

# The Expectations of Teachers and Students Who Visit a Non-Formal Student Chemistry Laboratory

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Non-formal student laboratory environments for primary and secondary school science education have become a major trend in the German educational arena in recent years. These non-formal student laboratory environments are thought to offer unique experimental learning experiences that often cannot be realized in daily school routines. The biggest challenge for successfully operating non-formal education is to carefully and firmly link outer- and inner-school learning. To better facilitate this linkage this paper describes a study providing insight into students' and teachers' expectations on visiting non-formal student chemistry laboratories. Over a period of three years, 461 students and 37 teachers participated in a written survey. The results clearly show that students and teachers have similar expectations when visiting non-formal laboratory learning environments. The main foci addressed here concern the improvement of personal attitudes and the intensification of practical learning experiences.

*Keywords:* attitudes, chemistry education, non-formal learning, out-of-school learning, practical work

## BACKGROUND

Out-of-school learning environments are provided in many countries as a support to science learning (Rennie, 2007) as it is the case for Germany too (Di Fuccia, Witteck, Markic, & Eilks, 2012; Scharfenberg & Bogner, 2014). Excursions take school classes to places which are normally outside of their usual learning environments in school. Museums, science centers, and non-formal educational centers are generally reported as being common locations for out-of-school science learning (Davidson, Passmore & Anderson, 2009; Griffin, 1994; Kisiel, 2005; Rennie, 2007; Stockelmayer, Rennie & Gilbert, 2010; Storksdieck, 2001). Learning experiences at these places have been said to provide the potential needed to raise learner motivation and support pupils' cognitive achievement (Coll, Gilbert, Pilot & Streller, 2013). Many teachers are willing to endure administrative, pedagogical, and logistical difficulties in order to provide their students with such opportunities (Griffin & Symington, 1997; Michie, 1998).

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In Germany, more than 300 non-formal student laboratory environments have been established in recent years to support science and technology education beyond the school classroom (Di Fuccia et al., 2012; Hempelmann, 2014). In German they are called Schülerlabor (SL), which can be translated as 'student laboratory.' However, the word Schüler in German refers only to school pupils, not to university students (Garner, Hayes & Eilks, 2014). SLs are generally located at universities, larger research institutes, or industrial plants. Primary and secondary school classes are invited to visit the SLs with their teachers for hands-on science and technology learning. The SLs offer full programs with repeated visits, single morning or afternoon sessions for school classes, study days, or summer camps for interested students, which can be visited independently from any school program and without the corresponding teachers (Hempelmann, 2014).

SLs try to overcome some of the gaps existing in pupils' practical work during their everyday school routines and to contribute to attitudes and motivation to pursue science education (Di Fuccia et al., 2012). Practical work in science education is limited in many schools, generally because of a lack of time, high material costs, or poor school facilities. Nevertheless, practical work is broadly acknowledged as having a key role in any type of science education (Abrahams, 2011; Tobin, 1990). SLs are believed to be an alternative place which can support this claim by offering well-equipped laboratory learning environments to school science classes (Hempelmann, 2014). Based on specific science goals and topics SLs offer experimental courses for school classes of different ages. Students can learn using laboratory equipment during either half or full day excursions. SLs attach great importance to intense and inquiry-type experimentation and are therefore often less structured than the formal practical work normally found in school (Hempelmann, 2014). SLs have also been suggested as a good place for carrying out science curriculum innovation and for supporting teachers' continuous professional development (Garner et al., 2014). This article explores teachers' and students' expectations when visiting SLs in the context of German chemistry education. It attempts to provide a better knowledge base for structuring and carrying out SL-based learning.

## THEORETICAL FRAMEWORK

Out-of-school learning is differentiated into informal and non-formal learning forms (OECD, 2012). Both types of learning differ from formal education in school in terms of place, structure, organization and connections to a national or regional syllabus. Informal learning is voluntary and takes place mainly in the students' leisure time. Visiting a museum or a science center on the weekend and learning science from the media are examples of informal learning activities (Rennie et al., 2010). Non-formal learning lies in between informal and formal learning. However, deliniation of formal, non-formal and informal learning is not always consistent (Coll

### *State of the literature*

- Non-formal science learning is recognized as being of growing importance in many countries.
- Effective out-of-school learning requires a firm connection to formal education and needs to meet the expectations of teachers and students.
- The knowledge base of the expectations of both students and teachers is limited with respect to visiting non-formal learning environments in general, and the German Schülerlabor in particular.

### *Contribution of this paper to the literature*

- This paper reports on the expectations of teachers and students before visiting a non-formal student chemistry laboratory, namely a German Schülerlabor in the context of chemistry education.
- The paper compares teachers' and students' expectations of non-formal laboratory visits and shows that their interest in practical activity outperforms any other objectives of visiting a Schülerlabor.
- The study reveals that cognitive gains are more important to students than to their teachers when visiting non-formal laboratory environments.

et al., 2013; Eshach, 2007). Generally non-formal learning can be described as being rather less organized than formal learning. However it is sometimes carried out by fixed groups of students, can be mandatory, may be connected to school learning, and can also follow a given structure and a certain set of learning objectives (OECD, 2012).

Because of widespread positive expectations towards out-of-school learning (Stocklmayer et al., 2010) many researchers have started investigating learning during field trips. It has been shown that out-of-school learning experiences in science education can increase student motivation (Csikszentmihalyi & Hermanson, 1995; Jarvis & Pell, 2005; Wellington, 1990), support cognitive learning (Stronck, 1983; Orion & Hofstein, 1994), improve pupils' attitudes (Orion & Hofstein, 1991; Nadelson & Jordan, 2012; Rix & McSorley, 1999), make learning more meaningful (Muscat & Pace, 2013), and offer learners an opportunity for acquiring broader social experiences (Anderson, Kisiel & Storksdiel, 2006). However, such benefits are often only of short-term effect. Falk and Dierking (1997) found that only nonspecific memories of such experiences existed among students a few months after a single field trip.

The positive effects of out-of-school learning experiences do not seem to be self-evident. The effectiveness of out-of-school learning experiences is influenced by various factors. Learning environments that differ greatly to formal learning settings in school may even reduce the impact of student learning during a field trip. Orion and Hofstein (1994) mentioned the novelty of a learning environment in this context. Teachers should carefully prepare their students for a field trip and reduce the distraction of stepping into the unknown. Wolins, Jensen and Ulzheimer (1992) also point out that a linkage to the national syllabus and multiple visits may enhance long-term effects. In general, linking outer- and inner-school learning through carefully-planned preparation and follow-up phases in school have been described as essential elements for the success of out-of-school learning. An intense connection between the formal and non-formal learning contexts has also been suggested to effectively link non-formal learning with formal education, so that out-of-school learning experiences are not perceived as detached, unrelated events (Bybee, 2001; Eshach, 2007).

Initial research has also become available in the context of the German SL-trend. The findings mirror the results of previous international studies: SLs can have a positive impact on student learning and may lead to improved motivation and attitudes towards science education (Guderian & Priemer, 2008; Itzek-Greulich et al., 2014; Weßnigk & Euler, 2012; Scharfenberg & Bogner, 2014). However, the benefits were also described as merely short- and medium-term if the SLs visits remained isolated, sporadic events. Zehren, Neber and Hempelmann (2013) showed that regular SL visits with strong links to formal learning in school have more sustainable effects. For further discussion of the effects of out-of-school learning experiences in the German context see Scharfenberg and Bogner (2014).

Both international studies on field trips in general and German studies on SLs in particular highlight the importance of the preparation and post-processing of out-of-school learning experiences. Teachers are also crucial for the success of field trips. Studies have suggested that students' learning during excursions largely depends on the attitudes expressed by their teachers (Griffin, 1994; Davidson et al., 2009). It is also important that the students know exactly what is expected of them during the field trip. Research shows that students participating in field trips are often not aware of the overall goals. These students are unprepared for effective, goal-oriented learning during the field trip. Teachers must therefore carefully inform their students about the expectations. However, many teachers are often not aware

of this responsibility (Griffin & Symington, 1997; Orion & Hofstein, 1994; Storksdieck, 2001).

In order to meet the expected learning goals, the staff members and organizers of out-of-school learning environments also need to be aware of teachers' expectations and needs when designing their programs (Anderson et al., 2006). Staff members need to be familiar with teachers' expectations in order to structure suitable and efficient learning environments. Some studies have already provided hints into teachers' personal expectations of out-of-school learning environments. In general they desire both affective and cognitive learning objectives. Affective goals are generally considered more important than cognitive gains in the eyes of the teachers (Anderson et al., 2006). Kisiel (2005) conducted a survey and interview study in order to pinpoint teachers' expectations for field trips to a museum. Eight general objectives were identified: connections with the classroom curriculum, providing a general learning experience, encouraging lifelong learning, enhancing student interest and motivation, providing exposure to new experiences, providing a change in setting or routine, enjoyment, and meeting school expectations. Other studies suggest similar aims (Tal & Steiner, 2006; DeWitt & Osborne, 2007). In Germany, teachers' expectations of SLs have not been the focus of very many scientific studies. Schmidt, Di Fuccia and Ralle (2014) showed that the actual experiences of teachers often do not correspond with their previous expectations. Nevertheless, Schmidt et al. (2014) also identified increasing student motivation and bettering learners' attitudes as two of the main reasons for teachers to visit a SL. However, another driving factor is the opportunity for more practical labwork, where the acquisition of content knowledge does not seem to be so important to the teachers. In contrast school principals primarily expect that pupils' content knowledge growth would represent the largest gain due to SL visits (Schmidt et al., 2014; Linn, 1983).

Appleton-Knapp and Krentler (2006) show that student expectations influence learners' satisfaction with their out-of-school learning experiences. Ramey-Gassert (1997) and Falk and Storksdieck (2005) relate this point directly to field trips. They found a correlation between student's attitudes before a field trip and their expectations prior the excursion with the learning outcome. Thus, the expectations of students may also positively or negatively affect the experiences during a field trip and pupils' satisfaction with it. Davidson et al. (2009) argue for including the expectations of students within the design of learning environments. Contrary to the teachers' expectations, very little is known about the expectations of students with respect to out-of-learning experiences in general and concerning SLs in particular. Linn (1983) stated that students expect the location of the field trip to be different from daily life in school. It is also important for the students that they be given the opportunity for different forms of social interaction and more intensive collaboration with their classmates (Linn, 1983; Davidson et al., 2009). Storksdieck (2001) emphasized that students often do not know what will happen during the excursion and what their teachers expect from them. Accordingly, he stresses the responsibility of teachers in preparing their students and shaping their expectations towards any out-of-school trips.

In general, research suggests that it is necessary for the organizers of out-of-school learning events to know about the expectations of the participants. Concerning this claim, this study aims to the gap in our knowledge by researching the expectations of teachers and students before they visit a SL in the case of German chemistry education. Accordingly, a questionnaire study was initiated. The results may be helpful to better design and operate SLs.

## METHOD AND SAMPLE

The study is based on questionnaires for both teachers and students prior to their visit to an out-of-school laboratory learning environment, namely a SL covering issues of sustainability in chemistry-related topics (Garner, Siol & Eilks, 2015; Garner et al., 2014) as contribution to Education for Sustainable Development for which chemistry education has a special responsibility (Burmeister, Rauch & Eilks, 2012; Eilks, 2015). Different questionnaires were used for the two groups. The questionnaires were developed and validated communicatively with the help of experts and a sample of participants.

The questionnaires consist of both open-ended and Likert-scaled questions. Both questionnaires for students and teachers consist of three parts:

- a) The first part collects general information on the participants. The students were asked for their age, gender and their favorite subject in school. Teachers were asked for their age, gender, amount professional experience and academic qualifications.
- b) The second part is comprised of open questions enquiring into the participants' expectations of SL learning environments. General expectations and the expected differences with regular lessons at school were both surveyed.
- c) The final part of the questionnaire was designed to complement and triangulate the open-ended part of the questionnaire. It consists of 14 and 12 Likert items (5-step) for teachers and students respectively. The participants are asked for different attributes that are particularly important to them when visiting the SL.

The evaluation of the open questions was performed using Qualitative Content Analysis (QCA) according to Mayring (2010). For the open-ended questions used in the teachers' questionnaire, a first set of categories was derived deductively from the literature. In the analysis of the material, however, some categories had to be added and others refined during the cyclical evaluation of the data. The validation was performed communicatively by discussing the interpretation with one of the participants. Because of a lack of suitable literature, the categories for the students were developed inductively from the data following QCA. The answers of the open-ended questions were coded and the number of hits in each category was then counted. Two independent raters applied all of the categories to the data. Reliability of the rating was high. Cohen's Kappa was very good, with a value of 0.86 for the students and 0.83 for the teachers.

The Likert questions were analyzed statistically. Values for Cronbach's  $\alpha$  ranged from .47 up to .83, a fact which can be explained by the small number of items. Cronbach's  $\alpha$  is dependent upon the total number of items used. In the literature, a minimum of .7 for Cronbach's  $\alpha$  is often required. Scales consisting of a small number of items, however, are considered reliable with even lower values (Hatcher & Stepanski, 1994). The teacher and student responses to the Likert section of the questionnaire can be considered to be normally distributed. Thus, a t-test for independent randomness was used as an additional investigation of the data.

The study collected data from teachers and students who visited a SL offered by the University of Bremen, Germany, over a span of three years. The SL learning environments were developed during the course of a project called "Sustainability and chemistry in non-formal student laboratories (SLs)" (Garner, Siol, Huwer, Hempelmann & Eilks, 2014). One of the central aims of this SL initiative was to link non-formal and formal learning in a meaningful manner. The out-of-school learning environment had been suggested to be closely linked to formal education in school. Materials for the preparation and post-processing phases were provided to the

teachers prior to the SL visit. Emphasis was placed on meaningful socio-scientific contexts within the learning environments. The activities followed an inquiry-based, student-orientated approach (Garner et al., 2014). Different SL learning environments for secondary chemistry education in grades 5-13 (age range 10-19) were implemented. The learning environments focussed on issues of sustainable development – a topic that has become very important in German science education in recent years (see Bögeholz, Böhm, Eggert & Barkmann, 2014; Eilks, 2015). The contexts ranged from the use of renewable raw materials (in grades 5/6), to the chemistry of the atmosphere (in grades 7/8) to biofuels (grades 9/10) and modern technologies and synthesis strategies in the chemical industry (upper secondary level). Over a period of three years, about fifty school classes visited one of the different learning environments; more than thirty of them participated in this survey. The sample thus included 461 students and 37 teachers. Additional details about the participants are given in Table 1.

## FINDINGS AND DISCUSSION

Data analysis using QCA led to nine categories being formulated for teachers' expectations on the SL visit and six categories for students. Table 2 gives an overview of the categories sorted by their frequency.

The most important expectations of the students focussed around the hope of receiving better, more student-active, and more highly cooperative experimental activities than are generally available in normal school lessons. The following three quotes are typical for this large set of expectations:

The work here will be different than in school, just because of the possibilities and the materials. In school we very rarely experiment.

**Table 1.** Overview on the teacher and student sample

Students					
Gender	No.	Grade	No.	Favorite subject	No.
<b>m</b>	207	5/ 6	198	Chemistry or science	145
<b>w</b>	242	7/ 8	20	Others	297
<b>No answer</b>	12	9/ 10	142	No answer	19
		11 - 13	100		
Teachers					
Gender	No.	Professional experience (years)	No.	Academic degree in chemistry	No.
<b>m</b>	12	< 5 years	22	yes	20
<b>w</b>	24	6 - 10 years	8	no	16
<b>No answer</b>	1	11 - 20 years	4	No answer	1
		> 20 years	3		
		No answer	-		

**Table 2.** Teachers' and students' expectations on SLs (sorted by frequency)

Teachers' expectations		Students' expectations	
1.	Experimental work experience	1.	Experimental work experience
2.	Additional science content	2.	Experiencing better laboratory conditions than in school
3.	Improvement in attitudes	3.	New experiences
4.	Ideas for own teaching improvement	4.	Better achievement in school assessments
5.	Everyday life relevant content	5.	Learning meeting own interests
6.	Vocational orientation	6.	Vocational orientation
7.	Support by supervising staff for experimental learning		
8.	Supply of innovative teaching materials		
9.	Content knowledge gains		

Most of the time the teacher performs the experiment, since the school can't afford to let everyone do experiments. (13-year-old schoolgirl)

I think that we will experiment more in the student lab than in school, because we have more time and are not just being prepared for an exam. (15-year-old schoolboy)

It will be better here than in school, firstly because we will experiment the whole time, secondly because we will be able to work in groups and thirdly, because we won't have to be quiet as just listen to the teacher all the time like in class. (16-year-old schoolboy)

Almost 70% of the students combined a positive anticipation of the SL visit with the hope of doing a lot of experiments. This is in line with the results published by Urbančič and Glažar (2012), who indicated that students believe experiments to be the most motivating part of science education. At the same time, the student responses indicated that they would like to do more experiments in the classroom. Especially the first and the third quotes above show that the students hope for a form of different, more student-active learning than they generally experience in regular teaching situations in school. They wrote of their desire to perform more group work, carry out more experiments and have less teacher-centered lectures. Students clearly stated that the necessary conditions for student-centered practical work in school are generally not present. The first two quotes refer to insufficient equipment in schools and the overriding pressure to learn for good marks. Spatial conditions, as well as a lack of time, were provided as further reasons for the unenviable conditions reigning in most school labs. Altogether, 35% of the students expected to find better learning conditions in the SL than in their daily school classes. A total of 24% of the young participants were looking for new learning experiences. Some of these students have never visited a SL before and wanted to see what learning outside of school could offer.

The students also expected that the practical laboratory work activities in the SL would support their learning efforts and that they would be able to better understand the content of the previous chemistry lessons.

I will understand things [through experimentation], which I did not understand in my lessons. (14-year-old schoolgirl)

To learn [through experimentation] through this and write a good exam. (13-year-old schoolgirl)

A total of 20% of the students indicated that they expected to achieve a deeper understanding of chemical subject matter as a pre-requisite for better grades in their school assessments. It seems that even if the visit to the SL will not be graded, students cannot entirely free themselves from the pressure to achieve good marks. At the same time, the first statement quoted above implies an expectation that the topics within the SL should be consistent with the contents taught in school. However, a few other students did not expect too close a link with formal learning experiences or topics:

I am glad [of the SL], since we will probably do something different than we normally do in science class. (11-year-old schoolgirl)

'Doing something different' is indeed a very general statement, but the student carefully differentiated between the out-of-school learning experience and her formal learning experiences. Although the visit was part of school science learning, some students expected other content than in regular science lessons.

Seventeen percent of the participating students expected an offering which would meet their personal interests. Only 7% mentioned expectations for vocational orientation by visiting the SL. A very small portion of students (less than 5%) also expressed negative expectations when visiting the SL. All further comments on SLs were more general and unspecific.

The teachers mentioned similar expectations to those of their students. The question of what was expected from the SL led to the following general answers:

The offering should thematically mirror the curriculum, should broaden the teaching taking place in school and should be supported by teaching materials. [...] I hope that the students will recognize the relevance for everyday life ... and thereby for the topic itself. Additionally, I hope that the kids will be carried away by the fun of experimentation, so that it carries over into the classroom. [...] The pupils should also get a feel for work in the lab. (male teacher, younger than 35 years old)

Introduce fast, easily summarized experiments, which are not practicable in the everyday situation at school. Give an impression of work in a professional laboratory. [...] Get ideas for my own teaching. [...] Cause stronger interest in my kids and receive ideas for the planning of a new teaching series." (male teacher, between 35 and 45 years old)

Practical experiments, which are impracticable for school settings. Support scientific thinking (winning knowledge), deepen what is covered in class. [...] Background materials covering the experiments, ideas for new school experiments. (male teacher, between 35 and 45 years old)

The teachers expressed wishes for intense practical work during their SL visits. 95% of the participants stated similar comments. Similarly to their students, the teachers also commented that student-centered, experimental work is often very limited in the regular school context. They stated that it is very difficult to conduct experiments in the number and quality they desire, because of insufficient time, lacking equipment, and substandard facilities. In addition, they believed that the workload of teachers in Germany is increasing. The SL was therefore expected to provide an opportunity for intense, student-centered experimentation. Accordingly, the teachers also hoped for experimental possibilities that are hardly able to be realized in daily school routines. These teachers hoped to gain additional learning value through experiments which support those that they are able to perform in their classrooms.

The teachers also expected the SL learning environments to contribute to their lessons in school in a meaningful manner. They expected the SL experience to be closely related to school learning. Trips to the SL are intended to complement and deepen chemistry lessons in school. This expectation can be found in more than 70% of the teachers' statements. The desire for a closer link between outer- and inner-school learning can also be seen elsewhere. Almost 70% of the teachers hoped for improved attitudes in their pupils towards science and chemistry learning after the excursion. The teachers hoped for more "fun in science education on the part of students", while others referred directly to an improvement in learners' attitudes. The teachers seem to hope that they can counteract the oft-reported negative attitudes expressed by students against science (Koballa & Glynn, 2007; Osborne, Simon & Collins, 2003) by visiting the SL.

Only a few of the open-ended answers by the teachers referred directly to knowledge acquisition by visiting the SL. This was expected by only 10% of the teachers. Vocational orientation is another factor which seems to play only a minor role in the decision-making processes of the teachers. Only 20% even mentioned the SL as offering some kind of career orientation help. The same percentage hoped for direct support in mentoring their students during the laboratory visit.

Aside from any student gains, about 45% of teachers hoped to personally benefit with regard to their own teaching. The teachers wanted to learn about newly available teaching and learning materials which could be useful in their own teaching. The teachers even showed an interest in the SL visit as a possible source of new content matter knowledge and innovative ideas (also in terms of previously

unknown experiments) as part of their continuous professional development. Nearly half of the participating teachers saw the SL as an opportunity to enrich their own teaching in this sense.

The analysis of the Likert questions supports the findings from the open questions (Table 3). The Likert-scaled items show that content learning in the SL is much more important for the students than it is for their teachers. Both groups stated that getting practical labwork experiences is the most very important issue and the teachers saw it as a way to benefit their own teaching, too. Bettering the attitudes of their students towards science learning was a very important factor for the teachers. Career orientation was not rated very high by either group. The discrepancy between ‘understanding chemistry concepts’ and ‘applying content knowledge’ among the students was surprising. One possible explanation is that students perceive the SL as an opportunity to understand the chemistry content knowledge they need to learn in school. The quote of a fourteen-year-old schoolgirl shown in the previous part of this chapter seems to confirm this assumption. This student did not understand the contents of a previous chemistry lesson, but expected to understand it by doing experiments in the SL. From the students’ point-of-view professional science labs seem appear more suitable for learning science than by just applying scientific knowledge in paper-and-pencil tasks in schools.

The categories ‘understanding chemistry concepts’ and ‘dealing with issues related the life’ were judged to be significantly more important by the female participants on a 95% confidence interval. The acquisition of knowledge and handling of daily-life contexts seems to be more important for girls than it is for boys. All other categories did not lead to statistically significant differences. Regarding the age of the students, the results of the t-test - at first glance - are quite astonishing. Students from 5th to 8th grade rated all of the categories - with the exception of the category ‘understanding chemistry concepts’ - significantly higher than the older participants. Greenfield (1997) provides one possible explanation. The author was able to show that the attitude of younger students towards science education is much more positive than the attitude of older students. Thus, younger students are probably more open to new learning experiences and more interested in science topics on average. Finally the students’ data were also analyzed with regard to their specified favorite subject. With exception of the category ‘dealing

**Table 3.** Teachers’ and students’ expectations on SLs

	Number of items	Mean value	Standard deviation	Cronbach’s $\alpha$
<b>Teachers’ expectations</b>				
<b>Improvement in students’ attitude</b>	3	1.44	0.43	.47
<b>Development of students’ scientific thinking and working skills</b>	4	1.71	0.44	.64
<b>Content knowledge gains</b>	2	1.97	0.83	.79
<b>Benefit for own teaching practices</b>	2	2.15	1.00	.76
<b>Career orientation for students</b>	3	2.81	1.03	.83
<b>Students’ expectations</b>				
<b>Understanding chemistry concepts</b>	2	2.04	1.04	.70
<b>Development of scientific thinking and working skills</b>	3	2.17	0.79	.56
<b>Career orientation</b>	3	2.39	1.03	.76
<b>Dealing with issues related the life</b>	2	2.80	1.30	.72
<b>Applying content knowledge</b>	2	2.97	1.07	.70

with issues related the life', all categories were rated significantly more important by those students who chose science or chemistry as being among their favorite school subjects. This result is not surprising since these students are more interested in science than their classmates. Because of the unequal distribution of participants further tests of significance were omitted.

From the teachers point of view there is also an unequal distribution. Accordingly, only one aspect was identified using a t-test. Sixteen teachers visited the SL with their 5th or 6th grade classes. A total of twenty teachers took part of the SL experience with students in higher grades. The first group of teachers stated that the category 'career orientation for students' was significantly less important than it was to their colleagues. Aspects of career orientation are not considered relevant for young students of age 11-12, but become more important in later years as school graduation nears. All other categories did not lead to significant differences.

## CONCLUSIONS AND IMPLICATIONS

Out-of-school learning environments should emphasize the needs and expectations of the participants (Anderson et al., 2006). In order to create such learning environments, it is important to know more about the people taking part in the programs. With respect to the SLs in Germany, it has been shown that the participants expect to experience intense, student-centered experimentation, which complements current teaching in schools. The teachers expect the betterment of their students' attitudes and motivation towards science (see also Schmidt et al. 2014). Other student-related expectations, such as a gain in knowledge or the support of vocational orientation, generally fade into the background. However, students tend to regard pure knowledge gains in terms of assessment and grading during the SL as much more important than their teachers do.

A comparison of these results with students' and teachers' feedback after the corresponding SL visits (Garner et al., 2015) shows that SLs seem to meet the teachers' and students' expectations. Both opportunities for intense experimentation and the potential to improve learners' attitudes and motivation were mentioned by the participants. SLs in Germany define themselves by offering student-centered experiments for students and school classes. This expectation of the participants will therefore almost automatically be fulfilled.

Under certain conditions out-of-school learning environments may lead to a more positive student attitudes towards learning science (Orion & Hofstein, 1991). But, this does not apply to just any learning environment. German studies on similar learning environments showed that single SL experiences usually lead to positive effects that are only short or medium-term. Single learning experience in a SL can therefore most probably not meet teachers' high expectations in long term effects. However, regular visits to SLs with an intense linkage of inner- and outer-school learning do have the potential to lead to long term improvements (Zehren et al., 2013). But also here it is necessary that the SL environments are adapted to formal learning content to achieve their upmost potential. Only SLs that are related to the school science curriculum have good potential to support school science learning. In this case, the content of formal learning can be enriched by the experimental experiences in the SL. That means that the SL staff needs to be well informed about the lesson content in formal education of a certain student group and the pedagogies generally applied. The evaluation of the student responses in our study, however, reveals that students who are participating in a non-formal learning environment do not automatically expect a connection with formal educational contents. Thus, approaches must be found which allow systematic integration of the SL visit with formal educational processes in school on the one hand, but also offer the students additional experiences that are not or cannot be part of school science learning on

the other. This means concerning to both groups' expectations first of all intensive, hands-on experimentation, but experimentation that is connected to the school learning content and in the same time goes beyond school science laboratory experiences (Garner et al., 2015). All of the participants seemed to be aware that laboratory conditions in schools are far from optimal for carrying out practical work. That is why SLs can be of great value to offer schools an important addition in their pedagogy by adding intense and different laboratory work experiences to the learning of the students. Students can perform new experiments in new formats, particularly those which impossible to implement in formal education environments.

Another important focus is the idea of the SL as a place for continuous professional development for teachers. Teachers hope to reap the benefits of their visits into the SL. Although other authors have reported that many teachers are unwilling to use teaching materials given to them for their own lessons in school (Griffin, 2004), the expectations revealed here and the positive feedback from the project, reported in Garner et al. (2015), do not confirm this suggestion. Teachers expected and enjoyed getting ideas and impulses for their own teaching and in receiving the corresponding materials for the experiments. Thus, the current study supports the idea that SLs offer a great chance for teachers to earn new content and pedagogical content knowledge, as well as come into contact with new and updated materials developed for and tested by their learners. Since roughly half of the teachers expressed interest in using these new materials in their own teaching, we can recognize the great potential which introducing teachers to new ideas, materials and experiments can have. Maybe the difference in expectation to regular in-service teacher education workshops is that in this case the teachers do the continuous professional development together with their students, they can learn about new content and pedagogies and in the same time observe how their students are reacting to it. Thus, such programs can support and expand the learning taking place in schools too (Garner et al., 2014).

Overall, this study shows that SLs should be designed to be consistent with teaching experiences the students face in their schools and in the same time go beyond them. Flexible learning environments allow adaptability to both the school science curriculum and the pedagogy generally applied by the teacher. Only with a good combination of inner and outer school learning both students and teachers may get the optimal benefit from visiting SLs. Further studies are necessary to shed light on the long-term effects of certain of these linking strategies and what frequency of SL visits will be of benefit to support formal learning without disturbing regular school routines too much. Further research might also focus the influence regular cooperation of schools with SLs can have on teacher continuous professional development, curriculum development, and classroom innovations in corresponding schools.

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