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Out-of-school learning in the botanical garden: Guided or self-determined learning at workstations?

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ABSTRACT

Guided tours are the method of choice for school classes visiting botanical gardens. However, it remains unclear, which influence such teacher-centered approaches have on learning outcome in such informal learning environments. We compare a teacher- to a student-centered *learning at workstations* program under the topic *plants and water*. 16 school classes at eighth grade visited the botanical garden of the University of Würzburg, attending either one of both treatments. We used multiple-choice questionnaires measuring knowledge scores and found no significant differences in learning outcome – tested in a pre-post-retention design. We also monitored the students' intrinsic motivation, which resulted in similar and high scores. Possible causes for our results and consequences for education at botanical gardens are discussed.

Introduction

Out-of-school learning settings reveal positive cognitive outcomes

"Field trips to museums, zoos and science centers or the natural environment could deepen students' understanding of subjects usually taught in the classroom" (Sturm & Bogner, 2010, p. 14). The named institutions as well as botanical gardens meet all demands of out-of-school learning settings. For example, the demonstration of living or "dried" animals/organisms could transport more information and could change students' beliefs and affective reactions, like the fear of snakes (Bitgood, 1989). Compared to classrooms, education of global environmental sciences at out-of-school learning settings is possible in a more visual, visceral and trans-disciplinary way (Storksdieck, 2006). Teachers often make use of field trips to such settings to complement and supplement their instructions (Ackermann, 1998), as well as to form class cohesion and to increase the students' motivation (Storksdieck, 2006). Hence, in recent years many studies, especially in science education, focused on this topic. Researchers have mainly been interested in the comparison between classroom-based teaching and different out-of-school learning settings. Results of these studies showed a cognitive benefit of the out-of-school settings at museums (Sturm & Bogner, 2010), laboratories (Scharfenberg, Bogner, & Klautke, 2007) and science centers (Dairianathan & Subramaniam, 2011). Yet, for a salt mine, Meissner and Bogner (2011) measured cognitive levels, which were comparable to those achieved in classrooms. Still, in all of these interventions students showed a significant increase in knowledge about the particular topic at the respective out-of-school learning setting.

Botanical gardens as informal learning environments

Nowadays botanical gardens in Germany are not only museums for plants under the motto "don't touch". For instance, in some German cities, like Frankfurt am Main, Heidelberg, Ulm and Mainz, so-called "green schools" or "green classrooms" add an educational and sustainable component for all age groups of garden visitors, but especially for students in schools and universities. In the surroundings of a few, especially large, cities, several landscape forms, like for example meadows and forests, can only be found in botanical gardens. Consequently, botanical gardens are today not only responsible for the rearing, cultivation and research of plants, but also for the comprehensive communication of knowledge in a didactically appropriate manner. Trips to botanical gardens allow a teacher to be comparably flexible regarding the topic and offer opportunities to meet and involve experts. Additionally, botanical gardens are not necessarily learning environments focused on botany or even biology. Besides topics like adaptation or plant–animal

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interactions, students can there potentially also learn about for example geography or natural or human history. Hence, an important current task of botanical gardens, namely environmental education and education for sustainable development (Willison, 2006), can effectively be addressed.

Botanical gardens are informal learning environments (Sellmann & Bogner, 2012), as they fulfill the four preconditions summarized by Storksdieck (2006): 1. Media are present to visualize the botanical and/or global context. 2. Botanical gardens have to be visited by the students. 3. Students get the chance for primary encounters with plants and animals and gain knowledge about species and 4. They can learn about ecological and environmental issues (Killermann, Hiering, & Starosta, 2011). Additionally, out of school lessons tend to be more open and socially interactive (Hofstein, Nahum, & Shore, 2001). The atmosphere is often more relaxed (O'Brien & Murray, 2007), bearing no school time pressure in concert with a non-evaluative nature. All of these advantages can potentially foster the learning of students. Sellmann and Bogner (2012) found significantly higher knowledge scores for 10th graders following an instruction in a botanical garden for the topic of climate change. They also measured the students' attitudes toward utilization and preservation of nature, according to the Two Major Environmental Value model of Bogner and Wiseman (2006). Also, Drissner, Haase, and Hille (2010) investigated effects of a short-term education program regarding small animals in the "green classroom". Both analyses revealed positive effects of the interventions in botanical gardens on the utilization, but not on preservation values. Furthermore, the intrinsic motivation of the involved students was higher in comparison to control groups (Drissner et al., 2010). Thus, education programs in botanical gardens could influence cognitive, affective and motivational attitudes positively.

Intrinsic motivation inventory (IMI)

In this study we investigate, adjacent to the learning outcome, whether students are intrinsically motivated for the topic *plants and water* in the setting of a botanical garden. In this context we make use of the intrinsic motivation inventory (IMI), established by Deci and Ryan in 1985. The IMI is based on self-determination theory, which suggests that people are intrinsically motivated when doing something inherently interesting or enjoyable (Ryan & Deci, 2000). In contrast, extrinsic motivation results in low-quality learning, because the act itself leads to an extrinsic, separable outcome, like a grade for instance. However, intrinsic motivation results in high-quality learning and creativity (Ryan & Deci, 2000), which is desirable in education research.

Student-centered vs. teacher-centered approaches

Few studies in the last decade dealt with the effects of student-centered against teacher-centered methods at out-of-school learning settings, like laboratories (Abrahams & Millar, 2008; Scharfenberg et al., 2007; reviewed by Hofstein & Lunetta, 1982, 2004), natural history museums (Wilde, Urhahne, & Klautke, 2003) or zoos (Randler, Kummerer, & Wilhelm, 2011). Scharfenberg et al. (2007) detected a higher short-term learning outcome for the so-called *hands-on* group. Additionally, Randler et al. (2011) found best scores for the learner-centered environment six weeks after the zoo visit. However, Abrahams and Millar (2008) as well as Wilde et al. (2003) did not find significant differences between several compared learning methods over longer time-scales.

Furthermore, there are many studies, which compare (constructivist) *student-centered* to (instructional) *teacher-centered* approaches within classrooms (e.g. Gerstner & Bogner, 2010; Heyne & Bogner, 2012; Randler & Bogner, 2006; Sturm & Bogner, 2008). However, the results of these studies were contradicting. Also, neither of them was focused on botanical gardens nor on a botanical topic. Our intention was to bridge this gap and to investigate the learning outcome as well as motivational differences of a teacher-centered compared to a student-centered approach at this particular informal environment.

The most often used educational methods in botanical gardens worldwide are guided tours, talks and lectures as teacher-centered methods, followed by student-centered interventions, like workshops or training courses (Kneebone, 2007). Approximately 20% of the botanical gardens evaluate their educational programs on the regular basis, with a focus on the effectiveness of the programs. Yet, they do so mainly by observations. Hence, the aim of our study is to investigate, whether often conducted student-centered workstations are more successful in teaching at a botanical garden (with regard to motivation and cognition) than teacher-centered workstations (similar to guided tours). Our student-centered workstations were designed on the basis of a constructivist approach. For the guided approach (instructivist) we used the same workstations, but involved a teacher instructing the students successively (see methods section). With this classification we follow the work by Heyne and Bogner (2012), although they called the guided approach *student-centered guided* or *guided learning at workstations*. The authors additionally made use of a third group, which was teacher-centered *sensu stricto*. In our study we omit this third group.

The student-centered workstations we developed adhere to the requirements of the three innate needs of the self-determination theory (SDT, see above), which should foster learning and retention (Randler et al., 2011): competence (Harter, 1978; White, 1963), relatedness (Baumeister & Leary, 1995) and autonomy (deCharms, 1968; Deci, 1975). In our approach, a student in a student-centered group may act depending on its competence, while working in a small group, and simultaneously interact with around two to four group members. Another attribute of the student-centered learning method is that the students can freely decide about the order, in which they work on the stations, and determine the working time needed for each station. Thus the students are comparably autonomous – they can conduct all trials by themselves and may decide, whether they want to gain knowledge via texts, images or originals (plants). All these attributes stand in contrast to the teacher-centered workstations we developed, where the students had to follow the teacher's order and speed. Furthermore, the teacher showed trials and images during his talk for a bigger group of 13–18 students. The teacher-centered workstations do not meet the requirements of the self-determination theory and should lead to lower motivational values and consequently to lower cognitive achievement. In general, we hypothesize:

1. Students, who participate in the student-centered workstation program, show higher motivation than those attending the teacher-centered program.

2. The student-centered workstations lead to higher cognitive outcome than the teacher-centered workstations at the out-of-school learning setting botanical garden.

Gender effects at out-of-school learning settings

Recently, some studies support the hypothesis that females prefer learning about botany, when compared to males (Fančovičová & Prokop, 2011; Hong, Shim, & Chang, 1998; Prokop, Prokop, & Tunnicliffe, 2007). Following from this we expect females to achieve higher cognitive scores than males, caused by a higher emotional preference of females for plants. This phenomenon is usually traced back to the evolutionary history of humans. Once, females predominantly were gatherers (Kaplan, 1996), whereas