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Learning in Student Scientist Partnerships – Do Students Exploit Their Potential

Suzanne Kapelari[1], Elisabeth Carli[2], Stefan Mayr[3]

Abstract

Student-scientist partnerships are based on the idea that students learn science best, if they work like real scientists. A multitude of learning opportunities arises from authentic research project. The experience of authentic science is supposed to support students in understanding the nature of science (NOS), in attaining scientific content knowledge and boosting confidence and self-efficacy regarding the way scientist work and think. However, do learners really succeed in exploiting these opportunities?

In the context of the Austrian research project "Woody Woodpecker", about 44 students aged 15-19 years investigated the anatomy of conifers together with scientists from the University of Innsbruck. Thereby they ran more or less through every step of a research process. An empirical social research approach was applied to learn more about whether and how participants develop their understanding of the NOS and become more self-confident in doing science. Data was collected via participating observations, questionnaires and interviews in a pre-post intervention design. Findings suggest that there was a small but significant increase in the students NOS understanding in the fields of "experiments" and "characteristics of a scientist" in particular. In addition, "confidence and self-efficacy" was increasing. Students had difficulties in understanding that science is characterized by a simple and precise language and that scientific laws and theories are explained as simply as possible. Participating in the research project did not lead to the desired NOS understanding as such.

Keywords: *Nature of science (NOS), learning opportunities, Student-Scientist-Partnerships*

1. Introduction

Student-scientist partnerships are based on the idea that students learn science best, if they work like real scientists. To bring science and society closer together various efforts have been made. Not only in Austria or Europe but all over the world scientists are put on the spot to provide insight to their work. More and more research funding associations worldwide ask scientists to include respective activities into their research projects to demonstrate broader impacts on science and society [1]

A multitude of learning opportunities arises from participating in an "authentic research project". The concept of authentic scientific inquiry refers to research that is carried out by scientist. Chinn and Malhotra [2] contrast authentic inquiry from *simple inquiry tasks*, which are carried out in school and Lee and Songer [3] argue that real world science may not be accessible to students because authentic activities that are interesting to students are too open-ended and require content knowledge and scientific thinking'. However, the experience of authentic science is supposed to support students in understanding the nature of science (NOS), in attaining scientific content knowledge and boosting confidence and self-efficacy regarding the way scientist work and think. However, do learners really succeed in exploiting these opportunities?

2. Theoretical background

When participating in a student-scientist project, students and their teachers have the opportunity to get insight into an authentic research process. There is great potential for such an authentic experience of science to help students better understand NOS, gain scientific expertise, and gain self-efficacy in scientific work and thought [4]. Sadler and colleagues [4] conclude in their review of 53 studies on collaborative student -scientist projects that different learning opportunities are observable. Influences on career plans, on the understanding of NOS, on the self-perception and the intellectual development of the participants are described. However, the authors also make it clear that the framework conditions prevailing in such a cooperation project and the participants themselves have a strong influence on perceived learning outcomes. This study addresses the question: "Will students be able to take advantage of the learning opportunities offered to develop their career aspirations in

[1] University of Innsbruck, Austria
[2] University of Innsbruck, Austria
[3] University of Innsbruck, Austria

science, their understanding of NOS, and their science content knowledge while participating a research project?"

3. Methods

Since 2007, the Austrian Ministry of Science has been funding 'Sparkling Science' projects. This funding scheme is based on the idea of creating student scientist partnerships. 260 projects were funded, of which 200 have been completed so far. Sparkling Science research projects aim above all to promote young scientists and to enable a qualified study choice. In the context of the research project 'Woody Woodpecker', 44 students aged 15-19 years investigated the anatomy of conifers together with scientists from the Institute of Botany of the University of Innsbruck, Austria. The project lasted three years (2014-2017). Pupils participated in most of the research activities over a period of six to nine months. An empirical social research approach was applied to learn more about whether and how participants develop their understanding of NOS and become more self-confident in doing science. Data was collected via observations, questionnaires and interviews in a pre-post intervention design. On the one hand, students expertise and, on the other hand, their attitude to the characteristics of the natural sciences were measured by means of a two-part questionnaire validated and publish by Urhahne, Kremer and Mayer in 2007 [5]. Semi-structured interviews were conducted with scientists, teachers and students and evaluated via applying qualitative content analysis as suggested by Mayring [6]

4. Results

Triangulation of findings suggests that there was a small but significant increase in particular aspects of students understanding in in the NOS fields of 'experiments' and 'characteristics of a scientist' in particular. In addition, students 'confidence and self-efficacy was increasing. Students had difficulties in understanding that science is characterized by a simple and precise language and that scientific laws and theories are explained as simply as possible. However, students referred to various learning experiences they rate important and did not want to miss out such an experience. In terms of scientific knowledge only little increase was observed.

5. Discussion

It was very important to the scientists to offer pupils a wide range of learning opportunities and exciting experiences. They wanted them to profit from this joint project as much as possible. Involved teachers and students described the cooperation with the scientist as very good. However, only a few pupils took advantage of this opportunity in the sense of developing already existing ideas about NOS as a multifaceted concept much further. Authentic research settings require that students deal with scientific and methodological knowledge that may sometimes be incompatible with their existing content knowledge and experience [3]. It is thus not surprising that many pupils had problems with the idea that 'natural sciences prefer simple to complicated explanations of a phenomenon' [5]. Students were supposed to take over a sequence of scientific tasks. Whenever a methodology was introduced scientists explained the procedure in great detail. Following this introductions, students were expected to collect data on their own responsibility. Scientists made clear that they trust them to collect reliable data. After the project, students understood the characteristics of 'experiments' better and trusted themselves more. The difference between 'theory and law' or 'the changeability of scientific explanations'- both areas in which no major progress was made – were not explicitly addressed neither by scientist nor by teachers. Thus, these characteristic if though might have only be implicitly perceived as Schwartz and colleagues [7] suggest. When referring to the questionnaire results only, a change of ideas in the areas of content knowledge and NOS was observable only to a small extent.
However, many students uttered that they have "*learned and experienced a lot*" while participating in this project and stated that they do not want to miss this experience. E.g. one student said: "*Yeah, like I said, we learned basic science knowledge and more generally (we learned) to deal with things, because at first I would never have thought about whether a tree has other cells, when it grows in a different altitude*." Thus, learning is in many ways a personal experience and learning success is subject to subjective evaluation criteria.

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