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Simulation of a Real Call for Research Projects as Activity to Acquire Research Skills: Perception Analysis of Teacher Candidates

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Abstract: In this research, a novel methodology based on the simulation of a call for research projects was applied for the training of STEM secondary school teachers, with results raised and analyzed to determine the response of the students to this new methodology. The activity was applied in the same course during two academic years with student groups from very different teaching specialties such as mathematics, physics and chemistry, biology and geology, technology and health processes who were studying the Master's Degree in Secondary Education, specifically, the 3 European Credit Transfer and Accumulation System (ECTS) course of Initiation to Educational Research (IER), this Master's course being mandatory for working as a secondary professor. The Master's students are asked to write their own research project proposals for a fictitious call on a topic freely chosen by them, which might have been related to the research line of the final Master's thesis. In it, they had to propose all the contents studied in the course (such as writing a brief state of the art, establishing a research team, setting objectives, a description of the methodology for educational research, instruments, a plan for the dissemination of the results, the needed resources, etc.). The students' perceptions of the usefulness and reality of what they had learned for their professional development and for writing their final theses were assessed. The results based on the perceptions of the students demonstrate that the activity had been useful for assimilating concepts related to educational research in the context of secondary education (research skills), which will be useful for improving the critical sense of the students (teacher candidates) and for their professional future in the context of applied research in day-to-day secondary teacher activities. Furthermore, the results show the activity was useful for the development of the final Master's thesis. The difficult aspects that the activity presented for them were analyzed. The results were statistically compared for the students of the different specialties, deducing, in all cases, a homogeneous good acceptance with slight differences between them.

Keywords: teacher training; quality education; curriculum development; educational innovation; research project; secondary school; science learning

1. Introduction

Participation in teaching innovation projects is much higher among university professors than among secondary school teachers. A fact that reflects this is the difference in the number of conferences and specialized journals that exist in both sectors. Thus, many secondary school teachers have never had any experience in the field of research. However, many of the published teaching innovation ideas come from the primary and secondary levels [1–3] since it is precisely at these educational levels where the essential training is established to subsequently be able to access university.

In this sense, the instruction of the candidate teachers is essential so that they know the different aspects related to the educational profession: evaluation [4], the organization of educational centers [5], and methodologies—e.g., project-based learning (PBL) [6–9], gamification [10,11], the use of new technologies based on augmented reality or virtual reality [12], and the use of computers and web technologies [13], etc. Regarding the last aspects, it is worth noting that the most important is the methodology used since new technologies do not imply a methodology by themselves [14,15]. In addition, self-efficacy regarding computer use becomes an important predictor of success in education [16].

All this takes on greater importance in the context of the Sustainable Development Goals (SDGs), which have been laid down by the United Nations Organization as part of the sustainable development agenda for the 2020–2030 decade because the students of this program will be secondary school teachers in the short term. Specifically, Goal 4 (quality education) is achieved, among other things, through educational research and development. Furthermore, the students of this program will be teachers in a scientific and technological subject, and their future work is crucial for the acquisition of skills by the new generations related to technologies, energy resources, infrastructure, and other concepts related to the SDGs.

On the other hand, research and innovation training is also an important aspect of the development of a teacher candidate [17–20]. However, some teaching candidates feel that their education did not prepare them to work as teacher-researchers [21]. In this regard, in the Secondary Teaching Master's Degree, regulated in Spain by the Ministry of Education and Science [22], one of the compulsory subjects is precisely related to the research and innovation training of the secondary school teacher candidates. Specifically, one of the specific competencies that must be developed in this topic is "Know and apply methodologies and basic techniques of educational research and evaluation and be able to design and develop research, innovation and evaluation projects". The community interest in this aspect has been increasing in last years, thus creating a growing trend in the number of published papers related to "training teachers" and "research skills" (Figure 1). Nonetheless, although recent articles reveal the necessity of designing new methodologies to enhance the educational research skills of students of a Master's Degree in Secondary Education (future teachers) [23,24], there are hardly any references to experiences with or research on such a specific topic.

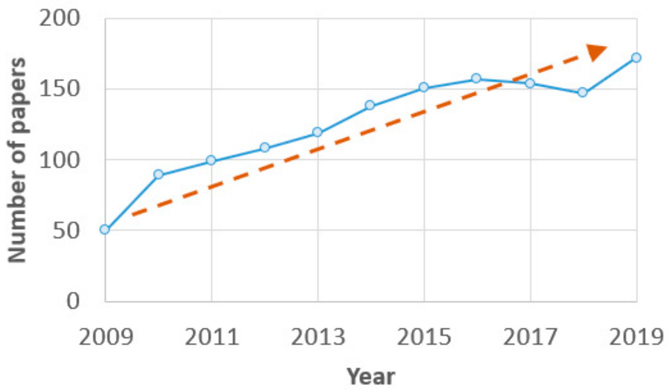

Figure 1. Number of papers published in the last decade including "training teachers" and "research skills" throughout the article (data collected from Google Scholar on 15 August 2020).

Some of the previous articles related to similar interests are linked to the application of multidisciplinary methodologies [25,26], those most appreciated by teacher candidates being related to new or improved methodologies and the use of updated technology in the classroom [27–29]. The analysis of the students' perception of the Master's degree level can be implemented using SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis [30,31]. This type of analysis allows for understanding, verifying or increasing the effectiveness of learning, improving strategies and assessments to be more efficient, verifying that what was planned is being done, facilitating management and generating data and information that can be shared [31]. For this reason, strategies such as the one applied in this article that measure students' conception of innovative activities are necessary for continuous improvement and for increasing the quality of training.

For this reason, an experience carried out during two academic courses in the subject "Initiation to Educational Research" (IER), corresponding to the Master's Degree in Secondary Education of the Catholic University of Ávila (Spain), is presented in this article. During these two academic courses (2017–2018 and 2018–2019), a practical methodology was applied for the specific training of teacher candidates in the field of research and innovation. Specifically, said methodology was based on a simulation of a real call for research projects, and after the experience in the classroom, a questionnaire to extract quantitative results for different issues was carried out among the teacher candidates (students of the Master's Degree). Furthermore, taking into account that the sample of teacher candidates analyzed covers different fields (biology, geology, technology, mathematics, physics, chemistry and health processes), the results shown in this study are easily extrapolatable to any educational environment.

Furthermore, this Master's course is based on official programs of the European Union (not only for Spain), so the requirements, competences and main lines of the course (IER) on which this research work is focused are defined in the context of the European Higher Education Area. Therefore, since the Master's Degree in Secondary Education of the Catholic University of Ávila (Spain) has been designed in accordance with the competencies set out by the European Union to harmonize the educational programs of all member countries (BOE Nº 305, 21 December 2007; BOE Nº 312, 29 December 2007; BOE Nº 278, 28 November 2008; Real Decreto 861/2010, 2 July 2010), the objectives and competences could be extrapolated to any other similar course for the same Master's degree of another European university. In turn, teacher training programs have similarities in almost every country in the world, and educational research skills are often included in them. Consequently, this research is not limited to Spain but is of global interest, and the proposed methodology could be applied in many universities from different countries with similar Master's programs.

2. Methodology Design

2.1. Research Aim

The authors sought to know the response of students when a new methodology based on the simulation of a call for research projects was applied. Therefore, the following questions were to be answered in this study:

- Is the activity perceived by the students as a useful and realistic activity?
- What tasks do students find most difficult?
- Are there different answers depending on the students' specialization?
- Do students prefer to propose a research line related to a methodological proposal, or, on the contrary, do they prefer to propose an integration of a new technology in the classroom?

2.2. Academic Context

The Master's Degree in Secondary Education at the Catholic University of Ávila (Spain) covers the following specialties for the teacher candidates: (i) physics and chemistry; (ii) socio-community intervention; (iii) health processes; (iv) mathematics and informatics; (v) technology; (vi) biology and geology; (vii) English; (viii) philosophy; (ix) language and literature (Spanish); (x) economy, business and trade; and (xi) job training and counseling. A total of 13 subjects (42 ECTS), external practices (12 ECTS) and the final Master's thesis (6 ECTS) are covered in this Master's degree. The subjects are divided into two categories: (i) the subjects common to all the specialties, which are developed first, and (ii) the subjects related to a specific specialty, which are developed once the common subjects are completed. Specifically, the study presented in this article was developed in a subject of the second group, IER (6 ECTS), which involves all the science and technical specialties: biology, geology, technology, mathematics, physics, chemistry and health processes. Please note that these specialties are the most related to STEM competences; therefore, in the future, these secondary school teachers will be the ones in charge of awakening the student's interest in STEM subjects as mathematics, technology, physics, chemistry, informatics and others.

2.3. Activity Design

The course was scheduled for 26 h of classroom time (3 European Credit Transfer System, ECTS) in a synchronous modality using the Blackboard Academic Suite [32] as a Learning Management System (LMS). The lessons started on the first days of February (depending on the academic calendar of each course) and ended on the last days of May.

There were both face-to-face and remote-connected students. Firstly, the theoretical aspects of the course were explained (using magistral lessons, which were recorded), while the more practical aspects were explained in practical workshops with constant interaction with the students.

The contents of the theoretical and practical lessons generated for the acquisitions of competences are summarized in Table 1. Once the theoretical and practical lessons had been explained, the activity under research was implemented. Firstly, as indicated in Figure 2, the activity was presented and detailed to the students. Then, the activity was developed by the students in autonomous work but holding two group-tutoring sessions of two hours each to share ideas and solve questions. Finally, the activity was uploaded on the Blackboard platform [32].

Table 1. Contents of the course.

Theoretical Contents	Practical Contents
T.1. Scientific knowledge and scientific method	P.1. Searching for scientific bibliography: academic databasesP.2. Support for publication of research: journals and other forms of support, impact indexation
T.2. Fundamentals of academic work	
T.3. The education research process I: creation of the research group, justification and phases	
T.4. The education research process II: methodology, analysis, and evaluation of results	
T.5. Presentation and divulgation of research results	

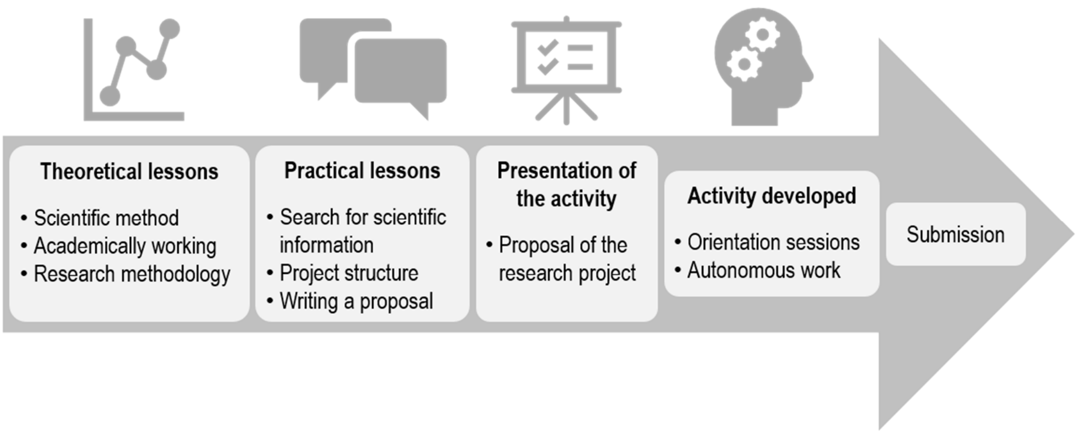

Figure 2. Workflow for the activity designed.

All the students of the Master's Degree have done an internship in secondary schools that have allowed them to have a vision of the needs in the secondary school classroom in their respective specialties. Since this internship lasts a total of 180 h, the students are expected to be able to identify needs or possibilities for improvement that can be investigated. Said internship is divided into two specific periods: (i) 90 h of observing the development of different classes, learning how the time of a class is distributed, attending to the difficulties that occur in secondary school, learning how the teacher solves problematic situations, learning the organization of the educational center, observing the different methodologies applied in the classroom, etc., and (ii) another 90 h of acting as an active teacher under the supervision of the responsible teacher (tutor) and designing the didactic units that will be taught in the classroom.

The activity under research consists of the simulation of a call for a research project (fictitious). To this end, students should prepare a proposal indicating a research idea—specifically, a methodological improvement or the integration of new technologies in the classroom for the specific specialty. For this, a specific activity was designed to develop and evaluate the competences in terms of educational research in the students (future teachers). Three different criteria were followed to design the activity (Table 2) [33,34].

Table 2. Criteria for the activity design.

Quality	Reality	Economy
The statement should provide enough information about the activity.	The proposal must have the structure of an actual research project proposal.	The activity is limited (3000 words) to evaluate the students' ability to synthesize.
The activity must be divided into sections that allow an evaluation heading.	The economic budget is limited to EUR 6000 so that students can prioritize what is most needed and make the work easier.	The statement will be uploaded in the platform, and the sending of the activity carried out will be done by that means.
It should be possible to evaluate the students' opinions after the activity.	A fictitious entity called "*Fundación Buen Saber*" is created, which is the entity that launches the call for applications.	Students are allowed to take advantage of ideas they may have in mind for their final Master's Thesis.

In this way, the statement realized for the activity is the following: "This non-profit organization opens a call for research projects, in education and teaching innovation corresponding to this course to provide winning projects with funding of up to 6000 euros to develop the research papers. The research projects will have a duration of 12 months and will start on 1 September of this year. The projects will be aimed at research in the field of science and technology education in Secondary and High school. We, as teachers, want to put forward an individual research proposal to get resources to carry it out. We will have the help of Dr. Benito Clavel (fictitious), a researcher in the University, an expert in education research methodologies, and with other possible researchers to choose from by the student who is part of the team. The research proposal will be presented in a totally free way by the only requirement that it constitutes a research on a methodological improvement or the research on the integration of new technologies in the classroom for the specific specialty and that adapt to the structure of the application. The student must write a proposal according to the structure established in the call which must have the next structure".

The proposal template was created following the criteria established in Table 3. This was to be given to the students in order to clarify the aspects needed for each point of the proposal, each of these points being related to the contents of the subject.

Table 3. Structure of the proposal (max. 3000 words).

Point	Contents Related	Description
Research team	T.2 T.3	The team must have at least three researchers with profiles related to the subject to be addressed, justifying their profiles according to the objectives of the call. It is left to the student to propose imaginary profiles (for example, an expert in e-learning, an expert in educational research methodology, an expert in gamification, etc.).
State of art	T.1 T.2 T.3 P.1 P.2	Brief bibliographical research on the subject to be dealt with should be carried out here in order to study what has been researched so far and to determine the starting point of the investigation. In this section, the student should consult scientific and specialized literature and cite according to the updated APA standards.
Justification	T.1 T.2 U.3	This section should clearly and concisely indicate the contribution of the research, in order to inform the "*Fundación Buen Saber*" about the potential of project and the reasons why it should be selected. The proposal must meet a real need.
Objectives	T.1 T.2 T.3	General and specific objectives should be numbered.
Materials and methods forecast	T.4 P.1 P.2	This section should justify and describe in detail those methodologies of education research and teaching innovation (bibliographical, quantitative and qualitative) to be applied in research, as well as the tools and techniques to be used and the necessary material.
Stages and chronogram	T.3	The stages of the investigation should be listed first, and then, to make a schedule that contemplates all the activities to be carried out, the dates of the start and end should be stated. It should also set out concisely what the relevant tasks for each member of the work team are, always trying to optimize the use of time as best as possible.
Budget	T.3	The call states that the amount to be covered by the Foundation will be EUR 6000. On this basis, the applicant must make a list of the materials and/or services that will be needed for the investigation, in an orderly manner and with items properly broken down. A justification of the needed materials should be raised in the materials and methods forecast section.
Results communication plan	T.5 P.1 P.2	This section should set out a detailed plan for disseminating the results of the research, so that it has the greatest possible impact. In this respect, one should choose a number of potential periodicals, preferably indexed in the JCR or in the SJR, where the results of the research can be published, as well as at least two national congresses or conferences or international networks where the results can potentially be presented.

2.4. Sample

The study involved students enrolled in the Master's Degree in Secondary Education at the Catholic University of Avila during the 2016–2017 (21 students) and 2018–2019 (53 students) school years. Two non-consecutive courses were chosen to avoid information flow between students that could condition or bias the answers chosen by each student. As it is a Master's degree with a limited number of students, all the students who wanted to do the activity were accepted for the study; a random choice could not be made because it would have greatly reduced the sample size. Please note that all the students of the Master's course have in common a high level of studies (at least Bachelor's degree level) and interest in teaching. All these students converge in the same classroom. The distribution of the total sample is indicated in Table 4. The sample age is shown in Table 5.

The classes of the Master's Degree were held on weekends since many of these 74 students were working during the week. Therefore, the average age of students is higher than the average of recent graduates (Table 5). In general, students who work at the same time participate actively in the teaching–learning process, and they are very involved in the training they receive, thereby conditioning the research work presented here.

Table 4. Distribution of student sample according to the teaching specialty.

Teaching Specialty	Number of Students	%
Technology teaching	34	45.9%
Mathematics teaching	12	16.2%
Physics and chemistry teaching	6	8.1%
Biology and geology teaching	9	12.2%
Health processes teaching	13	17.6%

Table 5. Sample age.

Age Range	% of Students
20–30	23%
30–40	47%
40–50	23%
50–60	8%

2.5. Instrumentation and Data Analysis

A quasi-experimental design with an experimental group and based on post-test was established to obtain information on student conception. The activity was developed following the sequence established in the previous sections (Figure 2) in two different academic terms (2016–2017 and 2018–2019). After carrying out the activity, a questionnaire was given with the questions established in Table 6 to extract quantitative results for the different issues to be discussed.

Table 6. Questions raised in the questionnaire.

Question N°	Statement	Type	Category
LQ1	The proposed compulsory work has been useful to assimilate concepts about the subject	Likert scale (1–5)	Utility
LQ2	Adaptation to the reality of the raised project	Likert scale (1–5)	Utility
LQ3	The development of the idea has been a simple task	Likert scale (1–5)	Difficulty
LQ4	The bibliographic research (state of art) has been a simple task	Likert scale (1–5)	Difficulty
LQ5	Allocating resources has been a simple task	Likert scale (1–5)	Difficulty
LQ6	Synthesizing the work has been a simple task	Likert scale (1–5)	Difficulty
LQ7	What I learned in the course has helped me to develop my final Master Thesis	Likert scale (1–5)	Utility
LQ8	What I have learned in the course can help me to foster a critical spirit among my students	Likert scale (1–5)	Thinking over
CQ1	I'd rather have done something different than the one proposed	Categorical (Yes/no)	Satisfaction
CQ2	If in the future I apply for a research or teaching innovation project, I believe that what I have learned in the development work will serve as a reference	Categorical (Yes/no)	Reality
CQ3	Before taking the course, I didn't have a clear idea of what a research project was	Categorical (Yes/no)	Previous
CQ4	The realization of the research project has changed my view of the matter	Categorical (Yes/no)	Thinking over
CQ5	I have used content from my Master Thesis to prepare the research proposals	Categorical (Yes/no)	Utility
CQ6	I have used concepts or contents from other subjects to carry out the activity	Categorical (Yes/no)	Utility

The first eight questions (LQ1–LQ8) were designed based on a five-point Likert scale [35]. All these answers were raised in terms of the level of agreement (according to the following: 1—strongly disagree, 2—disagree, 3—neither agree or disagree, 4—agree, and 5—strongly agree). However, only the two extreme responses were listed in the answers (strongly disagree and strongly agree) to allow the students to choose the correct answer in a continuous way without limiting the specific meaning of each reply. The scale was selected to ensure the simplicity and homogeneity of the responses so as not to generate misleading or confusing answers, while providing an accurate interpretation of the data. The rest of the questions (CQ1–CQ6) were designed based on a categorical response (yes/no). An explicit answer from the student for some issues was sought in order to establish comparisons between those who responded in one way or another with respect to the previous questions evaluated using the Likert scale. The questionnaire also asked the student's age and specialty. The same questionnaire was applied during the 2016–2017 and 2018–2019 academic terms.

The questionnaire addressed five attributes:

- Previous skills of the students (previous).
- Effectiveness of the activity for the training objectives and competences of the Master's program (utility).
- Adaptation to the reality of the activity (reality).
- Difficulty of the activity perceived by students, as well as detecting those aspects that present greater difficulty (difficulty).
- Satisfaction of the student with the activity (satisfaction).
- Invitation to reflect on and change one's beliefs regarding the issue at hand (thinking over).

The data analysis for LQ1–LQ8 questions was based on descriptive statistics: the mean ($\overline{x}$), standard error (SE), and deviation error (DE). Despite the sample not being large, parametric statistics were chosen because they are sufficiently robust to provide correct results using Likert scale responses [36]. However, the parametric statistical treatment of Likert type data is a controversial issue. It can be treated as an interval scale to be handled using parametric statistics [37], but some authors argue that nonparametric statistics should be used [38]. Thererfore, the two statistical approaches (parametric and nonparametric) were applied. On the one hand, the parametric approach was based on the one-way ANOVA test. It was applied previously using Levene's test to evaluate the equality of variances for each group. This test allows the determination if a robust statistical parametric test (Welch's test) must be applied. On the other hand, a nonparametric approach was applied, taking into account that the answers for Likert questions can be considered as a non-continuous variable. In this case, Kruskal–Wallis was chosen for the nonparametric evaluation of the data. The statistical significance values obtained using the two approaches (parametric and nonparametric) were compared in order to reinforce the conclusions drawn for the data.

The results are presented as individual items in the questionnaire and detailed by student specialty. The data are discussed in terms of mean values, errors, and confidence limits (95%) based on standard deviation, and according to students' attitudes towards the proposed approach. Categorical questions are analyzed by relative frequencies, and they are used to determinate groups for hypothesis contrasting.

3. Results

The results section is divided into three different subsections. Firstly, the global results for the whole sample will be shown. Then, results will be statistically analyzed in the function of the student specialization in order to study possible group differences. Finally, the proposal of the students is analyzed in order to know the type and main examples.

3.1. Global Results

The distributions of the answers for each question based on the Likert scale (LQ1–LQ8) are shown in Figure 3. The descriptive analysis and the upper and lower confidence intervals (UCI and LCI) for all of the students show good acceptance in terms of usefulness for assimilating concepts about the subject. This was evaluated by LQ1 ($\overline{x}$ = 4, SE = 0.12). Good acceptance was also demonstrated in terms of realism, evaluated by LQ2 ($\overline{x}$ = 4.08, SE = 0.77). The least easy task for the students was the creation of the state of the art ($\overline{x}$ = 2.53, SE = 0.13). Allocating resources was the easiest task for the students ($\overline{x}$ = 3.12, SE = 0.13) among all the difficult questions (LQ3–LQ6).

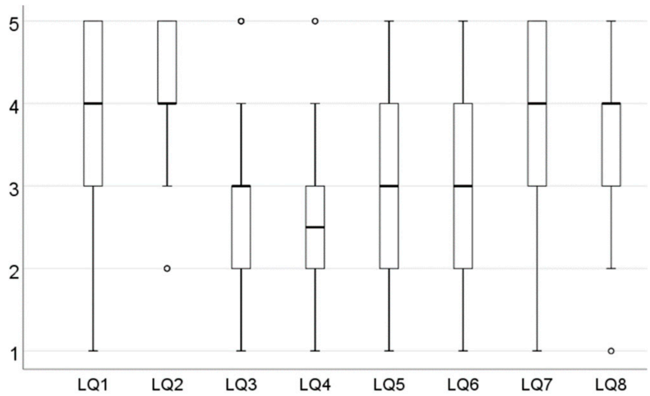

Figure 3. Distribution of the answers for questions based on Likert scale.

The students valued the activity positively; they believed that it had been useful for making their final Master's thesis, according to the results of the question LQ7 ($\overline{x}$ = 3.74, SE = 0.12). At the same time, the activity served to improve critical thinking among their future students in school ($\overline{x}$ = 3.55, SE = 0.12) (question LQ8).

The results obtained for the categorical questions (Table 7) show that 45% of the students did not previously know what a research project really was (CQ3). Only 24.3% of the students would have preferred to do other work (CQ1), this being another indication of good acceptance. Furthermore, 94.6% considered that the activity would serve as a reference for future calls to which they could respond (CQ2) in their future work as teachers. The conduct of the activity had changed the points of view of 77% of the students (CQ4). Finally, 58% considered that they had used content from their theses, and 70.3% had used content from other subjects, which shows a good integration of the activity with the competences of the Master's program, complementing the results of LQ7.

Table 7. Frequency results for answers for the categorical questions.

Question N°	Statement	Yes	No
CQ1	I'd rather have done something different than the one proposed	24.3%	75.7%
CQ2	If in the future I apply for a research or teaching innovation project, I believe that what I have learned in the development work will serve as a reference	94.6%	5.4%
CQ3	Before taking the course, I didn't have a clear idea of what a research project was.	55.4%	44.6%
CQ4	The realization of the research project has changed my view of the matter	77.0%	23.0%
CQ5	I have used content from my Master Thesis to prepare the research proposals.	58.1%	41.9%
CQ6	I have used concepts or contents from other subjects to carry out the activity.	70.3%	29.7%

3.2. Results by Specialty

In this subsection results are raised by the specialty of the students (Table 8). A one-way ANOVA analysis was applied (Table 9). However, Levene's test showed that the population variances for LQ4

(F(4.69) = 4.58, *p*-value = 0.039) and LQ5 (F(4.69) = 3.24, *p*-value = 0.017) were not equal (for the rest of questions, the condition of the equality of variances was met). Thus, the Welch test and Games–Howell post-hoc test were applied to compare the means of the different groups as a function of the teaching specialty for the categorical questions. The Welch and Games–Howell post-hoc tests were chosen because of their robustness to unbalanced variances and sample sizes, in order to verify the information provided by the ANOVA analysis, whose results are also reported (Table 9). This analysis was also used to compare the means for the groups conformed based on categorical responses (CQ1–CQ6).

Table 8. Results by student's specialty.

		n	Mean	Mode	DE [a]	SE [b]	LCI [c]	UCI [c]
LQ1	Biology and geology	9	3.33		1.12	0.37	2.47	4.19
	Physics and chemistry	6	4.00		0.63	0.26	3.34	4.66
	Mathematics	12	4.17		0.83	0.24	3.64	4.70
	Health processes	13	4.08		0.76	0.21	3.62	4.54
	Technology	34	4.09		1.11	0.19	3.70	4.48
	Total	**74**	**4.00**	**4**	**0.99**	**0.12**	**3.77**	**4.23**
LQ2	Biology and geology	9	3.89		0.78	0.26	3.29	4.49
	Physics and chemistry	6	4.50		0.55	0.22	3.93	5.07
	Mathematics	12	4.33		0.78	0.22	3.84	4.83
	Health processes	13	3.69		0.85	0.24	3.18	4.21
	Technology	34	4.12		0.77	0.13	3.85	4.39
	Total	**74**	**4.08**	**4**	**0.79**	**0.09**	**3.90**	**4.26**
LQ3	Biology and geology	9	2.56		1.01	0.34	1.78	3.33
	Physics and chemistry	6	3.00		1.41	0.58	1.52	4.48
	Mathematics	12	3.25		1.14	0.33	2.53	3.97
	Health processes	13	2.54		0.52	0.14	2.22	2.85
	Technology	34	2.71		1.19	0.20	2.29	3.12
	Total	**74**	**2.77**	**3**	**1.09**	**0.13**	**2.52**	**3.02**
LQ4	Biology and geology	9	2.33		1.41	0.47	1.25	3.42
	Physics and chemistry	6	3.00		0.63	0.26	2.34	3.66
	Mathematics	12	2.50		1.38	0.40	1.62	3.38
	Health processes	13	2.85		0.90	0.25	2.30	3.39
	Technology	34	2.38		1.10	0.19	2.00	2.77
	Total	**74**	**2.53**	**3**	**1.13**	**0.13**	**2.27**	**2.79**
LQ5	Biology and geology	9	3.22		1.30	0.43	2.22	4.22
	Physics and chemistry	6	2.33		0.82	0.33	1.48	3.19
	Mathematics	12	3.42		1.38	0.40	2.54	4.29
	Health processes	13	3.00		0.71	0.20	2.57	3.43
	Technology	34	3.18		1.17	0.20	2.77	3.58
	Total	**74**	**3.12**	**3**	**1.13**	**0.13**	**2.86**	**3.38**
LQ6	Biology and geology	9	2.56		1.42	0.47	1.46	3.65
	Physics and chemistry	6	3.17		1.17	0.48	1.94	4.39
	Mathematics	12	3.08		1.16	0.34	2.34	3.82
	Health processes	13	2.62		0.87	0.24	2.09	3.14
	Technology	34	2.76		1.16	0.20	2.36	3.17
	Total	**74**	**2.80**	**3**	**1.13**	**0.13**	**2.53**	**3.06**
LQ7	Biology and geology	9	3.11		0.78	0.26	2.51	3.71
	Physics and chemistry	6	3.50		0.55	0.22	2.93	4.07
	Mathematics	12	4.00		0.85	0.25	3.46	4.54
	Health processes	13	3.08		1.26	0.35	2.32	3.84
	Technology	34	4.12		0.88	0.15	3.81	4.42
	Total	**74**	**3.74**	**4**	**1.01**	**0.12**	**3.51**	**3.98**
LQ8	Biology and geology	9	3.11		1.17	0.39	2.21	4.01
	Physics and chemistry	6	3.67		0.82	0.33	2.81	4.52
	Mathematics	12	3.92		0.90	0.26	3.34	4.49
	Health processes	13	3.38		0.96	0.27	2.80	3.97
	Technology	34	3.59		1.08	0.18	3.21	3.96
	Total	**74**	**3.55**	**4**	**1.02**	**0.12**	**3.32**	**3.79**

[a] Deviation Error. [b] Standard Error. [c] At 95% confidence interval.

Table 9. ANOVA analysis according to student's specialty.

		Sum of Squares	df	RMS [a]	F	p [b]
LQ1	Between	4.675	4	1.169	1.198	0.320
	Within	67.325	69	0.976		
	Total	72.000	73			
LQ2	Between	4.159	4	1.040	1.735	0.152
	Within	41.354	69	0.599		
	Total	45.514	73			
LQ3	Between	4.333	4	1.083	0.903	0.467
	Within	82.762	69	1.199		
	Total	87.095	73			
LQ4	Between	3.724	4	0.931	0.724	0.578
	Within	88.722	69	1.286		
	Total	92.446	73			
LQ5	Between	5.159	4	1.290	1.003	0.412
	Within	88.747	69	1.286		
	Total	93.905	73			
LQ6	Between	2.793	4	0.698	0.528	0.715
	Within	91.167	69	1.321		
	Total	93.959	73			
LQ7	Between	15.280	4	3.820	4.480	0.003
	Within	58.841	69	0.853		
	Total	74.122	73			
LQ8	Between	3.833	4	0.958	0.913	0.462
	Within	72.451	69	1.050		
	Total	76.284	73			

[a] Root Mean Square; [b] p-value.

Upon comparing the groups by student specialty, statistically significant differences were detected only for the answers for question LQ7 (it had helped them in their final theses) ($F(4, 21.806) = 4.114$, p-value = 0.012) (Table 10). When a nonparametric test was applied to compare the groups (Table 11), the results yielded the same conclusions in terms of statistical significance: only for LQ7 were significant differences between the groups detected ($p = 0.007$). Applying an analysis based on Games–Howell post-hoc analysis, the difference detected between the means for this issue was statistically significant between technology students with respect to biology and geology students (p-value = 0.033).

Table 10. Robust test for comparison of means among students' specialties.

	Statistic [a]		df_1	df_2	p [b]
LQ1	Welch	0.910	4	21.934	0.476
LQ2	Welch	1.788	4	21.159	0.169
LQ3	Welch	1.005	4	20.012	0.428
LQ4	Welch	1.151	4	21.718	0.360
LQ5	Welch	1.384	4	20.929	0.273
LQ6	Welch	0.492	4	20.094	0.741
LQ7	Welch	4.114	4	21.806	0.012
LQ8	Welch	0.853	4	20.968	0.508

[a] F asymptotically distributed; [b] p-value.

Table 11. Nonparametric test for comparison of samples. Among student's specialty.

	Statistic		df_1	p [a]
LQ1	Kruskal–Wallis H	4.580	4	0.333
LQ2	Kruskal–Wallis H	6.656	4	0.155
LQ3	Kruskal–Wallis H	3.617	4	0.460
LQ4	Kruskal–Wallis H	3.965	4	0.411
LQ5	Kruskal–Wallis H	4.549	4	0.337
LQ6	Kruskal–Wallis H	2.164	4	0.706
LQ7	Kruskal–Wallis H	14.209	4	0.007
LQ8	Kruskal–Wallis H	2.587	4	0.629

[a] Asymptotic significance.

Then, different groups were created depending on the Yes–No answers to the categorical questions (CQ1–CQ6), also using Welch's test and the Games–Howell test (robust methods for unbalanced variances and sizes). In this way, two different groups were created for each question: a group of students who answered yes and those who answered no for each question. Students who planned to apply for research projects in the future (CQ2) perceived the utility differently (LQ1). Students who responded that they did not intend to do so ($\overline{x}$ = 2.5, SE = 0.5) perceived the utility differently from those who responded that they did ($\overline{x}$ = 4.09, SE = 0.11) (F(1, 3.303) = 9.58, *p*-value = 0.047). This result was corroborated using the Kruskal–Wallis H test ($p = 0.006$). However, this result may not be reliable due to the small size of the sample set that gave a negative response (only 5.4%). A statistically significant difference was detected in terms of the conception of the activity's usefulness for assimilating concepts about the subject (LQ1) among the students whose point of view had been changed by the activity (CQ4). Students who indicated that the activity had changed their way of looking at things valued the usefulness of the activity significantly differently ($\overline{x}$ = 4.16, SE = 0.298) from those who indicated no in question CQ4 ($\overline{x}$ = 3.47, SE = 0.114) (F(1, 20.89) = 4.626, *p*-value = 0.0043). This result was also corroborated using the Kruskal–Wallis H test ($p = 0.026$). Finally, there was no evidence of significant statistical differences in the results among students who previously knew what a research project was and those who did not (CQ3).

3.3. Lines Proposed by the Students

The final activities submitted by the students are being treated with confidentiality so that the students can use them in the future for their future professional activities or for the final theses of the Master's degrees. In general, the students' research lines related to (i) methodological applications in specific subjects—flipped classroom, cooperative learning, PBL, gamification, etc.—and (ii) the use of new technologies in the classroom—augmented reality, virtual reality, virtual laboratories, Information and Communication Technology (ICT), etc. (Table 12). Since the contents of this Master's degree are focused on methodologies, evaluation, history, didactics, etc., it seems logical that students tend to choose ideas close to what they have received in class. Furthermore, many of these topic proposals were linked with the final theses of the Master's degree, and, hence, students took advantage of the work dedicated to this subject to advance their theses. It is worth noting that many of the final theses addressed real experiences during the external practices in a real secondary school. Thus, both innovative methodologies and the use of new technologies were the most chosen options for the research activity proposed in the subject IER. In the authors' opinion, this activity of researching in the subject IER can reinforce the level of the final theses, since many students had to carry out more research than they would have done, on many occasions, for theses.

Table 12. Research lines chosen for the activity.

Research Line	% of Students
Methodological improvement	55.9%
Integration of new technologies in the classroom	44.1%

4. Discussion

Taking into account the limitation of the sample, especially for some specialties such as physics and chemistry, which makes it difficult to generalize the results, this study has shown that the activity based on projects is adequate for training future secondary school teachers in research matters regardless of the specialty, which may initially seem crucial for establishing specific training activities. Thus, this research work demonstrates that this type of multidisciplinary activity is adequate for all the students belonging to the different STEM specialties, corroborating previous studies applying multidisciplinary methodologies [25,26]. Furthermore, this type of multidisciplinary activity reinforces the necessities exposed in previous papers related to training teachers in Spain [24].

The experimental results show that students perceived the activity proposed in this article as real and also useful for assimilating concepts from the subject. The teachers who tutored the activity noticed the high interest and motivation that the activity aroused in the students because they asked very good questions and made an effort to improve the proposal of the work with imaginative ideas and high creativity. On the other hand, the majority of the students recognized that the activity had changed their way of thinking, which is an important fact because it implies that the activity induced a modification of their own beliefs regarding research, which could provide educational knowledge for more intelligent praxis in their professional future as teachers [39]. In turn, the students who stated that the activity had caused them to change their mentality perceived the activity as more useful, with a relationship between the perception of utility and the change in the way of seeing the problem. Most students thought that, if they attended a real call in the future, this activity would have helped them. In turn, this subset of students considered the activity as more useful than those who thought that the activity would not work in the future, demonstrating a relationship between the perception of utility and the hope of being able to make a research proposal in the future. This corroborates previous experiences in motivating research students by means of non-traditional methodologies (flipped classroom, collaborative and cooperative practice, etc.), with good consequences for the research skills of students [18–21].

A majority of the students used information from their final Master's theses in this work. In this regard, it should be borne in mind that not all final theses are research work, but many of them are. Finally, the majority used content from other subjects to carry out the activity, and the students who would have preferred to do a different job in the subject were few, which implies a good level of satisfaction with respect to the activity raised; it indicates that the activity has good integration and a multidisciplinary character and serves to enhance other skills.

Regarding the analysis of the differences between the groups, the statistical strategy applied shows a fairly homogeneous trend among students from different specialties, which is intrinsically a relevant conclusion, given the important differences between some specialties and academic backgrounds of the students. Another important drawn conclusion is that there were also no differences detected in terms of the answers given based on the students' prior knowledge, which can be explained insofar as the Master's course is taken by students who have not had previous experience in educational research. They may have had contact before with some specific research task in their respective scientific specialties but not with the day-to-day activity of the educational researcher, which was a novelty for them. Therefore, there were significant differences among the results obtained for the students of each specialty for the use of the knowledge developed in their final theses. Differences were only detected among the students of the different specialties regarding the use of content specific to the final theses, and these differences were accentuated between the specialties of technology and biology and geology. Although both are STEM disciplines, this may be due to the large differences between the two types of profiles. Regarding the rest of the parameters evaluated, the results of the hypothesis contrast hardly show significant differences among the students of the different specialties, which, hypothetically, could imply that the response to the activity might not depend so much on the specialty.

The questions regarding the ease of the tasks were different in some groups than in others. However, they considered that the most difficult part of the work was the bibliographic study and the simplest was the allocation of resources. In this regard, it is a critical conclusion, and, hypothetically, this could be because all the students belonged to scientific and technical specialties and there were no students from subjects related to the humanities or social sciences, more accustomed to doing tasks related to documentary work and bibliographic reviews.

Regarding the specific content of the proposal presented by the students, slightly more than half of the students chose the improvement of a methodology and the other half, the investigation of a new technology in the classroom, which corroborates the high interest for both topics revealed in previous studies [27–29]. The lines proposed by the students were, in general terms, original and responded, in many cases, to the current state of the art in research in their respective areas, related to new topics such as virtual reality, gamification, motivation and others. The students showed interest in the activity and strove to do it as well as possible. These data are also important due to the great workload that the students of the Master's course have because it is a very intense program with a duration of only one course.

On the other hand, the research does not allow a significant conclusion to be drawn about the lines preferred by the students. This will require a more detailed study of the lines proposed by each student and by specialty. Furthermore, the interest expressed in previous research articles about the influence of different variables in the teacher training, e.g., age, gender, etc. [40,41], was not considered in this analysis since this is out of the scope of the article. Therefore, these aspects will be considered for the future, thereby continuing the research line initiated through the methodology proposed in this study.

5. Conclusions

An activity based on the simulation of a real call for a research project was thoroughly designed using quality, reality and economy criteria for proper, adequate competence acquisition within the Master's Degree in Secondary Education. The proposed activity was carried out with the students of the scientific and technological specialties of the Master's degree: technology, physics and chemistry, mathematics, biology and geology, and health processes. The students of this Master's course have particular characteristics: the average age is high when compared to that for other programs, and they come from different specialties, which implies very different visions for the same problem.

The main conclusions of this research work can be summarized as follows: (i) the activity "a real call for research projects" was perceived by students as a useful activity for assimilating the concepts from the subject Initiation to Educational Research; (ii) many students recognized that the activity had changed their way of thinking about researching; (iii) it was demonstrated that a relationship between the perception of utility and the hope of being able to make a proposal in the future was crucial in the conception of students regarding this methodology; (iv) many students used the topic developed in this subject for their final Master's thesis (or vice versa); (v) the statistical strategy applied shows a fairly homogeneous trend among students from different specialties; (vi) students of the Master's degree, in general, have not had previous experience in educational research; (vii) the students stated that the most difficult part of the work was the bibliographic study and the simplest was the allocation of resources; and (viii) the topics selected by the students to develop this activity were mainly related to the improvement of a methodology and the investigation of applying a new technology in the classroom.

Finally, the results show good acceptance of the activity, which can be applied in the context of training secondary school teachers in STEM specialties, and the conclusions reinforce the need for students in the Master's degree to acquire skills related to educational research and its procedures so that they themselves can carry out research in the fields of their teaching specialties and progress can be made towards the quality objectives for education set out in the context of Sustainable Development Goals (SDGs).

There are two possible future lines of work: on the one hand, those oriented to deepen the results obtained, applying an investigation with an experimental design using a control group. On the other hand, future lines would address the analysis of the research line proposal among the different specialties or ages/genders of the students and would study the performance of the activity with a higher sample size. Another possible line would be to apply this methodology in non-STEM teacher specialties, for example, in the humanities and social sciences.

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