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Research competence in post-compulsory secondary education (baccalaureate)

Competencia investigadora en educación secundaria postobligatoria (bachillerato)

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Abstract

Research competence is a crucial cross-cutting skill in the baccalaureate stage (post-compulsory secondary education), which is specifically developed and assessed in subjects such as "Research Project," taught in Catalonia and other Spanish autonomous communities. The aim of this study was to investigate the perception of both baccalaureate students and teaching staff regarding the development of cross-cutting and specific research competencies through Research Project. To achieve this a research approach was carried out, which included the application of an ad-hoc questionnaire and in-depth interviews. The research sample comprised 1496 baccalaureate students from Catalonia and 15 teaching staff members who were tutors for Research Project. Among the most relevant findings, the alignment in the perception of both groups stands out. Both students and teachers primarily identify the development of competencies related to information search, critical thinking, and self-learning. However, students show a greater disagreement regarding the development of skills such as creativity, leadership, and decision-making. These results suggest that Research Project represents a valuable opportunity to foster the development of research competence. However, it is emphasized the importance of promoting this competence in a cross-cutting manner, both in the work carried out in the various curricular areas of baccalaureate and in prior education throughout secondary education.

Keywords: secondary education, baccalaureate, research competency, cross-cutting competencies, scientific literacy, research project.

Resumen

La competencia investigadora es una habilidad transversal crucial en la etapa de bachillerato (enseñanza secundaria postobligatoria) que se desarrolla y evalúa específicamente en asignaturas como el "Trabajo de Investigación", impartido en Cataluña y otras comunidades autónomas españolas. El objetivo de este estudio fue investigar la percepción tanto del estudiantado de bachillerato como del profesorado tutor sobre el desarrollo de competencias transversales y específicas de investigación a través del Trabajo de Investigación. Se llevó a cabo una investigación que incluyó la aplicación de un cuestionario diseñado ad hoc y entrevistas en profundidad. La muestra de la investigación abarcó a 1496 estudiantes de bachillerato y a 15 docentes tutores/as. Entre los hallazgos más relevantes, destaca la coincidencia en la percepción de ambos grupos. Tanto estudiantado como profesorado identifican principalmente el desarrollo de competencias relacionadas con la búsqueda de información, el pensamiento crítico y el autoaprendizaje. Sin embargo, los estudiantes muestran un mayor desacuerdo en cuanto al desarrollo de habilidades como la capacidad creativa, el liderazgo y la capacidad de elección. Estos resultados sugieren que el Trabajo de Investigación representa una oportunidad valiosa para fomentar el desarrollo de la competencia investigadora. No obstante, se subraya la importancia de promover esta competencia de manera transversal, tanto en el trabajo realizado en las diversas áreas curriculares del bachillerato como en la enseñanza previa durante toda la educación secundaria.

Palabras clave: enseñanza secundaria, bachillerato, competencia investigadora, competencias transversales, alfabetización científica, proyecto de investigación.

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1. Introduction

To build a sustainable future and a democratic society based on social justice, new imaginaries that conceive education as a public project and a common good are necessary (UNESCO, 2015, 2022). Education, in all its stages, must offer spaces for constructing ways of knowing, acting and being in the world that contribute to overcoming the current worldwide crisis. This implies approaching education from a competent and comprehensive perspective, but away from its more neoliberal orientation, guided by the framework of human rights and the revisited foundations of critical and humanist pedagogy.

Within this framework and based on the Budapest Declaration (1999), scientific literacy is essential to achieve full citizen participation and to respond to the social challenges that we must collectively overcome. Although the notion of scientific literacy has a long history (Bybee, 1997; Cañal, 2004; Hurd, 1958), it is polyhedral (Kemp, 2002) and sometimes questioned (Gil & Vilches, 2006). Today it is widely known that it is not enough to acquire scientific knowledge, but rather to develop ways of reasoning and acting in everyday situations where science and technology are present for informed decision-making (Almeida et al., 2022; Romero-Ariza, 2017). However, its teaching cannot be reduced to a technical orientation, but must be approached from a critical perspective (Torres & Solbes, 2016) and include its syntactic or epistemological dimension (García-Carmona & Acevedo, 2018; National Science Teaching Association, 2020), otherwise it will be highly unsuccessful for the common project mentioned above.

By highlighting the importance of its application in everyday situations, close to the reality of the students, its competence approach is reinforced, which is why scientific competencies are also discussed (OECD, 2023). According to the recommendations of the Council of the European Union (2018) on key competencies for inclusive and quality learning throughout life, scientific competence should be understood as the ability to "explain the natural world using the set of knowledge and methodology used, including observation and experimentation, in order to raise questions and draw evidence-based conclusions" in addition to "understanding the changes caused by human activity and the responsibility of each individual as a citizen". In the Spanish context, this framework has been adopted by the current educational legislation, the LOMLOE (Organic Law amending the Organic Law of Education), which considers that scientific competence must be developed throughout the entire process of schooling as a key competence. This is consistent with research on the subject, where it is considered that research training cannot be relegated only to higher education (Akerson et al., 2011; Curran & Kitchin, 2019; Menoyo, 2020). However, it is also important to point out the existence of critical voices that argue that the new curriculum derived from LOMLOE does not sufficiently address this competition (García-Carmona, 2022).

In Catalonia, within the post-compulsory secondary stage, all high school students must carry out a Research work (hereinafter, Rw), with the aim of developing research competence and understanding the fundamental elements of the scientific method. However, in addition to Catalonia that pioneered this practice in 1998, four other autonomous communities have incorporated research work into their curriculum: in the autonomous community of Murcia it was done experimentally in 2007 and became mandatory in 2010; in the autonomous community of Castilla y León it was introduced as a specialized option in 2012; in the autonomous community of Madrid it was offered optionally in the program of excellence in Baccalaureate since 2012; and, recently in 2022, the same Catalan proposal has been introduced in the Balearic Islands in all modalities of Baccalaureate. In the rest of the Spanish territory, the research works in the baccalaureate stage are carried out exclusively on the initiative of the teachers, either individually or at the center level, without a specific regulatory framework.

According to Article 18 of Decree 171/2022 of September 20, on the organization of high school education (in Catalonia), RW requires structured activities that students carry out applying the scientific method to investigate a specific subject, receiving tutoring by teachers. This work represents one tenth of the final note of this stage, align with one of the main objectives of the Baccalaureate related to "understanding the fundamental elements and procedures of research and scientific methods" (RD 243/2022).

This initiative is very relevant, since it is one of the few structured initiatives that deal with scientific competence in secondary education in a transver-

sal way. However, we found an absence of research around this, probably due to its specificity (Ferrés et al., 2015; Menoyo, 2020). Moreover, despite the important tradition of study in the didactics of science in pre-university stages, there is little research on the development of scientific competence in post-compulsory secondary education through transversal didactic proposals. In this regard, it is evident that there is a need to examine how this initiative contributes to the development of scientific competence.

Based on the evidence available in other areas, we can distinguish between different factors that are involved in the development of this scientific competence: (a) specific research competencies; (b) transversal competencies; and (c) attitudes towards science. In this article we will address how RW contributes to the development of the first two, leaving in a second term attitudes towards science, despite its relevance and interest (Muñoz et al., 2019; Palacios, 2021).

On the one hand, the specific research competencies refer to the actions involved in the research process and the communication of the results obtained (Franco-Mariscal, 2015; Rubio et al., 2018). Within the new scientific competency framework proposed by the OCDE (2023), this corresponds to the sub-competence of "constructing and evaluating designs for scientific inquiry and interpreting scientific data and evidence in a critical way". In a more detailed analysis, the proposal presented by Payá et al. (2018) stands out for its exhaustiveness in describing eight dimensions involved: 1) the definition of the problem; 2) the conceptual framework; 3) the planning and execution of the research methodology; 4) the structuring of the results obtained; 5) the formulation of relevant conclusions; 6) the drafting of the report; 7) the dissemination of the main results obtained; and 8) the consideration of ethical and social aspects in the research process.

On the other hand, there are transversal competencies that are interconnected with the research process and are necessary for its correct deployment, but that are not specific to it, but are useful for other situations. In other words, as called by Menoyo (2020) life competencies, related to four domains: (1) scientific integrity and responsibility; (2) solution capacity; (3) entrepreneurship; and (4) self-regulation.

In this regard, the relevance of investigating how the Research Work contributes to the development of both categories of competencies is evidenced, considering the perspectives of the two main actors involved in its conduction: the students and the tutor teachers. In summary, the article addresses the following research objective: to analyze the perception of high school students and tutor teachers on the development of specific and transversal research competencies through the elaboration of the Research Work.

2. Methodology

We opted for a methodological approach that combines both quantitative and qualitative strategies for obtaining information. This approach allowed to obtain a multidimensional vision of the studied phenomenon and to understand it in its globality. With the quantitative strategy, a deductive and extensive collection of information in the students is intended, while the qualitative one is oriented to collect the interpretations that the teaching group attributes to the development of the research competence of the students.

2.1 Information collecting tools

To understand the students' perception of the development of research competence, a scale was designed aligned with the approach proposed by the OCDE and other theorists, understanding these as a set of specific competencies specific to the research action, aligned with the logics of the scientific method and its processes (OCDE, 2023; Payá et al., 2018; Rubio et al., 2018; Valdés et al., 2013). On the other hand, to explore the perception of transversal competencies, a scale was designed under the approach proposed by Menoyo (2020) on life competencies. Both scales were structured in a five-point Likert format (5 "I totally agree", 4 "I agree", 3 "neither agree nor disagree", 2 "I disagree" and 1 "I totally disagree").

The research competence scale contains 14 items that address two main aspects: actions of the research action, and communication of the results obtained. Meanwhile, the cross-competency scale contains 13 items that address four cross-competency sets: scientific integrity and accountability; decisiveness; entrepreneurship; and self-regulation.

Both scales were subjected to a content validation process through a trial of experts, with the participation of eight university professors who are experts in research methods and competencies. In addition, a pilot test was carried out in which participated 31 high school students from a public institute located in the metropolitan area of Barcelona, who had completed their Research Work. It is worth mentioning that these students were not included in the study sample.

The scales showed good reliability, evaluated by Cronbach's Alpha internal consistency index (Nunnally & Bernstein, 1994), with a value of 0.92 for the research competence scale and 0.93 for the transversal competence scale.

The application of the scales was carried out online to the group in December 2021. All participants were informed about the objectives of the study and their responses were anonymous, as was their exclusive use for research purposes.

In order to know the perception of teachers, a semi-structured interview was developed consisting of 20 questions, which answered a network of previously defined deductive categories. Below are the questions raised in the dimension "research competencies", which have been the object of analysis in this work:

- What do you think research work offers to the formation of high school students?
- What research competencies do you think the student can acquire when doing the research work?
- Do you think students are aware of these learnings?
- The research competence is a transversal competence, do you think that enough work is done in the different curricular areas?

2.2 Sample of participants

The sample of the participating students was 1496 high school students, from various institutes in Catalonia. A non-probabilistic sampling was used for convenience, considering representativeness criteria of the four Catalan provinces (47.2% of the metropolitan area of Barcelona, 23.5% of the regions of Girona, 8.8% of Tarragona, 7% of central Catalonia, 3.9% of Ponent and 0.6% of the Terres de l'Ebre). The median age was 17 years, with 61% of students being male, 36.6% female and 2.4% non-binary. With regard to the ownership of the centers, 73% were public and 23% agreed. As for the type of baccalaureate course, 49.8% belonged to the scientific-technological field, 44.1% to the humanistic-social and 6.1% to the artistic.

As for teachers, the sample corresponded to 15 high school teachers from different institutes in the province of Barcelona, specialists in different subjects or curricular areas (Catalan, English, chemistry and physics, natural sciences, social sciences and humanities). The only inclusion criterion was to be a teacher or have had previous experience in RW tutoring. The selection was made by means of an intentional or convenience sampling, considering the possibilities of access to the field of study by the research team and depending on the adaptation level of the objectives of the study.

2.3 Data analysis

Central trend indices (averages and standard deviations) were calculated for the quantitative analysis of the scales using the SPSS statistical program, in its version 24.

The analysis of qualitative data from interviews was carried out using the content analysis strategy (Krippendorff, 2002). Through this analytical method, the information obtained was classified into a system of categories (both deductive and inductive) that shows all aspects of the studied reality and assigns them a new meaning. As a support tool for managing all qualitative information, the ATLAS.ti program was used, in its version 22.

3. Results

3.1 The Student Perspective

Regarding the perceptions about the research competencies developed thanks to the Research Work (RW), as detailed in Table 1, a moderate development is observed. Scores on a scale of 1 to 5, range from 3.2 to 3.8, receiving the highest perception of development competencies review of bibliographic sources, writing through a formal record and discussion of the data analyzed. On the other hand, the sample slightly disagrees with having developed competencies related to the formulation of signi-

ficant research questions, emotional management when speaking in public or in academic writing with scientific rigor and without spelling errors.

Table 1. *Average scores of the "research competencies" scale perceived by the student with the conduction of the Research Work*

Elements	Score
Review of bibliographic sources	3.8/5
Drafting by means of a formal register	3.7/5
Discussion of the analyzed data	3.7/5
Consistency in the wording of the work	3.6/5
Selecting relevant information	3.6/5
Searching for rigorous scientific sources	3.6/5
Argumentative capacity	3.6/5
Digital Competence	3.6/5
Knowledge of office package	3.5/5
Oral communication	3.5/5
Building data collection tools	3.4/5
Academic writing with scientific rigor and without spelling errors	3.4/5
Emotional management when speaking in public in defense of work	3.3/5
Formulation of significant questions for the scientific-professional field	3.2/5
Overall result	3.5/5

In terms of transversal competencies, the results obtained reflect an average agreement in the perception of their development after the conduction of the Research Work (RW), with a total average even lower (3.3 on a scale of 1 to 5) than the scale of research competencies. Competencies perceived as more developed are autonomous learning, critical ability and reasoning ability, as shown in Table 2. On the other hand, the skills that are perceived as less developed are creative ability, leadership and choice, which are linked to personality qualities on which the conduction of RW does not have any influence.

Table 2. *Average scores on the scale of "transversal competencies" perceived by the student with the conduction of the Research Work*

Elements	Score
Autonomous learning	3.7/5
Critical Capacity	3.5/5
Ability to reason	3.4/5
Scientific and research integrity	3.3/5
Entrepreneurial capacity and proactivity	3.3/5
Adaptability	3.3/5
Resolving capacity	3.3/5

Elements	Score
Responsibility	3.2/5
Self-discipline	3.2/5
Self-assurance	3.2/5
Ability to choose	3.2/5
Leadership Capacity	3.1/5
Creative ability	3.0/5
Overall Score	3.3/5

3.2 The faculty perspective

According to the data obtained, the student develops various research competencies throughout the conduction of the Research Work (RW). In this article, only the results belonging to the macro-categories of specific research competencies and transversal competencies are exposed. The units of meaning (UM), which support the interpretations made by the research team, include a numerical reference to identify the participant subject (example, P1=Participant 1).

3.2.1 Specific powers of the act of investigation

The information from the metacategory "specific research competencies" (n=56) indicates that the high school students, at the end of the process of elaborating their research work, have acquired a better understanding of what research requires, i.e. they manage to develop knowledge and basic skills in the different dimensions that make up the scientific competence in a teaching-learning context based on research.

From the interpretative analysis of the available data, it is deduced that learning related to the dimension of "Management and use of information" predominates. This means that RW contributes to the ability to review bibliographic sources and their critical and objective assessment.

According to the perception of the interviewed faculty, this informational competence is defined as the ability to "face a more academic work with the use of citations, a rigorous bibliography and that they are aware of issues of plagiarism and other elements…" (P3). In this line, some tutors highlight the importance of students looking for "experiential information…a more real and truthful, i.e. not to search for information on the Internet since there is everything on the Internet…" (P9).

According to the results obtained, something that many teachers and tutors agree on is the difficulties students face in relation to the specific competence in research. Among the most mentioned challenges, the following stand out: the search for rigorous sources; the discussion of the analyzed data, i.e. the transformation of the information into knowledge or the interpretation of the information; the drafting by means of a formal register; and the correct citation of the consulted references.

On the other hand, although less frequently, other learnings in the multiple dimensions that make up the scientific competence that high school students acquire during research work are also highlighted. Table 3 below provides a brief summary of the information provided by the interviewed teachers.

Table 3. *RW contribution to the development of specific research skills according to the tutor*

Dimension of research and learning developed	Information from data analysis
Theoretical Specific training in an area or on the topic they are researching	Q1: "First of all, a specific training of a topic of interest to them, be better done or less...". Q5: "I think it's very useful that enter the university having done more or less scientific research on a topic that they have chosen to investigate."

Dimension of research and learning developed	Information from data analysis
Research approach, planning or design Formulation of objectives and questions Development of hypotheses Discrimination of variables Study Planning Design of quantitative or qualitative methodology	Q13: "Of course they have learned research skills…to design and plan an experiment, to hypothesize, and obviously the first thing they have to do is ask questions, etc."
Development of research Experimental and laboratory work Data analysis and data representation Drawing conclusions	Q6: "…they have learned how to deal with data, which is ultimately a research competence or, if you want, treatment of scientific methods."
Linguistics Writing ability. Formal writing and academic rigor. Reading comprehension and analysis of written texts. Oral and written competence	Q2: "…the research works give them academic rigor. I think this is a very important and necessary aspect because they are used to carrying out work based on Internet sources, in a general way, randomly without any rigor." Q4: "communicative competence is fundamental, both oral and written…".

Finally, it should be noted that most teachers point out the importance of addressing and developing research competence in a deeper and earlier way, not only during high school, but also in previous courses.

> (…) research competence is a question that should be derived from ESO (…). (P14).

> (...) In my point of view, we should have started this scientific methodology from the early childhood stage and change registration when we talk about women, science or when we talk about humanistic learning. (Q8)

These statements by teachers support the legal framework of the high school curriculum, which states that research competence has a transversal character (even if it is a specific subject as is the case of the RW subject in Catalonia). However, it is considered that students should be introduced, from high school or even from ESO, in the logic of scientific research and in carrying out research work.

The information collected throughout the fieldwork reveals a duality in the perception of teachers with respect to the transversal character of the research competence. On the one hand, they indicate that it is addressed in a timely manner in some subjects of the curriculum, but, on the other hand, they consider that it is not sufficiently enhanced. This is reflected as follows:

> More work should be done... perhaps one works on time in different areas or subjects that require a specific job with a specific task, but they are small areas of work and there is no transversal continuum, as if there should be of the work of the research competence. (Q7)

> The research competence, regardless of the baccalaureate that the students do or the elective subjects that they can choose in third or fourth year, is not sufficiently developed from my point of view, among other things because there would be much more joint work, more group work … (P4)

The statements of these tutors also point to the difficulties they face in trying to address more transversely the development of research competence. Among the causes mentioned are the lack of knowledge about how to apply transversality, the rigidity of a fragmented and inflexible curriculum, and the lack of coordination among teachers, in addition to other aspects. Likewise, they stress that the framework for carrying out scientific research is not limited only to the natural or exact sciences, but can also be applied in disciplines such as the arts, humanities, sociology, politics, etc.

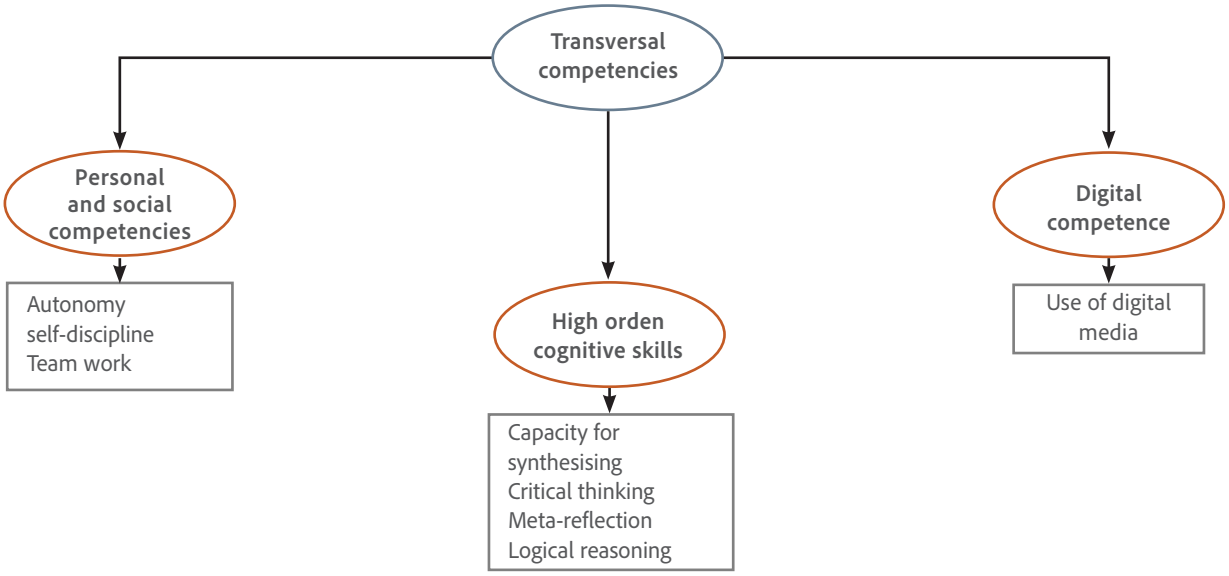
3.2.2 Cross-cutting competencies

According to the data collected, for some teachers, the research work not only provides a practical approach to the scientific method, but also a series of learning at the cognitive and personal level: "... I worry more about the personal part than the academic one, I must also say that what they learn is very

good at the cognitive level, but also at the personal level" (P1).

Thus, some transversal and useful competencies for life are also developed through the development of research competencies in high school students. Based on the interpretation of the meanings attributed by the interviewed faculty regarding this issue, Figure 1 presents, as a synthesis, the transversal or generic competencies enhanced with the development of the research work.

Figure 1. *Generic competencies that promote the conduction of RW, according to the perception of the tutor*



Teacher perception reveals a development of personal and social competencies, with a greater number of units of meaning that highlight autonomous learning and self-discipline: "They learn to carry out a work autonomously..." (P2). They also point out, although less significantly, teamwork, especially in those research projects carried out in pairs.

On the other hand, the tutor teacher mentions the development of cognitive skills, which are higher order cognitive processes widely used when researching. Some of these skills, the most mentioned, include: synthesizing, arguing, critically valuing and reflecting on learning. Regarding this last competence, the teachers affirm that the students are not fully aware of all the learning acquired until they reach the end of the research work. In this regard, they point out:

> This meta-reflection, which is a posteriori, is interesting for them to see the magnitude of the learning they have had... but at first, I think that all this is a "let's do" and they are learning, but they are not aware of it. (P10)

4. Discussion and conclusions

The research has allowed to identify the specific research competencies and the transversal competencies most developed by the high school students thanks to the conduction of the Research Work, from the perspective of both the students and their tutor teachers.

A first conclusion is the coincidence between students and teachers in the perception of the most developed competencies with RW. Both consider that the search for information is the most developed within the specific research competencies. Likewise, they also agree that autonomy, self-learning and critical thinking are the most developed within transversal or generic competencies.

Other works aimed at enhancing research competence in secondary school students have also shown improvements in the management of information and the communication of results (Franco-Mariscal, 2015). This same study also highlights the development of critical thinking in its experience

with secondary school students exposed to the conduction of research works.

As Morduchowicz (2018) indicates, "the school needs to train a student who knows how to think about the place of information in his/her life, who understands how it affects his/her perception of the world and who learns how to use it, to demand the best quality of information and to make the best decisions. In short, the student's objective is not to "copy and paste" the first link that appears in the search engine" (p.160).

Likewise, numerous authors claim the need to develop critical capacity and autonomous learning, since these competencies involve important intellectual or cognitive aspects from both the academic and citizen dimension. Promoting critical thinking in students favors their active and proactive participation in the face of the problems of their social context, becoming a tool that they can use to change their reality (Romero & Chávez, 2021). In addition, it facilitates the analysis and evaluation of everyday situations, the elaboration of judgments and reasoned arguments against situations in their near context, and the promotion of autonomous learning in line with the Sustainable Development Goals (Patiño, 2014).

Despite all this, the tutoring faculty agrees that the opportunities for students to carry out research work are scarce, since research is addressed in a timely manner in the curriculum. This could explain why other specific and cross-cutting research competencies that are also needed are not as developed. In this sense, it is appropriate to clarify that high school in Catalonia focuses on the University Entrance Tests (PAU), relegating research training to the background, beyond the specific framework of the subject of Research Work.

The competencies that the students perceive as less developed are the creative capacity, the leadership or the capacity of choosing, aspects related to personality qualities in which the simple conduction of RW does not manage to affect. However, from the LOMLOE it is claimed the need for the student to learn during the research process to identify and raise relevant problems, and the resolution capacity during the entire process of conducting the study. In addition, teachers do not perceive or consider that RW contributes to the development of personal skills, such as creative ability, leadership or adaptability.

The results suggest that RW is a good strategy to promote the development of competence and research, but on its own it does not manage to have a very important impact on the broad set of both transversal and research competencies. It is pertinent to ask whether this is due to the design of the subject or to the fact that prior secondary education does not prioritize investigative learning (Rojas et al., 2012). Probably both factors influence the observed results.

The research has allowed to deepen the contributions of the research work of high school to the development of specific and transversal research competencies. However, it presents some limitations derived on the one hand from the sample of teachers (limited to few participants) and the instrument aimed at students, of a very deductive nature. On the other hand, the results raise previously commented questions that should be answered. This encourages further research into the phenomenon, with methodological proposals that include the voice of young students and with the expansion of the sample of teaching participants, as well as the inclusion of participants who are experts in competencies and research.It may also be interesting to study the phenomenon with different methodological approaches, including pre-post designs, with the potential to establish the effectiveness of RW in the development of competencies.

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References

Akerson, V. L., Buck, G. A., Donnelly, L. A., Nargund-Joshi, V. & Weiland, I. S. (2011). The importance of teaching and learning nature of science in the early childhood years. *Journal of Science Education and Technology, 20*(5), 537-549. https://doi.org/10.1007/s10956-011-9312-5

Almeida, B., Santos, M. & Justi, R. (2022). Aspects and abilities of science literacy in the context of nature of science teaching. *Science & Education, 32*, 567-587.

https://doi.org/10.1007/s11191-022-00324-4

Bybee, R. W. (1997). Towards an Understanding of Scientific Literacy. En W. Gräber y C. Bolte (eds.), *Scientific Literacy* (pp. 37-68). IPN.

Cañal, P. (2004). La alfabetización científica: ¿necesidad o utopía? *Cultura y educación, 16*(3), 245-257. https://doi.org/10.1174/1135640042360951

Consejo de la Unión Europea (2018). Recomendación del Consejo, de 22 de mayo de 2018, relativa a las competencias clave para el aprendizaje permanente. *Diario Oficial de la Unión Europea,* 189/01. http://bit.ly/49eKAyk

Curran, F. C. & Kitchin, J. (2019). Early elementary science instruction: does more time on science or science topics/skills predict science achievement in the early grades? *AERA Open, 5*(3). https://doi.org/10.1177/2332858419861081

Declaración de Budapest. (1999). *Declaración sobre la Ciencia y el uso del saber científico. Conferencia Mundial sobre la Ciencia para el Siglo XXI: un nuevo compromiso.* UNESCO.

Decreto 171/2022, de 20 de septiembre, de ordenación de las enseñanzas de Bachillerato. *Diari Oficial de la Generalitat de Catalunya, 8758*, de 22 de septiembre de 2022. https://bit.ly/3TEnZpv

Ferrés, C., Marbà, A. & Sanmartí, N. (2015). Trabajos de indagación de los alumnos: Instrumentos de evaluación e identificación de dificultades. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias, 12*(1), 22-37. https://doi.org/10.25267/Rev_Eureka_ensen_divulg_cienc.2015.v12.i1.03

Franco-Mariscal, A. (2015). Competencias científicas en la enseñanza y el aprendizaje por investigación. Un estudio de caso sobre corrosión de metales en secundaria. *Enseñanza de las ciencias: revista de investigación y experiencias didácticas*, *33*(2), 231-252. http://dx.doi.org/10.5565/rev/ensciencias.1645

Garcia-Carmona, A. (2022). La comprensión de aspectos epistémicos de la naturaleza de la ciencia en el nuevo currículo de Educación Secundaria Obligatoria, tras la LOMLOE. *Revista Española de Pedagogía, 80*(283), 433-450. https://doi.org/10.22550/REP80-3-2022-01

García-Carmona, A., y Acevedo, J. A. (2018). The nature of scientific practice and science education. *Science & Education, 27*(5-6), 435-455. https://doi.org/10.1007/s11191-018-9984-9

Gil, D. & Vilches, A. (2006). Educación ciudadana y alfabetización científica: mitos y realidades. *Revista Iberoamericana de Educación, 42*(3), 31-53. http://hdl.handle.net/11162/22595

Hurd, P. D. (1958). Science literacy: Its meaning for American schools. *Educational leadership, 16*(1), 13-16.

Kemp, A. C. (2002). Implications of diverse meanings for "scientific literacy". En P. A. Rubba, J. A. Rye, W. J. Di Biase, y B. A. Crawford (eds.), *Proceedings of the 2002 Annual International Conference of the Association for the Education of Teachers in Science* (pp. 1202-1229). Association for the Education of Teachers in Science.

Krippendorff, K. (2002). *Metodología de análisis de contenido: teoría y práctica.* Paidós.

Menoyo, M. (2020). Educar la mirada científica del alumnado de secundaria en el marco de los objetivos del desarrollo sostenible, educar para una ciudadanía global en un momento de cambio educativo. *Modelling in Science Education and Learning, 13*(2), 21-42. https://doi.org/10.4995/msel.2020.13790

Morduchowicz, R. (2018). *Ruidos en la web: Como se informan los adolescentes en la era digital.* Penguin Random House.

Muñoz, J. M., Hernández, M. J. & Serratte, J. (2019). El interés por el conocimiento científico de los estudiantes de secundaria en España. *Educação & Sociedade, 40.* https://doi.org/10.1590/ES0101-73302019187204

National Science Teaching Association [NSTA] (2020). *Nature of science. Position statement.* https://bit.ly/4atMyfo

Nunnally, J. C. & Bernstein, I. H. (1994). *Psychometric theory.* McGraw Hill.

OECD. (2023). *PISA 2025 Science Framework.* OECD Publishing.

Palacios, L. (2021). Una revisión sistemática: Actitud hacia la investigación en universidades de Latinoamérica. *Revista de Investigación en Comunicación y Desarrollo, 12*(3), 195-205. https://doi.org/10.33595/2226-1478.12.3.533

Patiño, H. (2014). El pensamiento crítico como tarea central de la educación humanista. *Didac*, *64,* 3-9. https://bit.ly/3Vu4aC3

Payá, M., Ayuste, A., Cano, A. B., Gros, G., Escofet, A. & Piqué, B. (2018). *Guía para la formación en la competencia investigadora.* Universitat de Barcelona.

Real Decreto 243/2022, de 5 de abril, por el que se establecen la ordenación y las enseñanzas mínimas del Bachillerato. *Boletín Oficial del Estado, 82*, de 6 de abril de 2022. https://bit.ly/4elw1gi

Rojas, H. M., Méndez, R. & Rodríguez, A. (2012). Índice de actitud hacia la investigación en estudiantes del nivel de pregrado. *Entramado*, *8*(2), 216-229.

Romero, G. C. & Chávez, B. J. (2021). El pensamiento crítico en el desarrollo personal de los adolescentes. *Dominio de las Ciencias, 6*(7), 3-23. https://doi.org/10.23857/dc.v7i4.2408

Romero-Ariza, M. (2017). El aprendizaje por indagación: ¿existen suficientes evidencias sobre sus beneficios en la enseñanza de las ciencias? *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias, 14*(2), 286-299. https://bit.ly/3VCwHpg

Torres, N. &. & Solbes, J. (2016). Contribuciones de una intervención didáctica usando cuestiones sociocientíficas para desarrollar el pensamiento crítico. *Enseñanza de las ciencias: revista de investigación y experiencias didácticas, 34*(2), 43-65. https://doi.org/10.5565/rev/ensciencias.1638

UNESCO. (2015). *Replantear la educación: ¿Hacia un bien común mundial?* UNESCO. https://bit.ly/43zfv7B

UNESCO. (2022). *Reimaginar juntos nuestros futuros. Un nuevo contrato social para la educación*. UNESCO. https://bit.ly/3xlLdcc

Valdés, A., Estévez, E. & Vera, J. A. (2013). Desarrollo de competencias científicas en estudiantes de postgrado desde la perspectiva del docente. *Educere, 17*(56), 129-138. https://bit.ly/4ccngny