ACTION RESEARCH AS A PROFESSIONALISING METHOD: WORK INVOLVING THE IDEAS OF SECONDARY-LEVEL SCHOOL STUDENTS ON DOCUMENTATION, CULTURE AND SCIENTIFIC COMMUNICATION


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Abstract

A broad consensus exists on the use of cooperative action research as a suitable form of reflection to optimise the teaching-learning process. It is therefore appropriate that future secondary level teachers should know about this methodology as a means to professionalisation. So, is it enough to know of a method? According to our view of training, praxis must be consistent with the aims pursued and consequently the method must be experienced, particularly in an age when there is evidence that points to the need for cooperative work and skills training.

In accordance with this theoretical framework, a professionalising training action is described from the Master’s Degree in Secondary Education Teacher Training (MUFPES) course at the University of Extremadura during 2016-2017. The subject of study was the concept of “Science” in secondary level school students and the use of cooperative action research; we try to encourage the development of attitudes that favour investigation, reflection and educational innovation through the study of real cases. The MUFPES students began their experience by reflecting on their own ideas about the nature of science, the meaning of scientific in today’s society, and the scientific themes or content that are relevant to society and for obtaining scientific information. Subsequently, the investigation process started with a discussion on the problems of students in compulsory education who “don not want to learn” and their motivation with regard to science. The groups selected to apply the method were students from Years 1 and 3 of compulsory secondary education; the initial diagnostic tool used was an open questionnaire, together with an analysis of concept maps made by secondary level students and a multiple choice questionnaire using the INFLESZ scale to evaluate and validate the readability of the statements and options. Following analysis and interpretation of the qualitative and quantitative data an action plan was designed based on the incorporation of sequenced tasks through a taxonomy focused on thought models, and with these to develop key competences. The title of the proposed plan was “My programme and documentary schedule, and selection of my favourite science magazines”. Regarding the latter, we present a selection of the activities developed by the Master’s students so that secondary level students can work using a way of thinking that is reflective, analytical, logical, critical, systemic, analogical, creative, deliberative and practical. Finally, the students’ evaluation of the process is reviewed and the results of the survey on the students’ satisfaction are provided.

Keywords: Science Education, action research, innovation, documentation, research projects.

1 INTRODUCTION

The forms of understanding and implementing cooperative work in the classroom have been evolving progressively through time based on various theories, which have tried to justify new forms of learning and teaching. Thus, the History of Education allows us to reflect on the epistemological approaches about cooperation, which range from the theories of Piaget to the postulates of Vygotsky, or the theory of social interdependence of David and Rogers Johnson. Other theories, such as the meaningful learning of Ausubel, the theory of multiple intelligences of Gardner, the humanistic psychology of Rogers and behavioural learning according to Skinner or Bandura also support this kind of work in the classroom. However, all of these theories are going to focus on four fundamental elements: positive interdependence, scaffolding, socio-cognitive conflict and modelling [1-3].
In the experience that we present, the emphasis is placed on a type of cooperative work based on investigation-action, where a group of Master's degree students in Secondary Education Teacher Training (MUFPEs) at the University of Extremadura explores the ideas of students and elaborates a series of activities for teaching educative intervention. In line with one of the pillars of cooperative work, the design of this project is handled by the concept of positive interdependence, opening up the possibility for MUFPEs students and professors of the university to communicate their experience in a professional forum as co-authors and, effectively, this was what really happened: the authors of this work were a team of twelve students and three university professors in the Master’s degree programme.

There currently exists a rich bibliography of experiences based on investigation-action methods at all levels of education, and in some cases with the objective of maximising teacher professionalisation and even building bridges between initial and continuing education, between the school and the university [4-7]. Moreover, nowadays a new approach is adopted for education based on teaching using competences, according to the recommendations of the European Parliament and the Council on key competences for the well-being of European societies [8,9]. All this occurs as a consequence of a methodology based on investigation-action, and of course, it is linked to processes of educational innovation and renovation.

The professional advantages of participatory investigation-action range from professional to formative, social and cognitive aspects [10]. However, in order to design this experience within the framework of MUFPEs, university professors were interested in presenting as evidence some of the benefits of this methodology, such as generating attitudes of professional renovation, personal development and increased self-esteem, and providing an element of motivation. That is the reason why our principal objective was to present a professor-researcher model as the axis for future professional development across time. All this from real experience about the pre-existing ideas and concepts of secondary school students prior to undertaking a work placement or practicum. We also aspired to clarify concepts such as educational innovation, work by competences, to establish differences between groups, collaborative and cooperative work and to present the reality for certain students at compulsory levels who do not want to learn.

2 CONTEXT AND METHODOLOGY

In this pilot experience, 29 students undertaking the Master's Degree in Secondary Education Teacher Training (MUFPEs) at the University of Extremadura participated during the course of 2016-2017. This group was taking the module or speciality of Biology and Geology, which consists of various courses relating to the learning and teaching of these disciplines. The design and planning of this pilot experience is set in two of these, namely “Experimental Methodology and Learning Biology and Geology”, which is compulsory, and “The Scientific Foundation of the Biology and Geology Curriculum in Secondary Education”, which is an additional part of the disciplinary training. Students are expected to acquire basic techniques in both subjects, enabling them to approach the teaching-learning process in a strategic way by developing their own teaching materials to deal with the diversity of secondary level students. The first focuses more on the methodological approach and the second on didactic updating; nonetheless, using the links of both, the concept of “Science” was selected as an integrating element that allowed attitudes to develop that promote enquiry, reflection and educational innovation using real cases. The entire process described above was carried out in different groups of four or five students. Each group shared their own ideas and proposals with the rest of the class. After every class, all the groups wrote up a completed report that was handed over to the professor for evaluation.

First, the concept of science and scientific culture was contextualised in the Master's students themselves through open questions and an ideas-sharing session and debate. In addition, a group of students was asked to make concept maps to gain awareness of the skills needed to organise concepts related to science and its method. Clearly, these students, having already graduated in biology, veterinary or agronomic science with a high scientific qualification and some with doctorates, do not constitute a representative sample of society. So what ideas about science will secondary level students have? What treatment will these future teachers have with these representations? The work proposed to solve these questions was developed through real cases, that is to say, through the diagnosis and recognition of an educational context in a population of students in compulsory secondary education (known as “ESO”) aged between 12 and 16 years. The initial sample consisted of a sample of 30 students from the third and fourth years of ESO.
Once the starting point and the educational requirements had been identified, it was a question of preparing and designing a sequence of activities to encourage the secondary level students to communicate their own ideas and for them to hear the ideas of their fellow students. Later, the set of experiences would have to be adjusted to generate significant learning and finally to explain the content learned by formulating conclusions and reconstructing the entire teaching-learning process.

3 RESULTS

The action plan is based on an analysis of the responses to an open questionnaire given by a sample of 30 third and fourth year ESO students, which included the approaches discussed by the MUFPES students, who now took on the role of teacher-researcher.

Of course, the responses of secondary level students about the meaning of science for current society, the topics or scientific content relevant to our culture, as well as the obtaining and use of scientific information contrasted greatly with their own. After the analysis, in order to make a definitive diagnosis, 50 third year ESO students were asked for concept maps, which were checked by the same group of MUFPES students, who had made the maps.

As a result of these diagnostic activities a two-fold problem emerged. Firstly, the existence of students who do not want to learn, the lack of motivation and instrumental problems in a sector of the students, contrasting with a group with greater academic strength. However, the qualitative analysis led, secondly, to the recognition of epistemological problems about science, ignorance about scientists throughout history and, above all, misconceptions about documentation, culture and scientific communication. Nevertheless, the action plan to work on the representations of the students continued with the preparation of a closed questionnaire with the aim of carrying out a quantitative analysis. The readability of the questionnaire was validated by use of the Inflesz v1.0 program, which applies the Szigriszt Perspicuity formula as follows: \[ \text{INFZ} = 206.835 - 62.3 \times ( \text{syllables}/\text{words} - \text{words}/\text{sentences}) \] [11]. Its design was in Spanish and it was adjusted to normal reading difficulty, taking into account that the program performs an analysis at five levels, from "very difficult" to "very easy". The average number of syllables/words was 2.27 and of words/sentence 3.79: the INFZ result obtained was 61.45. The questions concerned recognising scientific information sources, identifying web pages to find scientific information, suitable places to do science, identifying scientific personalities, steps in the scientific method, or subjects that were considered science-related. Some of the conclusions drawn from the responses show the strength of Wikipedia in locating scientific topics, the association of a laboratory as a preferred place to do science, ignorance of some great scientists, such as Ramón y Cajal, and, above all, it was notable that all the students recognised the stages in the scientific method, but they were not able to explain it clearly. It is important to bear in mind that the secondary level students were also asked to explain and discuss their answers, so that they could better understand them. This methodological option provided a wealth of information. In addition, these explanations allowed problems to be corrected in questions where the options were not very precise, perhaps because of a lack of reflection on their possible consequences.

Once the learning context and the needs of the students had been identified, the educational problem focused on scientific documentation, culture and communication. From here, an action plan was drawn up, to create a programme of activities, resources and materials of their own, taking into account four technical elements: i) the interests of the students, ii) the students’ next area of development according to Vygotski, iii) their work competencies and iv) a taxonomy of abilities, based on thought models. This last element is fundamental since the current Organic Law for the improvement of educational quality (LOMCE) following the recommendations of the European Union, proposes a model for educational change in the curriculum based on competencies. These competencies are identified as key, and have been defined in the LOMCE as “the capacities to apply the content of each teaching and educational stage in an integrated way, in order to reach the full capacity for activities and effective resolution of complex problems” They are: linguistic communication, mathematical competence and basic competence in science and technology, digital competence, learning to learn, social and civic competencies, a sense of initiative and entrepreneurship, cultural awareness and cultural expression. Undoubtedly, the fundamental question rests on the form of teaching and learning competencies. For this, an effective way would be to respond to a problem-situation that can be understood as real [8,9,12].
3.1 The activities so that the secondary level students can work competently

The action proposal was to create a bundle of tasks with the title: "Your agenda of programmes, documentaries and favourite science magazines". Next, we would present the activities listed by the Master's degree students so that the secondary level students can work competently using reflective, analytical, logical, critical, systemic, analogical, creative, deliberative and practical thinking around scientific documentation, culture and communication.

3.1.1 Reflective thinking

Reflective thinking is the way of thinking that enables us to become aware of our ideas, operating with feelings and emotions. Thinking in a reflective way allows us to be aware of our mentality, recognising and appreciating it. The tasks designed were as follows:

a) Competence in linguistic communication

Draw up a list of your favourite television programmes and documentaries and next to each one write the reasons why you like it. If you read scientific magazines, do the same for those.

b) Mathematical competence and basic competence in science and technology

Complete your list of favourite programmes with the time you spend watching each of them and the time when you do it, using a spreadsheet. Do the same activity with your list of favourite magazines. Compare your preferences between watching documentaries and reading magazines.

c) Social and civic competences

Add to the previous list a description of your behaviour when you are watching these programmes or reading your favourite magazines (sitting, eating, reading, talking, etc.), and a description of the conditions under which you watch the programmes (in my bedroom, in the living room, in the kitchen, etc.)

d) Sense of initiative and entrepreneurship

Write your own scientific article about what you learn from your favourite magazines. Explain how you feel when doing this task and explain if your emotions influence the text that you have written.

3.1.2 Analytical thinking

Analytical thinking operates with data and facts, and enables abstractions to be made, and comparisons, similarities and differences to be found. Consequently, it helps us to "frame" reality in order to be able to think better, creating forms of representation based on clearly differentiated "boxes". The following tasks were designed by competences:

a) Mathematical competence and basic competence in science and technology

Create a table in your classroom using a spreadsheet in which you can put your favourite programmes and magazines and the times when watch or read them. Arrange the list in order of highest to lowest preference and represent it graphically. Compare your preferences between watching documentaries and reading magazines.

b) Competence in linguistic communication

Select a television news item and compare the form, content and vocabulary with how they appear on the different television channels.

c) Social and civic competences

Taking into account the data presented in the table, and the way the content has been treated in each medium and/or channel, describe in your own words what these data teach us about the impact of science on society.

3.1.3 Logical thinking

Logical thinking allows us to operate using reasons and creating arguments. With it we can express ideas in an orderly way and thus it leads us to the conviction that we are right. Thinking logically allows us to acquire new ideas from existing ideas, following precise rules. The following tasks were designed by competences:
a) Competence in learning to learn
   Identify the reasons given by people who do not watch programmes or read magazines and those who do.

b) Competence in linguistic communication
   Describe clearly and simply the conclusions you have reached from your analysis of the scientific information of programmes and magazines.

c) Social and civic competences
   Write and give your own reasons for the free or limited use of television.

3.1.4 Critical thinking

Critical thinking concerns the foundations on which our ideas, actions, assessments or judgements are based. So it is thinking which involves questions and looks for reasons, assumptions or conditions, it is thinking in which questions are formulated from reality in all its dimensions

a) Competence in linguistic communication
   Read and underline the reasons why the acquisition of scientific culture in society is important.

b) Competence in learning to learn
   Observe which programmes are scientific and see if they are understandable and interesting to you, giving reasons in your answers.

c) Cultural awareness and cultural expression
   Make a list of some of the positive and/or negative consequences of the existence of scientific programmes and magazines as a means of learning science for society.

d) Social and civic competences
   Make a criticism based on the social repercussions that news can have.

3.1.5 Systemic thinking

Systemic thinking operates with data and ideas and seeks to establish relationships of order; it defines relationships and presents them in the form of systems. With this thinking we can access complex realities, which disappear when we fragment them. The competence work produced the following tasks:

a) Digital Competence
   Search social networks for different scientific programmes and news broadcast on television and the internet, and see if there is any relationship between the programmes and the times when they are broadcast with the audience at which they are aimed.

b) Social and civic competences
   Analyse the lists of programmes most watched by your classmates and see if there is any relationship between the time spent watching them and their behaviour in regard to the school environment

c) Cultural awareness and cultural expression
   Search different information sources for some slogans on environmental preservation and see if there is any relationship between those used in other regions and countries.

d) Competence in linguistic communication
   Analyse the programmes that your classmates watch and relate this to the everyday vocabulary that they use.

3.1.6 Analogical thinking

Analogical thinking looks for metaphors and models, and similarities between things and situations that seem to be different and looks for differences between things that seem to be similar. The tasks designed were:

a) Cultural awareness and cultural expression
Have you used or have you ever heard the expressions “Mother Nature” or “Blue Planet”, and if so, try to answer these two questions: What do you think they mean? and Why do you think that they are used?

b) Social and civic competences

It is often said that people who go on TV become "role models". What do you think this expression means? Can you identify any of these "role models" applied to the dissemination of science (Feliz Rodríguez de la Fuente, Jacques Cousteau, Carl Sagan, Araujo)?

c) Competence in linguistic communication

Investigate whether the news you have chosen is related to any kind of popular wisdom and try to give a scientific explanation of this relationship.

3.1.7 Deliberate thinking

Deliberate thinking operates with decision-making criteria. It is the appropriate way of thinking for decision-making through criteria and values. The following tasks were set:

a) Competence in linguistic communication

Write clearly and precisely the criteria that should be taken into account in CHOOSING a good programme for scientific dissemination.

b) Competence in learning to learn

Prepare your own arguments for actively participating in the debate that we are going to hold in class to answer this question: should we select scientific dissemination programmes in our homes?

c) Competence in linguistic communication

Decide and enter in your weekly agenda the times and days on which you watch and read your favourite programmes and magazines.

d) Sense of initiative and entrepreneurship

Write down questions that your classmates can ask after watching the videos.

e) Digital competence

Choose one of the following topics: Saving the Arctic, Nuclear Power Stations, Hunting, Fishing or Introduction of Indigenous species, and argue whether you are for or against the chosen topic, based on information you have found on the internet.

3.1.8 Practical thinking

Practical thinking helps in overcoming all those situations in which it seems necessary to develop some action, either to solve a problem, introduce an improvement, or to prevent the situation from getting worse: thus, operating with prior information: data, documents, facts.

a) Competence in linguistic communication

Make a graphic representation of the sequence of actions necessary to carry out a project or campaign in support of the environment.

b) Digital competence

Organise a weekly schedule of activities, in an app specific to that purpose, including a good selection of digital programmes and documentaries, and that allows you to develop other activities, including homework.

c) Social and civic competences

Prepare the documents and space necessary in the classroom in order to debate the need to acquire scientific culture.

3.1.9 Creative thinking

Creative thinking can be seen as thinking of possibilities, operating with ideas and looking for new ones. The chosen activities by competences were:
a) Competence in linguistic communication

Write down some phrases that could work as slogans to encourage people to participate in a project in support of the environment

b) Sense of initiative and entrepreneurship

Prepare some proposals on scientific subjects, to create a three-part document on social awareness, with which the school can participate in a programme of scientific culture between schools.

c) Cultural awareness and cultural expression

Design some simple logos to encourage people to participate in the campaign to promote watching programmes and reading about scientific culture.

Lastly, it would be interesting to put these ideas into practice. However, it has not been possible to carry out this part of the project due to the schedule of the students.

4 CONCLUSIONS

The project was evaluated using a series of questions to measure the conceptual learning of the MUFPES students and a satisfaction survey approved by the National Agency for Quality Assessment and Accreditation (ANECA), which was conducted following the protocol of the Vice-Chancellor of Quality at the University of Extremadura.

The students had to devise a concept map for the construction of a summary on the subject of "Scientific Culture" relevant to the ESO Year 4 curriculum, and to prepare a teaching unit, taking into account the importance of working with the students' ideas, and the work on competences in the current educational system, bearing in mind that there are students who "do not want to learn", and the concept map created. MUFPES students addressed major issues such as health and quality of life, illness and the health system, sustainable energy and development, technology and the environment, knowledge of the universe, science itself and scientific information, and the scientific method and knowledge, as well as its dissemination. Finally, a group of XX students was asked for a description of their interest in educational innovation projects, and a critical analysis of their Strengths, Weaknesses, Opportunities, Threats and personal attitude using the SWOT methodology. The results obtained are similar to those obtained in the past three years when this methodology was used. Hence, 96% of the students pass the exam (42.2% distinction, 57.8% grade of B). Moreover, accumulative evaluation shows a differential of +1.25 points that are now above the final mark obtained in all the involved subjects.

The satisfaction questionnaire completed by the students consists of 24 items that highlight a set of boxes to evaluate the teaching methodology, the organisation of the teaching, the attention to students and the evaluation and results of an overall assessment.

We carry out a very exhaustive evaluation where one of the items is related to the objectives suggested at the beginning of the study. Thus, when we ask the students about the teaching contribution to the professional development of attitude and skills, the results show a positive evaluation. Hence, 8.56 points compared with the 7.44 points found in MUFPES, 7.37 at the department and 7.95 at the university. The evaluation carried out by the Unidad Técnica de Evaluación y Calidad (Technical unit for evaluation and quality) shows 8.04 points compared with 7.37 points obtained at the MUFPES, 7.74 at the department and 9.95 at the university.

Both evaluations were positive, although a detailed analysis of them shows elements for improvement. Among the difficulties observed is the way of temporarily setting this type of project within a teaching plan, because the pace of work can affect and alter the scheduling of other content. Indeed, some authors have noted that project-based work can lead to students learning certain ideas at a deeper level than others [13]. On the other hand, it was observed that some students were concerned to ask for notes or theoretical elements to prepare for the final exam. We assume that traditional teaching is still well-established in classrooms, and it raises questions about the current relationship between knowledge acquired through work by competence, strictly speaking, and passing the test that decides the final qualification. We made a subjective assessment about the presence, in all the classrooms, of some unmotivated students and it would have been interesting to measure the influence of the methodology employed. Nevertheless, it is important to emphasise that this project was not designed for testing innovation quality, but rather an experiment that needs to be revised over time. Thus, this
Project should be considered as a pilot experience that could be improved, revised and reproduced. Moreover, the typology of MUFPES students, who frequently need to combine their studies with professional activities, requires monitoring and adjusting in some aspects related to the performance of tasks. In this sense, some authors suggest that studies supported in cooperative projects can lead to an overload of work [14]. Positive interdependence as a motivating element is a measurable fact since 45% of the students decided to get involved in the publication of this project.

Cooperative learning has been analysed by a significant number of authors [15,16], suggesting that this kind of learning may develop critical thinking and metacognition. In this sense, the present experience may constitute a link between the MUFPES practical part and the professional course that the MUFPES students will carry out. Moreover, other studies have pointed out that all the methodology based on projects could be an essential tool for motivation [17,19].

Finally, it is important to mention that the purpose of this experience has been to verify or at least reinforce our certainty about the idea that teaching quality can be improved by solving problems, researching during the class, working at the proximal development area and analysing the interests of both the students and the teachers.

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