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Exploring pedagogical potential of outdoor context in teaching physics for prospective primary and secondary school teachers

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Abstract

This paper presents a conceptualisation of over ten years practical experience of working with “outdoor component” in science teacher education in Umeå (Sweden). The Activity Theory (AT) has been used to provide theoretical ground for reflection on educational work and students’ activities in the outdoor context. Our experience of exploring pedagogical potential of outdoor context in teaching physics for prospective primary and secondary school teachers is also illustrated by concrete examples from different courses and student examination papers. Evidence provided by this study and students research shows great potential of outdoor learning environment but also reveals issues related to motivators and pedagogical complexity of outdoor teaching demanding purposeful development of teacher competence and great deal of private interest.

Keywords: Activity Theory, outdoor context, physics, teacher education

Subject / Problem

There is obvious need of preparing future science teachers to work in post-modern society which is characterised by great uncertainties and complexities. According to our experience, outdoor context has powerful potential to serve as an exploratory learning environment where inquiry about authentic, complex and uncertain tasks can be naturally implemented. Therefore, we assume that teachers need to be purposefully taught to work with uncertainties and complexities when doing inquiry in outdoor context. This process demands systematic efforts from the teacher educators (Dillon, 2010).

Currently, in Sweden and internationally, there is a visible growing interest in outdoor education. Slingsby (2006) expresses his conviction that “the future of school science lies outdoors”. Research shows that a variety of natural settings can be used effectively for students’ science investigations outdoors such as schoolyards, playgrounds, gardens, zoos, and amusement parks (Braund, Reiss, 2006, Nilsson, Pendrill, Pettersson, 2006). However, most of the pedagogical activities outdoors are focused on social competence development, or study of nature from biological and ecological perspectives, but physics teaching remains largely indoors bound.

Vygotsky (1978) considered context as an active component of the learning process that interplays with learner’s and teacher’s activities. Following this line of thought, we suggest that partly placing the study of laws and properties of nature (physics) directly in natural settings and in the context of active social interactions between students and teachers, will make important contribution to building up prospective teachers’ pedagogical competence in science teaching.

Working in the field of science teacher education in Sweden, we have experienced that students of both sexes are interested in outdoor activities. During the last ten years more than
half of the more than 30 students, who studied outdoor teaching in the examination papers of teacher education at Umeå University, were female students. Free-choice outdoor courses have higher enrolment of female students as well. However, we have seen a need for purposeful development of teacher competence in outdoor physics as this is not a common part of school science education.

**Study design**

At our department, prospective teachers work with physics activities outdoors in different forms and on different occasions, such as outdoor education courses, assignments in didactics of physics, school practice, summer and masters courses. The various aspects of outdoor science were part of teacher students’ research projects presented at the end of their undergraduate studies. This study is mainly based on systematic reflection about our own experience of teaching outdoors courses and analysis of students’ research projects, course work and evaluations of such courses. Prospective science teachers have been active agents of this study. They developed specific outdoor physics tasks, tested these both by themselves and with pupils in schools and evaluated their outcomes. In this paper, we attempt to provide analysis of outdoor physics teaching at our department using Activity Theory (AT) perspective.

**Findings**

In this section we present what can be considered as ‘added value’ of outdoor physics extracted from our practical experience with help of Activity Theory perspective. Pictures in the text below illustrate outdoor physics activities done by our students in different courses.

**Practical collaborative activity facilitates physics learning**

Naturally, practical activities outdoors have joint-collective enactment. This means that group or team activity has been the basic form of activity in outdoor physics. According to Leont’ev (1981), the first and most fundamental form of human activity is external, practical collaborative activity. Davydov (1996) claims that thought is an idealisation of the basic aspect of practical activity involving objects, and of the reproduction in that activity of the universal forms of things, their measures, and their laws. Thus, doing and learning interplay naturally in outdoor context.

Fig. 1. Exploring composition of forces and balance.
Physical and cognitive mediation as facilitators of learning

The fundamental claim of AT is that human activity (on both the interpsychological and the intrapsychological plane) can be understood only if we take into consideration technical and psychological tools that mediate this activity (mediating artefacts). To achieve an understanding of scientific concepts, laws and theories, students need to be actively involved in thinking, which requires the use of different mediating cultural tools. Learning depends on cultural artefacts mediating this activity (Norman, 1994). In outdoor physics, investigation techniques or processes of science (also called process-skills or skills of scientific inquiry: observing, measuring, classifying, hypothesizing, etc.) are artefacts that have particular significance. These mental and manipulative skills serve as important tools in the culture of science. In outdoor physics, large-scale physical artefacts like cable drums, cars, poles, barrels, etc. were also used as tools for stimulating learning (Popov, 2006).

Fig. 2-3. Exploring principles of mechanics in the playground

Physics as target object of outdoor activity

According to Leont’ev (1981), activities are object-related. The content of human activity is determined first of all by its object. The object of activity is always a value-loaded social object, i.e. a human-nature or human-technology system. When doing outdoor physics, the object of students’ activities are natural or human made objects with their properties reflected in scientific principles, laws and theories of physics. Thus, the content (object) of learning is the acquisition of knowledge (embodied in learning objects) about properties and laws of nature. For example, when making a construction and studying different parameters of a hot-air balloon, the content of learning is about understanding density, heat transfer and Archimedes law.

Fig. 4. Exploring syphon principle.  
Fig. 5. Using the Sun and optics for fire-making.
**The dynamic nature of complex learning activity outdoors**

AT is based on an understanding of activity as a constantly developing complex process. Leont’ev often referred to constant transfers within the system “subject (learner) – activity – object” (Stetsenko, 2005). AT emphasises dynamic relations and constant transformations between external (physical) and internal (mental) activities that constitute the basis of cognitive development.

In outdoor physics, experience with cognitive and physical tools, instruments and artefacts (like building a water rocket and exploring its properties, doing observations and measurements with the help of binoculars or a telescope) are valuable for the development of the learner’s scientific worldview and his or her skills in and attitudes towards science.

The object transformations, along with learners’ new knowledge, capabilities, mental and bodily presuppositions which they acquired in this process, are the expected outcomes of the learning activity. As mentioned before, in outdoor physics activities, learning objects are real material objects in the surrounding environment with their properties reflected in scientific principles, laws, and theories of physics. The learner performs actions on the learning objects, transforming the objects in intellectual and/or practical ways and changing him or herself in that process. Thus, prospective teachers develop necessary professional competences.

**Openness and complexity of outdoor physics tasks forms student-teacher collaboration**

When students work with experimental problems outdoors, expected results can be quite unexpected. There is a need for more heuristic rather than algorithmic ways of approaching the problem.
Errors have to be seen as new opportunities and challenges for learning rather than failure. The complexity of the real world situations demands the lecturer to be more researcher and partner for students in this work rather than possessor of the right answers. This situation, when the lecturer had to think together with a student about authentic problems is not what prospective teachers normally experience in teacher education. Accumulated experience and know-how acquired by prospective teachers in an outdoor physics can lead, hopefully, to similar educational activities in their future teaching.

**Conclusions**

The natural environment provides genuine opportunities for meaningful learning based on combination of minds-on and hands-on activities, but also requires additional preparation and carefully designed pre- and post-field work to make outdoor learning productive. Our experience and theoretical reflections show that outdoor physics activities can lead to real empowerment of prospective science teachers, giving them more control over and understanding of the science learning processes. They gain confidence of using new mediating artefacts of learning and have more open-minded approach meeting new objects of the study.

![Fig. 9. Exploring torque.](image1)

![Fig. 10. Working with friction and tension.](image2)

We argue that outdoor physics can be an effective and important complement to classroom-based physics learning. Such an approach seems to create new learning opportunities for different categories of students, from the bright ones to those with special needs, male and female, native and immigrants. We agree with Justin Dillon (2010) who argues for the value of science beyond the classroom. He wrote “Done well, field-work works. It improves knowledge; it improves skills; it improves motivation. Denying students fieldwork is like denying them books, or pens, or computers.” (Dillon, 2010, p. 144).

**References**


