



Science Education in Out-of-School Contexts

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Abstract

Making use of out-of-school settings for learning is currently a topic of discussion. On the one hand, there is the wish for opening the school to new learning experiences that promote student learning. Arguably, such experiences may enhance students' motivation for the subject. In particular, school laboratories for natural sciences organized by institutions or companies other than schools seem to be especially promising with regard to the promotion of young researchers, as they provide the opportunity for students to conduct experiments that are relevant to current scientific issues and to do so in an authentic environment. This, in turn, is meant to foster students' interest and motivation for the sciences and for technology. On the other hand, due to the pressure that educational policy guidelines and requirements place on both teachers and students, it is questionable whether out-of-school places of learning are really worthwhile.

In order to learn more about German teachers' and principals' perceptions of the impact of out-of-school contexts on science education, their expectations of this form of learning and their corresponding personal experiences, a questionnaire study and an interview study were carried out. In this research, all those locations, which are didactically and methodically prepared, especially school laboratories that are organized by institutions or companies other than schools, were of special interest.

Framework

Due to the efforts made to improve scientific education, the discussion about out-of-school places of learning has increased dramatically in recent years [1,2].

The research on the effects caused by school laboratories is largely heterogeneous. There are four larger studies (Engeln, 2004; Brandt, 2005; Scharfenberg 2005; Guderian, 2007), which explicitly analyse the effectiveness of school laboratories for natural sciences in Germany [3]. The results of those impact studies suggest that making use of school laboratories has positive short-term and middle-term effects on students' interest in the natural sciences as well as on their ability to assess their learning process. The research results of Guderian (2007) indicate that integrating out-of-school places of learning at least helps to stabilize students' interest [4]. On the other hand Scharfenberg (2005) showed that students who visited school laboratories and conducted experiments there did not learn as efficiently as students who worked on the same topic without visiting a school laboratory [5]. According to the Cognitive Load-Theory, these results might be attributed to the handling of unfamiliar experimental activities for students which results in an overload. This indicates that preparing students for learning in out-of-school settings, e.g. school laboratories, could be an important factor when asking for the effectiveness of such learning environments.

Considering this, teachers and their way of dealing with out-of-school places of learning seem to play a very important role with regard to the effectiveness of visits to those places. Therefore, the focus of this research is on the expectations and experiences of science teachers and principals with regard to such aspects of out-of-school places of learning that according to the current state of research seem to be relevant for their impact and effectiveness. These expectations and experiences might be important factors influencing the way of integrating out-of-school places of learning into teaching.

Methodology



In a questionnaire-based study in 2009, teachers (N = 187, response rate 31 %) were asked about their expectations and experiences regarding natural science-oriented out-of-school learning. The questionnaire comprises 13 dimensions including a total of 75 items ($0.656 < \text{Cronbachs } \alpha < 0.831$) with 4-point Likert-scales (1: „I strongly agree“ to 4: „I strongly disagree“).

In order to clarify open questions and controversies on the one hand, and to validate the results of the questionnaire study on the other hand, eighteen science teachers were asked about their attitudes, expectations and experiences with regard to out-of-school places of learning in an interview study in March 2010. Furthermore, twelve principals were interviewed because they considerably influence teachers' opportunities to arrange visits to out-of-school places of learning. The interviews had a duration of 35-40 minutes and based on a guideline which was developed from the open questions of the questionnaire study with respect to the theoretical framework.

The categorical framework presented above has been assessed and co-coded by the authors and two other persons. Thus, three interviews with principals and five interviews with science teachers were multiple coded by assigning the categories as well as single aspects (subcodes) of these categories to the statements of the interviews. The results show high interrater reliabilities (science teachers: $\kappa \geq .80$, principals: $\kappa \geq .92$).

The following table gives an insight into the numbers of respondents of both studies.

Table 1. Numbers of respondents

Type of school	Questionnaire	Interview Study	
	Number of teachers	Number of teachers	Number of principals
Primary school	18	-	-
Lower secondary school (Hauptschule)	21	1	1
Lower secondary school (Realschule)	26	4	3
Comprehensive school	13	1	-
Gymnasium	89	12	7
Vocational school	7	-	-

Selected Results

a. Results of the questionnaire study

The results of the questionnaire study suggest that science teachers generally have a positive attitude towards visiting out-of-school places of learning because they consider them to be beneficial for both the students and themselves, but they acknowledged that the costs involved and the lack of students' interest in a given topic are arguments against visiting out-of-school places of learning (see *Fig. 1*).

The participants in the survey reported that obtaining expert knowledge is not the primary concern when visiting out-of-school places of learning and that the topics dealt with at institutions other than schools are not always part of the curriculum. Thus, it is rarely possible to use these outings to deepen topics included in the curriculum. Furthermore, teachers think that skills such as discussing errors or target-oriented communication are trained only to a limited extent. Therefore, the participants of the questionnaire study generally do not expect a long-lasting and successful learning experience.

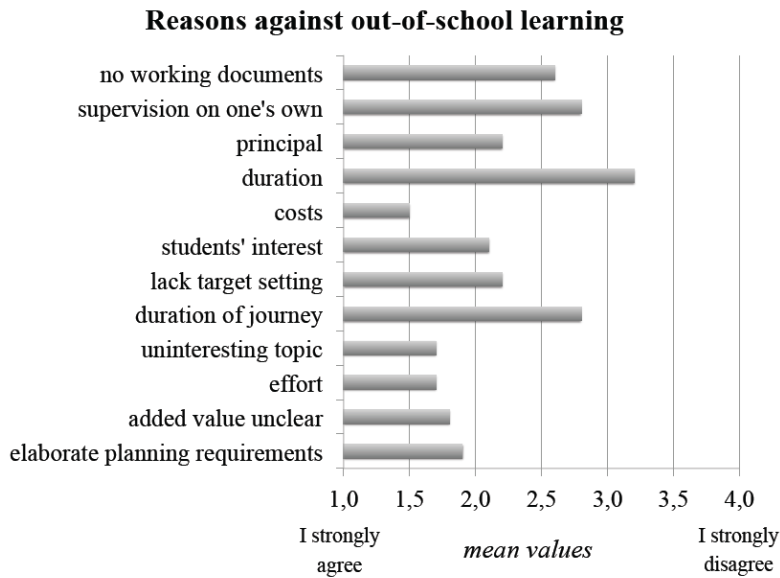


Fig. 1. Arguments against visiting out-of-school places of learning

The following figure summarizes the statements concerning the integration of out-of-school learning in class (see Fig. 2).

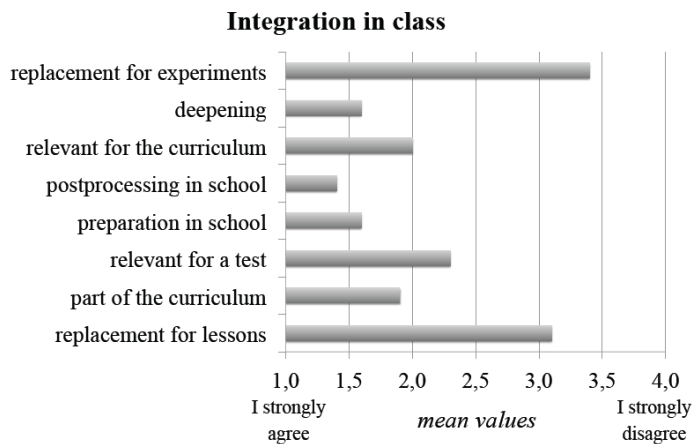


Fig. 2. Statements concerning the integration of out-of-school learning in class

b. Results of the interview study

What is expected of extracurricular places of learning?

What is especially remarkable is that the participants in the survey attach greater importance to enhancing students' interest in the sciences than enhancing students' knowledge. Although the interviewed teachers hope that students deepen their knowledge of the excursion's topic, only 28% expect a positive learning effect. In part, they believe that this is not the primary goal of out-of-school places of learning. On the other hand, they expect greater learning effects when dealing with the topic in class.



Teachers expect greater progress from students when, for instance, students who attend advanced courses participate in an excursion than when basic classes or students in the 7th to the 10th grade visit extracurricular places of learning.

Independent of the school type, principals expect a greater impact from excursions to extracurricular places of learning than do teachers, which might be due to the lack of sufficient personal experience with extracurricular places of learning.

According to the participating teachers, the promotion of social skills is not an aim of visiting student laboratories. Apart from learning how to behave properly in laboratories, students' social skills can equally be fostered by cooperative forms of learning in class.

56% of the participating teachers and 45% of the principals, respectively, assume that excursions to school laboratories do not contribute to a notable learning effect due to the fact that the topics of the excursions are not properly integrated into class. Consequently, students might not consider school laboratories to be places of learning, but rather perceive visits as mere »trips«. This explanation, however, is only suggested by grammar school teachers. Teachers of other school types attribute low learning sustainability to poor organization and particularly to the fact that learning contents are not presented in an appropriate manner for their students at extracurricular places of learning.

Organisation and feasibility

As school laboratories often ask for a reservation month before the visit, it is difficult to integrate excursions to student laboratories in everyday school lessons according to the interviewed teachers and principals.

In order to compensate for the classes omitted due to excursions, both students and teachers must expect that additional effort will be required. While students will be asked to study the content of the lost lessons themselves, teachers must provide work for supply teachers who take over their other classes. According to science teachers and principals, the additional effort is accepted and excursions to out-of-school places of learning are not renounced in light of their expected positive effect on students' motivation and interest in the natural sciences. In general, the teaching staff is very cooperative with regard to omitted lessons and the need to provide substitution for their colleagues.

Preparation and postprocessing in class

In general, the materials provided by several student laboratories are considered helpful for preparatory and follow-up lessons.

Principals of all school types agree that the preparation as well as the evaluation of excursions to student laboratories is essential for achieving lasting learning success.

Though the participating teachers generally emphasize the significance of preparing and evaluating excursions, they do not believe that they are able to integrate the preparation and evaluation process into lessons if the topics of excursions are not required in the curriculum.

While grammar school teachers consistently agree that receiving prepared materials from the out-of-school places of learning is important and useful, the teachers of other school types mainly indicate that provided materials are rarely of use, as they are usually unsuitable to the extent of students' knowledge. Yet, this group of teachers believes that specific information outlining how to prepare the topics of excursions is necessary.

In contrast, the interviewed principals of all school types are predominantly of the opinion that materials provided from extracurricular places of learning help in preparing excursions and are therefore advisable.

Reflection upon excursions to extracurricular places of learning among colleagues

The interviewed teachers and principals state that they exchange information and opinions about extracurricular places of learning by talking openly to each other and by reflecting upon the course of these kinds of excursions.



However, an organized and thus transparent feedback and the sharing of experiences within school conferences, for instance, only rarely takes place.

The promotion of gifted students

According to most participating grammar school teachers (88 %) and principals (91 %), the advancement of gifted students is very important and desirable. However, visiting extracurricular places of learning was found to rarely have furthered the learning of such students.

67 % of the interviewed science teachers report that they appreciate the possibility to promote learning among especially gifted students by assigning these students specific tasks or by encouraging them to participate in special activities and events.

In contrast, the interviewed principals of the other school types, in particular, consider the advancement of gifted students irrelevant and hardly feasible when visits to extracurricular places of learning involve entire classes.

Social relevance and topicality of issues

In the participating teachers' view, the social relevance and topics dealt with at out-of-school places of learning are interesting but not mandatory according to the curriculum. The topics of excursions are considered less important than the integration of such topics into everyday classes. However, current issues, in particular, can hardly be integrated. It seems to be difficult to present current research content to students taking into account their state of knowledge. Nevertheless, according to teachers it is important that there is a link between the issue dealt with at out-of-school places of learning and the students' everyday lives.

Demonstration of career prospects by excursions to extracurricular places of learning

Almost all participants assume that insights into day-to-day research work and the contact to real researchers (e.g. practical work in a laboratory) might offer possible career prospects.

Due to the fact that »real« researchers are often considered unable to explain their research content adequately to the average person, the participating teachers doubt that visits to extracurricular places of learning broaden career perspectives. Furthermore, this may also be due to the fact that student laboratories cannot be viewed as authentic workplaces where »real« researchers work.

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