Exploring outdoor science in teacher education from a comparative Scandinavian perspective

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Abstract

This paper focuses on the development of prospective teachers' competence to conduct outdoor science education in a Scandinavian context. This context is characterized by easy accessibility to open-air natural environment and folk traditions of being and doing different activities outdoors. Working in the field of science teacher education in Sweden and Norway, we have experienced that outdoor science is traditionally linked to environmental and biology field courses or teaching units that contain fieldwork. The Ministries of education in both countries are supporting outdoor science in schools through a variety of programs, that are internet- and open source-based (www.skolverket.se, www.naturfag.no; www.ndla.no). Cultural Historical Activity Theory (CHAT) lens is applied to the study. The conclusions of the study underline the importance of working actively with issues related to pedagogical complexity of outdoor teaching, which is demanding a purposeful development of teacher competence and teaching material.

Keywords: competence; Norway; outdoor context; science education; Sweden; teacher education

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Introduction: Delimitating the area of the study

Slingsby (2006) expressed his conviction that “the future of school science lies outdoors”. Teaching experiences in different countries show that a variety of natural settings can be used effectively for students’ science investigations outdoors such as schoolyards, playgrounds, gardens, zoos, and amusement parks (Tilling, Dillon, 2007). However, internationally as well as in Sweden and Norway, science teaching remains largely indoors bound, due to time, cost and safety issues, the curriculum, its assessment, teacher enthusiasm and expertise (Lock, 2010). 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 argue (Popov 2015) that placing the study of laws and properties of nature directly in natural settings will make important contributions to building up prospective science teachers’ pedagogical competence. Working in the field of science teacher education in Sweden and Norway, we have experienced that students of both sexes are interested in outdoor activities. However, we have seen a need for purposeful development of teacher competence in outdoor science as this is not a common part of school science education. Even in Scandinavia we must have concerns about an increasing “Nature deficit disorder” (Skaugen, 2014). We attempt in this paper to provide some systematic reflections on our outdoor science activities using Cultural Historical Activity Theory perspective, which has been shown to be supportive in such “real-world complex learning environments (Yamagata-Lynch, 2010).

Results of reflective analysis

Consequences of Nordic latitudes

The reflective analysis that follows has to be seen in the context we are living and teaching in. Both Scandinavian countries have traditions that should favour outdoor learning. The ratio of people vs. nature means that even around bigger cities, there is still a vast amount of habitats that can be used for teaching activities. There is the famous “Allemansrätt”, meaning free access to nature for everyone. Sustainability and outdoor teaching has traditionally been a strong component of national and personal ideologies and curriculums (Jordet, 2010), but is recently discussed to be counteracted by educational governance due to ambitions to improve scores on PISA and other globalized test programs (Sinnes & Eriksen, 2016; Sjøberg, 2015). Additionally, despite of science teachers theoretically knowing teaching methods promoting education for sustainable development outdoors, they seldom enact those in their practice (Sundstrøm, 2016).

On the other hand the Nordic climate can be seen as limiting outdoor activities. Even if there is midnight sun above the polar circle, most of this time is spent in long summer holidays in Scandinavia. Consequently, traditional field courses in biology are limited to a few weeks before and after summer vacation, due to a short vegetation period, that is followed by long winters and a period in darkness, extending with northern latitudes. Even if a strong impact of Climate Change can be observed in the North, with significant extension of vegetation period (Forsgren et al., 2015; Xu et al., 2013), it still is a very short period for biologically relevant content from core curricula, regarding for example investigations in flowering plants. Thus many of the classical outdoor-teaching suggestions in textbooks and online repositories (even Scandinavian ones) still cannot be used in the northern parts of Scandinavia. Only few publications focus on analysing possibilities of outdoor science education in hostile winter climate (Rimala, 2016).

Practical collaborative activity at the heart of science 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 science. According to Leontiev (1978), the first and most fundamental form of human activity is external practical collaborative activity that later internalised in intellectual form. Thus, performing group practical activities and learning interplay naturally in outdoor context. Parallel to trends in other countries (Glackin, 2016), this is acknowledged in Scandinavia, and is shifting from specific content to the basic competencies to understand scientific concepts and reasoning (Kolstø & Knain, 2011; Remmen & Frøyland, 2015). The Norwegian Centre for Science Education for example supports teachers and teacher-students with inquiry-based teaching resources in outdoor-contexts. These range from ready to use classroom-materials to recommendations and teacher development programs about how to create activities fostering deeper thinking processes in science education (Mork & Haug, 2015), for example in geology excursions outdoors (Remmen & Frøyland, 2015), emphasizing collaborative activities.

But there are critical voices, too, warning that too strongly emphasize the processes as the enduring, worthy knowledge from science disciplines, may lead to misconceptions if not implemented carefully. This means, while traditionally when teaching facts, the style often was authoritative and lecturing, now the opposite may occur. The student as a researcher who should be able to conclude to universal laws simply by observing nature, resulting in understanding nothing (Sjøberg, 2009).

Collaborative activities in Scandinavia also occur at another level, with nationwide, open source resources in order to create fieldwork that is more meaningful. Students can register their observations and compare to other schools, organizations and scientific databases (www.miljolare.no; www.artsdatabanken.no). These resources are especially interesting as they are bridging the vast geographical distances between people and landscapes, giving students in tiny Northern villages possibilities to actively participate in processes far away. Examples are phenomenological observations, bird migration, colour-ringed or gps-marked birds that can be followed on their way, or that spring in southern Scandinavia with flowers everywhere occurs while students in Lapland still use ski as the best vehicle to reach school. In order to give students deeper insights and being able to compare ecosystems and landscapes on a larger scale, we began a cooperation between faculties, with both student and teacher exchange. Even if both cities are situated in Northern Scandinavia, there are still several hundred kilometres between them. Tromsø in Norway, near the open Ocean, with significant tidal zones, steep mountain sides, North of the Polar Circle, and Umeå in Sweden below the Polar Circle and situated at the inner Baltic Sea, with low salinity, surrounded by endless forest landscapes, thus giving students a “glocalized”, integrated local and global, perspective in science outdoor education (Hallås & Odberg, 2015).

Physical, digital and cognitive mediation as facilitators of learning

The fundamental claim of CHAT is that human activity (on both the inter-psychological and the intra-psychological plane) can be understood only if we take into consideration technical and psychological tools that mediate this activity (mediating artefacts). In outdoor science, investigation techniques or processes of science (also called skills of scientific inquiry: observing, measuring, classifying, hypothesising, etc.) are artefacts that have particular significance. Inquiry based instruction models like 5E-model (Bybee et al., 2006) or Cognitive Acceleration through Science Education (CASE) (Shayer & Adey, 2002) become relevant in this context. These mental and manipulative skills serve as important tools in the culture of science. In outdoor science, large-scale physical artefacts like cable drums, cars, poles, barrels, etc. could also be used as tools for stimulating learning (Popov, 2015). Finally yet importantly modern hand-held tools as mobile phone equipped with probes could be powerful mediating artefacts for science learning outdoors (Höper, 2015). Most of natural sciences content seems to be covered theoretically in schools. Still one discipline, chemistry, focuses totally on indoor education. A recent didactical framework connects chemistry to education for sustainable development (Jegstad & Sinnes, 2015). While this approach mainly concentrates on secondary chemistry education, it is hard to find literature about using the outdoors in beginners´ chemistry education, consequently the possibility of teaching chemistry outdoors is hard to find, even in important didactics textbooks, for instance (Ringnes & Hannisdal, 2014). So we think it is time to apply teaching beginners chemistry in nature, for instance based on “chemistry trails” (Borrows, 2006) even in the harsher climate of the northern countries. Combining inquiry-based teaching methods with simple chemical experiments that can be carried out by students even at low temperatures outside, or analysing compounds with test strips (Schwedt, 2015) are just two possibilities. This could help reducing the deficit among students in understanding chemistry as an integrated part of nature and everyday life (Gröger, 2013) and thus low interest in “school-chemistry”(Sjøberg & Schreiner, 2010). As very small amounts of chemicals are used in test strips or digital data logging probes, these activities will contribute to chemistry education for sustainable development, as outlined by Jegstad & Sinnes (2015).

Science knowledge and skills as target object of outdoor learning activity

According to Leontiev (1978), activities are object-related. The content of human activity is determined first of all by its object. When doing outdoor science, the object of students’ activities are natural or human made objects with their properties reflected in scientific principles, laws, and theories. Thus, the content (object) of learning is the acquisition of skills and knowledge (content) about properties and laws of nature. Developing categories to define different kinds of fieldwork in Scandinavia, the following have been identified. The traditional excursion with a teacher as the expert, testing of hypotheses outdoors, inquiry-based fieldwork and the more freely exploring fieldwork, resulting in lesser predictable outcomes (Marion & Strømme, 2015). In all these activities knowledge and skills are the target object of outdoor learning.

The dynamic nature of learning activity

CHAT is based on an understanding of activity as a constantly developing complex process. Leontiev often referred to constant transfers within the system "subject (learner) – activity – object/content". CHAT emphasises dynamic relations and constant transformations between external (physical) and internal (mental) activities that constitute the basis of cognitive development. In outdoor science, experience with cognitive and physical tools, instruments and artefacts 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. In outdoor science, learning objects are real material objects in the surrounding environment with their properties reflected in scientific principles, laws, and theories. 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, in this way prospective teachers develop necessary professional competences.

Openness and complexity of outdoor science tasks form student-teacher collaboration

When students work with experimental problems outdoors, expected results can be quite unexpected. 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. Science curricula in Scandinavian countries in the past two decades have been focusing on both, the process and products of natural sciences, whereas daily science teaching has traditionally been concentrated on disseminating the products, concepts and knowledge (Sjøberg, 2009). In this context, Glackin (2016) found these two types of teachers in her recent study about how teachers' beliefs influence their practice, and that the beliefs were more fundamental than external factors like the content of the actual curriculum. The teachers engaging positively and successfully with inquiry-based outdoor activities could be categorized as social constructivists, giving their students "opportunities to develop multidimensional relationship with outside environment", they see the outdoors as a chance to gain "greater insights into the messiness of science and scientific inquiry"(Glackin, 2016). This situation, when the lecturer has to think together with a student about genuine problems is unfortunately still not what prospective science teachers normally experience in Scandinavian teacher education. Accumulated experience and knowledge acquired by prospective teachers in an outdoor science can lead, hopefully, to similar educational activities in their future teaching (Struyven, Dochy, & Janssens, 2010).

Conclusion

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. This is recognised by educational authorities and teacher education institutions in both Norway and Sweden. Our experience and theoretical reflections show that outdoor science activities can lead to real empowerment of prospective science teachers, giving them more control over and understanding of the science learning processes. Using CHAT conceptual framework we can say that our students in teacher education gain confidence of using new mediating artefacts and have more open-minded approach meeting new learning objects. Further, they develop the ability of accepting the right to fail or using failures and uncertainties as an important pedagogical tool in the complex learning contexts. We argue that outdoor science can be an effective and important complement to classroom-based science 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, and we see a need to increase our knowledge about these issues through further theoretical elaborations and research.

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