



Scientists and Science Teachers Working Together: the Research Experiences for Teachers as Professional Development

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Abstract

In the last several decades, the majority of Organization for Economical Co-operation and Development Countries have experienced a decline of students enrolling in the so-called STEM (Science, Technology, Engineering and Mathematics) departments. This problem has been addressed by reforming science education in the secondary schools and efforts towards improving science teachers' proficiency -- offering a wider selection of professional development. The Research Experiences for Teachers (RET) is considered a kind of professional development where teachers are immersed in research activities, doing science with scientists and exploring all stages of the inquiry process. RET programs have been in existence for more than 20 years in the USA but, basically do not exist in Italy. Even in the new document from the Ministry about the professional development of Italian Teachers, there is no mention of such programs. The International Ocean Discovery Program (IODP) and the European Consortium for Ocean Research Drilling (ECORD) offer teachers two kinds of professional development: 1) School of Rock, a training course for teachers based on data from drilling expeditions, and 2) the opportunity to sail on an IODP expedition as Education and Outreach Officer, working alongside scientists. The authors were involved in IODP Expedition 367 on board the JOIDES Resolution research drilling vessel as Education and Outreach Officer (A.C.), as scientist (C.L.), and as program manager (S.K.C.). During the two months of the expedition the authors organized 101 video connections from the ship with schools from all around the world, reaching around 7000 students. In every broadcast, students were able to see the ship, the labs and interact with scientists on board. In this study, we investigated using a qualitative approach, the strength of the relationship between teachers and researchers and the outcomes of the program in terms of the enhancement of students' motivation in science analyzing the outcomes of the video connections from the ship.

Keywords: Research Experiences for Teacher (RET), Outreach, International Ocean Discovery Program (IODP), European Consortium for Ocean Research Drilling (ECORD), Professional Development.

1. Introduction

During the last few decades, the Organization for Economical Co-operation and Development (OECD) countries have started reforms of secondary education, with the intention of enhancing the role of Science, Technology, Engineering and Math (STEM) disciplines and to raise the number of students enrolling in STEM departments. This approach arises from an assumption firmly demonstrated by many studies: the way in which science is taught is responsible for the decline in the interest in science among students [1]. It is for this reason that the Rocard Report [2] considers teachers as "the cornerstone of any renewal in science education". Improving science teachers' proficiency is considered crucial for enhancing students' interest for science.

In the USA, among the Professional Development (PD) opportunities for science teachers, Research Experiences for Teachers (RET) are considered one effective way to enhance students' STEM careers and achievements in science. This kind of professional development is based on studies that show that science teachers are likely to teach science in the manner in which they were taught. Teachers who lack experiences in a research setting may have difficulty teaching science by inquiry [3, 4], i.e., the way science really works. The pedagogical philosophy underpinning the RET is *constructivism* [5]: individuals build their own knowledge and are active in their own learning. Helping teachers to understand how science really works could be the means to affect their instructional practice and enable them to use an inquiry approach [6].

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2. Research Experiences for Teachers (RET) on board a ship

In the USA, RET programs are offered to teachers by universities, laboratories and private organizations and involve teachers in working in laboratory or in field settings alongside scientists. However, in Italy, even in the newest documents from the Ministry of Public Education and Research, there is no mention of such programs.

There is not in the literature a singular definition of RET and there is wide variation in the structure of these programs. However, according to current research on the topic, an RET:

- 1) Should be formalized by a call from universities and research institutes.
- 2) Should be recognized by the Ministry of Education as a training activity for teachers.
- 3) Must be free of costs for teachers involved or even pay a salary.
- 4) To attend an RET program teachers have the right to be given a leave from the school.
- 5) Workshops, seminars and training courses cannot be considered an RET.

Variations in RET structures also apply to the duration of the experience that can range from one week to months. The literature shows better outcomes for longer RETs than short ones. Usually an RET, since it occurs during the summer, is 6-8 weeks long.

The International Ocean Discovery Program (IODP) and the European Consortium for Ocean Research Drilling (ECORD) offer two kinds of professional development for educators: 1) School of Rock, a training course for teachers based on data from drilling expeditions; 2) the opportunity to sail on an IODP expedition as Education and Outreach Officer, working alongside scientists on board the research vessel *JOIDES Resolution* and sharing the science story with students and the public. The opportunity to sail on an IODP expedition as Education and Outreach Officer, working alongside scientists, could be considered an RET with respect to the criteria mentioned above. Expeditions are usually 8 weeks long and the duties of the Education and Outreach Officer are important to the overall goals of the expedition. The duties include: a) facilitating interviews between reporters from national media outlets and the science party; b) developing educational resources about the expedition and geoscience in general; c) managing the website and social media (www.joidesresolution.org); d) working *with* researchers as a researcher; e) broadcasting from the ship.

In this paper, we analyse the outcomes of broadcasting activity in order to understand if the sailing experience could be considered a valid RET and if the video connections enhance students' knowledge and interest for science.

3. Methodology

3.1 Survey

Here, we evaluate the experience onboard of the author A.C, teacher of science in the secondary school in Italy, and the effects produced on colleagues and students met in the video connections. This study is mostly exploratory and based on a qualitative survey. We could not select a representative sample of the teacher population but we surveyed teachers participating in the outreach project. Therefore, the samples could be considered as "convenience samples" and the study does not present a high degree of generalization.

The survey aims to explore the overall perception of teachers about the video-connection with the ship through open questions about the scientific topic learned from the students attending the video connection and about what students liked most about the video connection program. The questions are deliberately simple so as not to influence the opinions of the participants. They are, for example, "Your audience learned more about (please list one or more topics)"; "What did you like most about your Live video event?"

Then, we examined the questions with the method of *content analysis* using the discovery approach [7]. Independently, the authors identified from the answers the main emerging categories, letting them emerge naturally. Afterward we compared our results.

3.2 Broadcasting from the Ship

Every video connection from the ship had about the same characteristics. The broadcast was about one hour long, was guided by a scientist speaking the same language as the students and followed a common template: the identification of the geographical location; the presentation of geological questions addressed by the expedition; a tour of the ship with a close look at the drilling operation; a tour of the laboratories with a close look at the work of the scientists; and finally, question and answer time.



4. Results

During IODP Expedition 367 in the South China Sea (February-April 2017), we conducted 101 video connection from the ship (Table 1).

Country	Number of broadcasts	Number of students participants
Italy	40	≈1500
China	30	≈3400
USA	24	≈700
France	3	≈70
Germany	2	≈800
Spain	1	≈120
Argentina	1	≈300

Table 1. Video-broadcast divided by Country.

We send the post-event survey to all teacher participants. The Chinese teachers were surveyed by a Chinese-speaking Education and Outreach Officer. Additionally, we sent the survey while we were on the ship, using a Google application that is not completely supported in China. Therefore, 43 surveys in English are available and analyzed here.

In figure 2, we show the data about the perceptions of teachers. Data show that the strengths of the video-connections are undoubtedly the interactions with the researchers and the opportunity to see the scientists working live. Another aspect that is worth highlighting is that many teachers appreciated the enthusiasm of the students attending the video-connection.

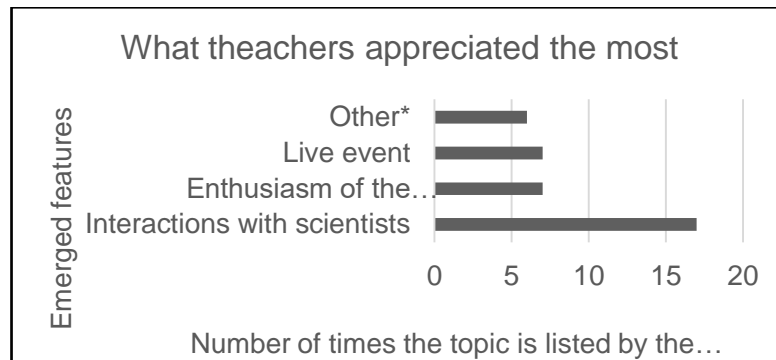


Figure 2. Categories emerged for the question about what teachers appreciated the most in the video-connection. * In Other we grouped all the topics mentioned a few times, such as drilling operations.

Moreover, 32 out of 42 teachers replied to the questions about the topics that, in their perception, students learned in the video connection. They could mention more than one topic (Fig. 3). From the answers of these teachers, it emerges that students learned topics related to the expedition, including plate tectonics theory, but also about topics usually poorly covered at school such as paleontology and paleomagnetism. Furthermore, they learned something about the drilling operations, a topic related to technology and engineering among the STEM disciplines.

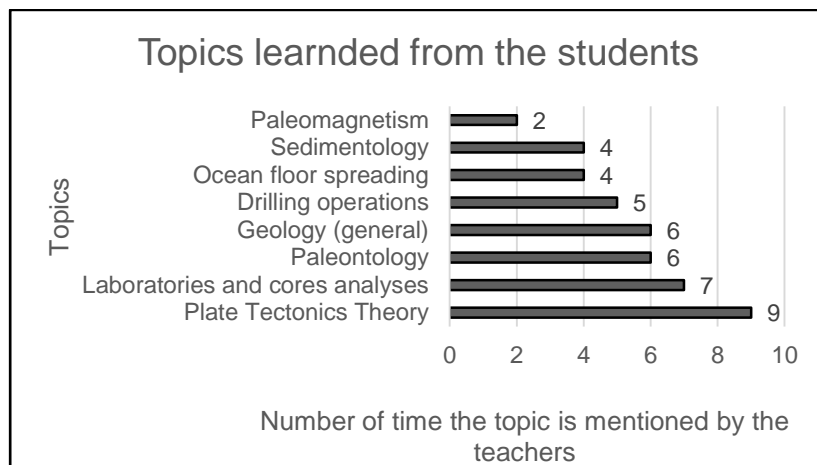


Figure 3. Topics emerged for the question about what students learned the most in the video-connection.

Finally, on their own initiative many teachers and students sent enthusiastic comments and decided to announce the experience in the local newspapers. In Italy, the activity benefited of more than twenty articles in the newspapers and two interviews in national WebTV and radio programs. In some occasions, students declared to seriously consider to study geology after the broadcast.

5. Discussion and Conclusions

The RET program investigated in this study seems to be effective in terms of the enhancement of students' knowledge and interest in science. We document that interactions with the researchers are really appreciated by teachers and students and enhanced by enthusiasm in the classroom. This aspect could be explained by the fact that, even for science teachers, it is not easy to see how scientific research is carried out. The activity of a teacher on board a drilling ship has permitted them to integrate the common knowledge of students with more professional information. A teacher on board a research ship living with scientists and experimenting with all the technical operations could make it easier to understand topics poorly covered at school. This integrated approach permits students to participate virtually in a real example of research in Earth sciences and to follow all the phases of the scientific method.

This preliminary study has a number of biases, such as the small group of teachers involved and the fact that data are self-reported by the teachers. However, it allows a first evaluation of the IODP Education and Outreach activity as an effective RET. Some further developments could be highlighted, for example, an experimental research about how this activity could have an effect on STEM studies at the University level or on students' future careers, and/or about the improvement of the Education and Outreach Officer in terms of knowledge and confidence in using inquiry in science teaching.

In conclusions, this investigation could be useful for people working on professional development (PD) of teachers especially in Italy where this kind of program is not yet widely available. In fact, the outcomes of this research suggest that RET programs are a kind of PD that are worth introducing among the PD offerings for science teachers.

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