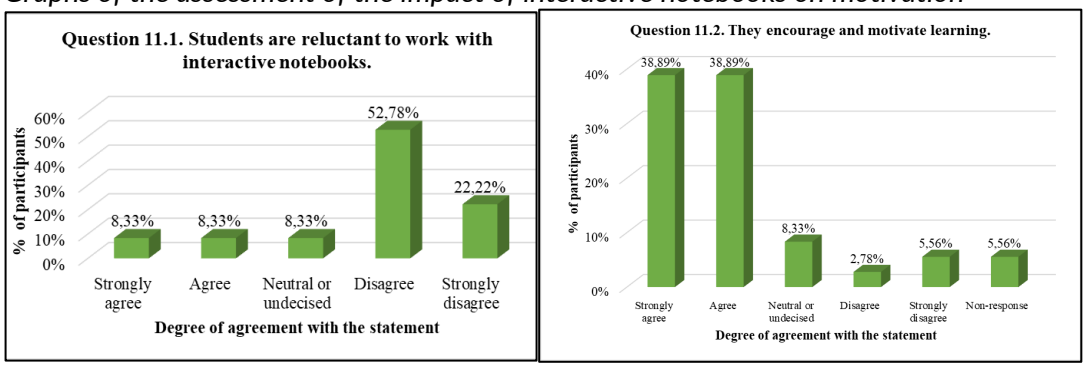
Graphs of the assessment of the impact of interactive notebooks on 'Learning to Learn'



The impact on student motivation is another variable to be analysed (Figure 7). The sample agrees or strongly agrees that notebooks encourage and motivate learning (77.78%) and that students do not express reluctance to use them (75%).

Figure 7

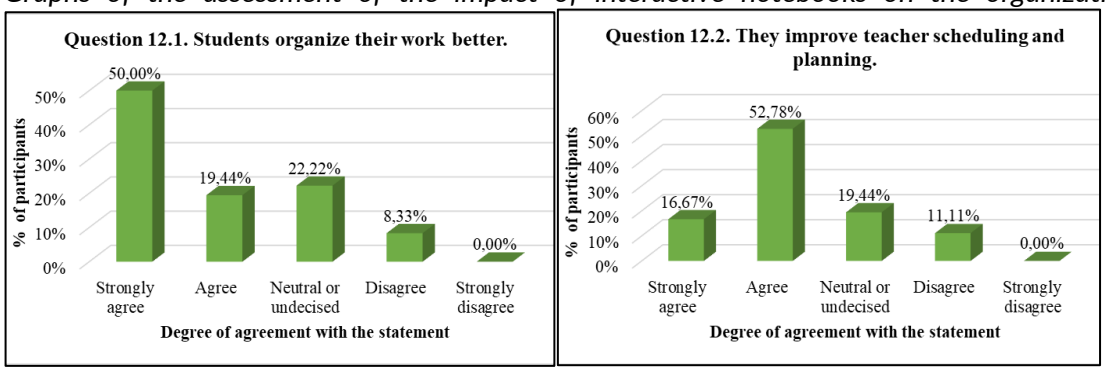
Graphs of the assessment of the impact of interactive notebooks on motivation



In terms of organization, 69.44% of the sample believed that students organize their work better with these notebooks; and 69.45% believe that they improve teaching programming and planning (Figure 8). The possible relationship between the years that teachers have been implementing the interactive notebooks and these last answers on the organization variable has also been studied, without finding a significant correlation.

Figure 8

Graphs of the assessment of the impact of interactive notebooks on the organization



Attention to diversity is another variable to be considered (Figure 9). 63.88% agree or strongly agree that smart notebooks allow students to cater for the diversity of their students. On the other hand, it highlights that 36.11% of teachers are neutral or undecided that students with learning difficulties prefer to work with these notebooks.

With regard to assessment (Figure 10), 86.11% of the sample believes that interactive notebooks serve as formative assessment tools, without implying great difficulty for teachers (61.11%). In addition, 55.56% of the teachers surveyed believe that it enhances the ability to self-evaluate, with 36.11% being neutral or indecisive in this question.

Figure 9

Graphs of the assessment of the impact of interactive notebooks on attention to diversity

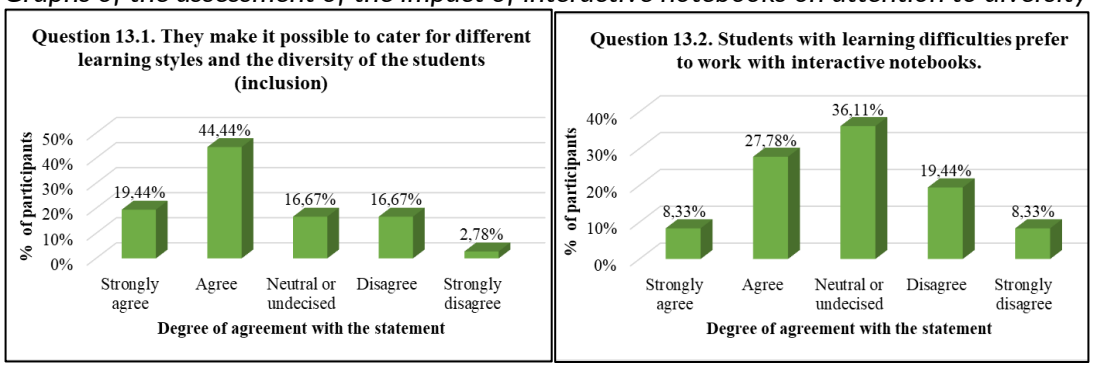
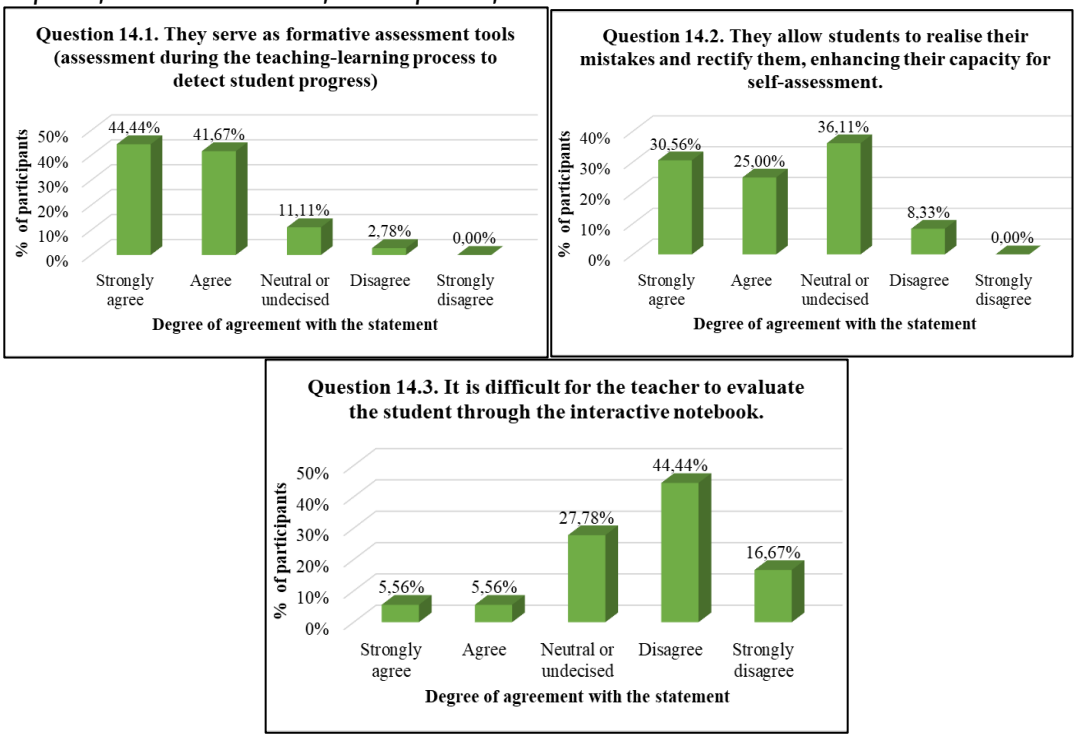


Figure 10

Graphs of the assessment of the impact of interactive notebooks on evaluation



In addition, the majority of teachers surveyed (61.11%) agree or strongly agree that interactive notebooks promote the exchange of ideas between students (Figure 11) and 67% show that they increase the relationship capacity between different educational agents such as families and teachers.

The results presented up to this point are consistent with the overall assessment of the surveyed teachers about interactive notebooks as a methodological tool (Figure 12). 92% consider that interactive notebooks are an effective methodological tool for students, and 86% believe that they are an effective methodological tool for teachers. As has been observed throughout the different variables (learning, organization, motivation, etc.), the benefits that this methodological tool brings to the classroom, for students and teachers, are numerous and varied.

Figure 11

Graphs of the assessment of the impact of interactive notebooks on relationships

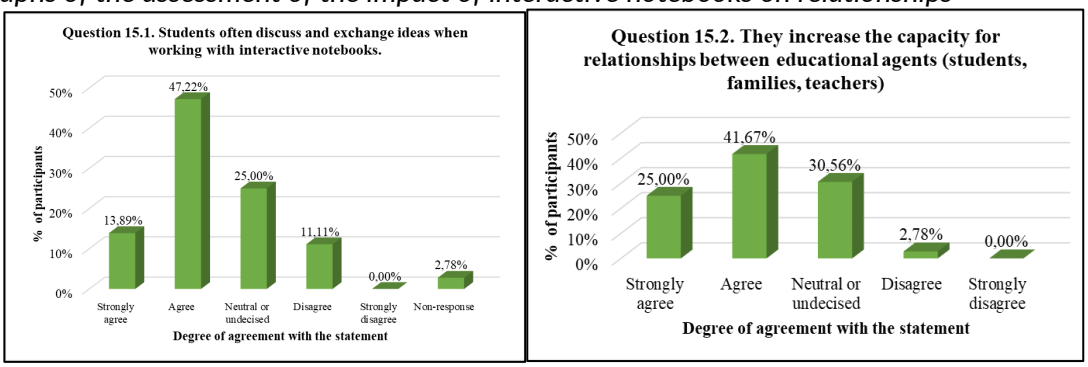
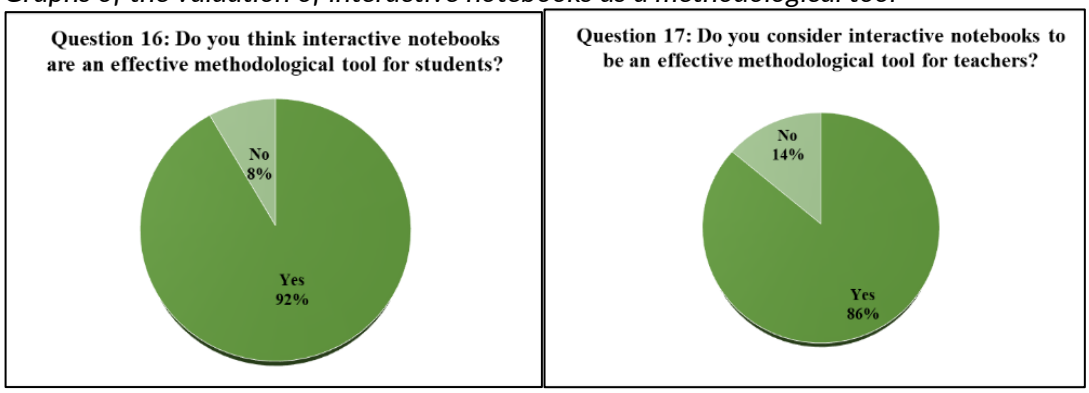


Figure 12

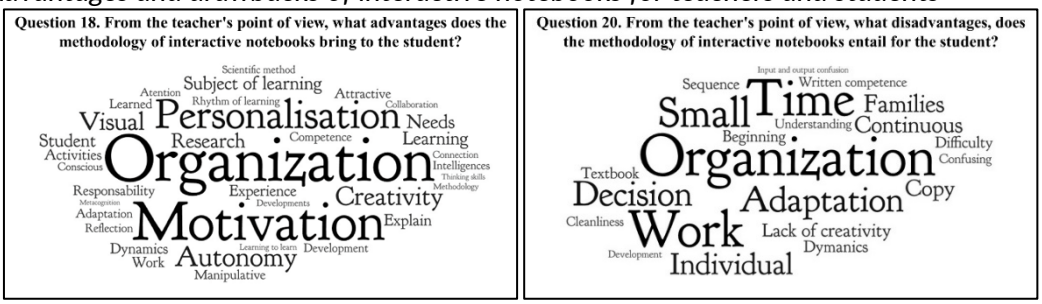
Graphs of the valuation of interactive notebooks as a methodological tool

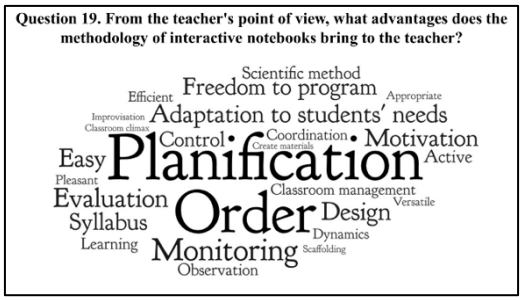


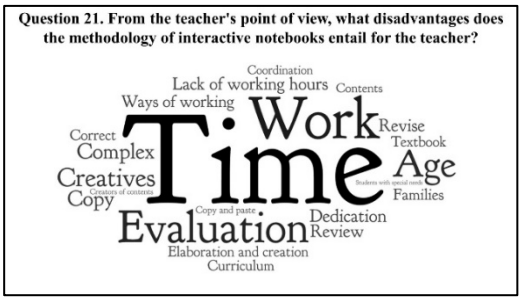
Once the evaluations of the impact of interactive notebooks on pedagogical and didactic variables were analyzed, teachers were asked about the advantages and disadvantages that, from their point of view, interactive notebooks have for both students and teachers. Figure 13 shows the graphical analysis of these questions, highlighting the most recurrent words or expressions in their answers with larger font size. As for the advantages that the methodology of interactive notebooks brings to students, the terms 'organization', 'learning protagonist', 'personalization', 'motivation', 'autonomy' and 'thinking' stand out.

Figure 13

Advantages and drawbacks of interactive notebooks for teachers and students







The most repeated drawbacks of interactive notebooks for students have been 'organization', 'work' and 'time'. It is worth noting the presence of organization as an advantage and disadvantage of this methodological tool.

On the other hand, the advantages of interactive notebooks for teachers themselves are the terms 'planning', 'order', 'freedom to program' and 'student monitoring'. The presence of organization and order takes on special relevance in both the advantages for the students and the teacher, becoming the most outstanding feature of interactive notebooks. Also repeated to a lesser extent are 'adapting to the needs and preferences of the students', 'assessment', 'classroom management' and 'motivation'.

The drawbacks of interactive notebooks for teachers themselves are 'work' and 'time'. To a lesser extent, 'evaluation' and 'lack of teaching hours' are also mentioned repeatedly. For both students and teachers, the most frequently mentioned drawbacks are the work and time involved in both implementing and carrying out interactive notebooks in classrooms. This is one of the key findings of this research, which will be discussed in the next section.

Discussion

The results of this study allow us to conclude that, according to the perception of the teachers surveyed, interactive notebooks are an effective methodological tool for both students and teachers in the teaching-learning process of Science.

With respect to students, as evidenced in previous studies, the benefits that interactive notebooks produce in the teaching-learning process are abundant and varied (Marcarelli, 2010; Young, 2003). The study sample overwhelmingly agrees that interactive notebooks can improve Science learning (Mallozzi, 2013; Drew, 2018) and the development of scientific skills and practices. Marcarelli (2010) already stressed that interactive notebooks could involve students in authentic scientific language and processes.

In addition, they believe that it can promote the acquisition of bilingual content, written and oral communication skills (Gilbert & Kotelman, 2005; Young, 2003) and the different competencies in foreign languages, showing that the interactive notebooks are clearly compatible with the bilingualism programs currently implemented. These results coincide with studies carried out in the context of the bilingual model of the Autonomous Community of Aragon (Bravo et al., 2016).

Teachers also highlight its impact on learning, highlighting its effect on the active and personal involvement of students as protagonists of their own learning (Gilbert & Kotelman, 2005) The sample, in accordance with previous studies (Marcarelli, 2010; Westfall, 2018), believes that interactive notebooks help to dig deeper into ideas, make it easier to understand scientific concepts, and use various learning strategies.

Another aspect to consider is its impact on the competence of 'Learning to Learn'. The teachers surveyed agree that it favours the construction of their own knowledge (Marcarelli, 2010; Mason & Bohl, 2017); greater autonomy and control over their own learning (Gilbert & Kotelman, 2005; Jaladanki and Bhattacharyya, 2014); and the possibility of continuously evidencing their learning, favoring metacognition (Young, 2003).

Other relevant benefits, according to the teachers' perception and supported, at the same time, by previous studies are the promotion of motivation (Yaylak, 2020), the improvement in organization and autonomy (Embid, 2018; Marcarelli, 2010); and formative assessment that recognises their progress and enhances their capacity for self-assessment (Gilbert & Kotelman, 2005; Westfall, 2018)

Benefits have also been demonstrated with respect to the teachers themselves. The most prominent, in line with previous studies (Gilbert & Kotelman, 2005; Marcarelli, 2010), is the improvement in teaching planning and programming, favoring both order and freedom to program. On the other hand, they believe that interactive notebooks are an adequate formative assessment tool capable of effectively monitoring each student throughout the teaching-learning process and that they can increase the relationship capacity between different educational agents such as families and teachers (Nesbit et al., 2004; Young, 2003).

In conclusion, all the pedagogical and didactic benefits mentioned show that the interactive notebook is a useful and effective tool that intervenes favorably in the learning of Science in the bilingual model of Aragon from the perception of teachers. However, some difficulties or proposals for improvement have also been identified. The teachers surveyed do not clearly agree that this tool allows full attention to the diversity of the student body, and more specifically, to students with learning difficulties. In addition, teachers agree that the organization is both a benefit and a drawback for the students. Finally, it is noteworthy that the most important drawbacks of interactive notebooks for both students and teachers are highlighted: the work and time they entail. In short, taking into account teachers' perceptions of this tool, it is possible to turn interactive notebooks into an effective and enriching methodological tool for any educational context in Science.

Consideraciones éticas de la investigación y uso de inteligencia artificial

En el momento de la investigación, no existía un comité de ética en nuestra universidad. Por lo tanto, el estudio siguió la guía de buenas prácticas (https://www.unizar.es/actualidad/ficheros/20181114/44451/codigo_de_buenas_practicas_en_investigacion_aprobado_cdg.pdf), cuyo punto 6.8 explica que: «El personal investigador que realiza investigaciones con seres humanos debe asegurarse de que los participantes hayan recibido toda la información precisa y adecuada para poder dar su consentimiento con pleno conocimiento de causa». Por lo que se solicitó un consentimiento informado a los participantes en dicho estudio.

No se ha hecho uso de la IA en ninguna de las etapas de este trabajo.

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Conflicto de intereses

Los autores declaran no tener ningún conflicto de intereses

Contribuciones de los autores

Los artículos de investigación elaborados por varios autores, deben especificar brevemente sus contribuciones individuales para las que pueden utilizarse las siguientes declaraciones: Conceptualización, V.R.A., J.P.M. y E. C.S.; metodología, V.R.A., J.P.M. y E. C.S.; software, V.R.A .; validación, V.R.A., J.P.M. y E. C.S.; análisis formal, V.R.A., J.P.M. y E. C.S.; investigación, V.R.A., J.P.M. y E. C.S.; recursos, V.R.A., J.P.M. y E. C.S.; análisis de datos, V.R.A., J.P.M. y E. C.S.; redacción del borrador original, V.R.A., J.P.M. y E. C.S.; redacción, revisión y edición, V.R.A., J.P.M. y E. C.S.; supervisión, J.P.M. y E.C.S..

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