Becoming animated when teaching physics, crafts and drama together – a multidisciplinary course for student teachers

Abstract

This article examines a physics course for preservice primary teachers in which physics, crafts and drama were taught together by connecting the standpoints of crafts and drama. The study was carried out by three university educators from these disciplines during an advanced optional course for student teachers at the University of Helsinki in Finland. This article discusses the impact of the multidisciplinary teaching approach on the participants' learning outcomes. First, the article explains the multidisciplinary teaching model, an educational energy game that the student teachers designed as part of the course. Second, it describes the learning that emerged from the student teachers' learning process, including 1) learning skills, 2) new pedagogic thinking and 3) a change of attitude towards integrative teaching. Finally, the analysis shows the strength of sociocultural animation, which is traced through a path of becoming animated.

Keywords: multidisciplinary teaching, teacher education, learning, sociocultural animation, educational gaming

Introduction

Multidisciplinary teaching, sociocultural animation and educational gaming are the core concepts framing our study. Multidisciplinarity in teaching and learning has been actively discussed in education during the last century and recently, especially in Finland since the new national core curriculum for basic education (Finnish National Board of Education 2014) has strongly recommended that teachers should integrate their teaching. The broad range of pedagogic interpretations and applications of multidisciplinary teaching have been presented in the international educational context (e.g., Bresler 1995; Drake and Burns 2004; Järnefelt 2007; Puurula 1999; Sarkar Arani 2008; Uusikylä and Atjonen 2005; Visanti 2007). These different dimensions of multidisciplinary teaching are more or less complementary and hardly ever purely fulfilled in practical teaching as such (Drake and Burns 2004).

Multidisciplinarity generally refers to a teaching act that connects topics, themes or disciplines (Cantell 2015; Koskenniemi and Hälinen 1970), which means gathering fragmented information on varied subjects into a more holistic set (Cantell 2015; Simola 1988, 5). The fragmentation of an individual's knowledge structure or the lack of a holistic view is a common problem in many learning activities. The individual often learns only narrow fragments or details without the ability or possibility to construct bigger pictures (Simola 1988, 5). This kind of knowledge fragmentation poses a problem not only to the student but to the teacher as well. One of the reasons for this fragmentation is the subject-based instruction in schools and in higher-level institutions, for instance, in class teacher education in universities in Finland (see e.g., Rantala, Salminen, and Säntti 2010). On one hand, subject-based instruction in teacher training ensures that the student teachers learn well the core contents of subjects, which is a basic condition for multidisciplinarity. Interestingly, although class teachers in the Finnish primary school teach almost all the subjects of a class themselves and would thus have an excellent opportunity to carry out this teaching in a holistic way, searching for connections among different subjects is not included directly in the teacher training programme (Syllabus of Class Teacher Training, 2014–2015), and all the subjects are taught separately. On the other hand, this kind of separation of subjects is an international practice in which the subjects are regarded as core elements of the curriculum and as standards for the school, state and national systems (Henderson 2001).

Every teacher should to be able to teach a holistic knowledge structure in a broad-based way so that students could acquire a more holistic picture of the complex phenomena of real life. The question is about the depth of understanding; the better the student perceives the whole picture in connection with other contexts or the surrounding world, the deeper he or she understands the content to be taught or learnt. This tendency towards a more holistic picture of the content area to be taught also relates to the more autonomous role of teachers in school (Finnish National Board of Education 2014). The teacher is not just an implementer of the curriculum but an independent and flexible developer of her or his own work.

In this study, holistic knowledge constructing and multidisciplinarity in teaching are facilitated by changing the role of educators into sociocultural animators and by giving the student teachers the learning task of planning an educational game. Together these two aspects widened the student teachers' views on the topic. In this study, the task of educators as sociocultural animators is to create a socially sensitive and inspiring atmosphere which helps the student teachers to become conscious of their possibilities to influence the situation and learning. Thus, the goal is to cause a domino effect where student teachers animate each other in order to be released from subject-centred thinking (Foth 2006; Karppinen 2008a; Kinnunen et al. 2003; Kurki 2000; Smith 2009). The educational gaming approach, which has many positive learning effects such as feeding creativity and the imagination (Poling and Hupp 2009) as well as the participatory learning (Kangas 2010) of the player, is here applied and reviewed from the perspective of a game designer. In this case, the student teachers were provided the opportunity to design the energy game in an animated, creative and sharing atmosphere that supports the planning of multidisciplinary tasks that cover the wide field of phenomenon included in the concept of energy.

The research reported in this article is part of our broader design-research project in multidisciplinary teaching (Karppinen et al. Forthcoming, 2013, 2012; Fernström, Karppinen, and Ojala 2014). Here we describe the results of a study where the multidisciplinary teaching approach was piloted during a student teachers' course in the University of Helsinki. The course was realised as multidisciplinary collaboration among educators of physics, crafts and drama. The main research question on the impact of the multidisciplinary training course implemented in the spirit of becoming animated on the student teachers' learning outcomes is answered through the sub-questions: 1) What kind of multidisciplinary teaching model did the student teachers produce as an end product of the course? 2) What kind of learning did the student teachers experience during the multidisciplinary course?

Sociocultural pedagogy and sociocultural animation

In this study, the principles of a sociocultural view and sociocultural animation are forward-pushing elements. The sociocultural view (Vygotsky 1931/1997) lies in mutual social interaction, cooperative action and the sharing of cultural and cognitive knowledge among actors (Karppinen 2005, 2008a, 2008b; Kinnunen et al. 2003; Kurki 2000, 2010; Säljö 2004). From the educational perspective, the most important element is constructing knowledge through social interaction. In our study, the cultural impact appears in varied ways of perceiving the issues, depending on the different discipline paradigms (physics, drama and crafts) represented by us as educators and authors.

Sociocultural animation originated from voluntary work (Foth 2006; Kurki 2000, 11). As part of the '*education populaire*' of social pedagogy, it started in the 1960s, spreading out to many scientific areas and mainstream education (Karppinen 2005; Kurki 2000; Wallenius 2009). Animation (see Figure 1) is a movement of pedagogic thinking, social creativity and equal participation (Kinnunen et al. 2003; Kurki 2000, 11–12; Smith 2009); in the pedagogic frame, it aims for individuals to become conscious of the possibilities to influence their lives, development and learning (Karppinen 2008b; cf. Henderson 2001).

The term *animation* originates from the film and computer graphics industries, which 'animate' virtual characters and cartoons; the term is also used to describe the acts of encouraging, motivating, involving, empowering and engaging human beings (Foth 2006). Ontologically, the animation concept derives from the Greek/Latin *anima*, which means 'life' or 'soul' and 'to give life to, make alive', 'to encourage', 'to motivate' and 'to set in relation to' (Webster's Encyclopedic Dictionary 1994). It indicates an active process that is not dominated according to hierarchy, but gives participants responsibility in the creation of an action (Kurki 2000, 74–75). According to Kurki (2000, 74), the motive of a holistic activity lies in solidarity towards the group, which furthers cooperation and raises the spirit of inquiry-based action.

The wider frame of sociocultural animation is based on empowering individuals to gain independence and step out of their comfort zones, strengthening and developing their skills of working in groups, and construing knowledge in social interaction (see Figure 1). In the best cases, this will enable individuals to face a range of problems as thought-provoking challenges and inspire them to search for creative solutions (Karppinen 2008b). An *animated* person is willing to find new ways to learn and also has the ability and courage to initiate new processes.

Figure 1. Frame of sociocultural animation (Karppinen 2008a).

Animators have always existed, even though they have not been considered as such, for example, when encouraging the mutual inspiration of teachers. The teacher's role as an animator varies, including that of a guide, leader and co-learner (Kurki 2000), as well as a negotiator (cf. Husu and Toom 2010). An animator follows the whole process and inducts students into a dialogue. An animator is required to have the abilities to listen, perceive, observe and become animated by others' thoughts and actions. A sense of community and mutual inquiry-based action may arise if the teacher is able to take the students' experiences, opinions and thoughts into account. This means that the teacher is also willing to attend and accept the processes initiated by the students (Karppinen 2005, 2008b). However, the teacher is responsible for the educational activity and keeps an eye on the situation. Active animators breathe life into situations and help build environments and relationships in which people can grow and care for each other (Smith 2009).

The excitement of an animated person (e.g., student or teacher) appears in one's willingness to act, experience and inquire when facing problems, for example. The problems emerge more like interesting challenges than obstacles, which increases the *initiative* (a concept adapted by Arendt in 1958) and sensibility to start new processes. The tasks of animation in this study performed by the educators as animators are directed at urging the student teachers to experiment with varied ways of learning, find creative links (among elements of physics, crafts and drama) and step out of their comfort zones, as well as to guide them to think independently and creatively.

Appearance (a concept adapted by Arendt in 1958) means acting in a social place among people or interacting with them. *Appearance* demands the *initiative* to express oneself to other people (Karppinen 2008a). An “active” orientation views people as subjects and active agents (Smith 2009). In this orientation, student teachers focus on the environment, one another and their interaction to make sense of themselves and the world – and to act (Smith 2009). This demands reflections on one’s own actions and attitude towards interaction with others. In this method, thinking and acting change through the active learning process of planning an educational game.

Educational gaming

Gaming and playing are natural parts of every child’s growth process. Children learn the lessons needed in real life by imitating them in improvised games. Different games with specific rules also teach us useful skills and contents. This particular game-based learning approach is new to educational settings (Johnson et al. 2010). The approach involves using games as a pedagogic tool in learning (Rieber 1996). The range of this approach covers both simple paper-and-pencil games and role-playing games, both digital and non-digital (Johnson et al. 2010). Using educational games makes learning multidimensional; its cognitive (Bergen 2002), social, emotional, physical and cultural aspects (Wood and Attfield 2005) are activated. According to Gee (2003), game playing can be understood as a form of situated learning, which is why the game-playing environment facilitates active critical thinking. Playing is often a social event; many games are played together, which increases participatory learning (Kangas 2010). Playing feeds creativity and imagination (Kangas 2010; Poling and Hupp 2009). Playing games can achieve better results in learning content knowledge (Klisch et al. 2012). Moreover, higher-level knowledge and skills are supposed to be more easily achieved by learners (van Eck 2007).

Playing games feeds learners through higher-order cognitive activities (Pivec and Dziabenko 2004). Thus, game playing is also understood as an original medium for learning (Sefton-Green 2003). In this study, educational gaming has two functions. Firstly, the student teachers design the game and learn multidisciplinary teaching and also widen their content knowledge about the concept of energy. Because the game planning is implemented through sociocultural animation, it is assumed that game designing will also bring these positive effects, such as better learning outcomes, participatory learning and active critical thinking. The second function of educational gaming is the actual gaming of the pupils in the school, but this aspect is not within the focus of analysis in this study.

The current focus is on digital educational games (see e.g., Kangas 2010; Klisch et al. 2012); however, Smith and Munro's (2009) educational card games and Frantz-Pittner, Grabner, and Kern's (2011) problem-based puppet science represent non-digital types. The energy game developed in this study belongs to the non-digital group; it was played on a large, physical board.

Implementation

The study was conducted during the pre-service primary teachers' (future teachers of grades 1–6) advanced course in physics education. Altogether, 12 second-year student teachers participated in this optional course, which aimed to teach and learn the concept of energy in physics by integrating physics teaching with crafts and drama. The three educators of the pre-service course belong to the staff of the university and are also the authors of the present article. The main target of the course was to develop an educational energy game that the participants would plan and implement for 10-year-old fourth graders in a comprehensive school.

The concept of energy was chosen as a course topic because it covers all the fields of phenomena in physics, so it would revise and deepen the content of the earlier compulsory physics course in class teacher education. The wide scope of the concept would also make it possible to find suitable aspects for multidisciplinary teaching with drama and crafts. Learning natural sciences is considered relatively difficult by high school students, and many teachers also find it difficult to teach (see e.g., Gardner 1998; Gunstone, Mulhall, and McKittrick 2009). Some special concepts in physics are particularly challenging to perceive as a whole. Energy is one of the most abstract concepts because the topic is so broad. In fact, several different forms of energy differ from one another but together construct a major concept (Kurki-Suonio and Kurki-Suonio 1994, 275). Thus, it is difficult to answer unambiguously and comprehensively what energy means. However, the concept of energy belongs to the essential content of Finland's national curriculum of basic education in classes 1–6 (Finnish National Board of Education 2014).

Crafts touch on many disciplines and scientific areas, such as psychology, economics, natural sciences, technology, culture and the social environment (Anttila 2006). There are natural interconnections between the core elements of crafts, technology and the natural sciences (e.g. Hast 2011; Viilo, Seitamaa-Hakkarainen, and Hakkarainen 2011), so a craft activity can be straightforwardly linked to everyday life, as we have tried to present with this course project and study. These elements and their interconnections just have to be discovered by students and student teachers. The national curriculum of basic education (Finnish National Board of Education 2014) guides crafts education for multi-materialism, crafts expression, design, technology use and interdisciplinarity.

Drama education has been seen as a flexible method for integrating the teaching and learning of different subjects. Braund (2015) sees socio-cultural approaches and views as fundamental and argues that using drama methods helps children to understand the nature of science and science's relationship with society. Ødegaard agrees and states that conceptual understanding is advanced through the use of drama (Ødegaard 2001; 2003). Heikkinen (2002) has also argued that drama can be used as a method for teaching and learning cultural themes and issues.

The course was implemented in the following pedagogic phases: 1) Familiarising the students with and deepening the content to be learnt, that is, the concept of energy from the standpoint of physics (physics educator). The concept of energy was discussed from the different standpoints of everyday life. The goal was to clarify and differentiate the scientific concept of energy (e.g. kinetic energy) from the expressions used in everyday language (e.g. girl energy). 2) Presenting examples of multidisciplinary teaching of the concept of energy with physics, crafts and drama (physics, crafts and drama educators). In the physics example, energy was approached through an experiment on the thermal conductivity of different materials, e.g. spoons (heat energy). For crafts, a familiar crafts technique, marble painting, was approached from a new perspective through pondering what different forms of energy (mechanical energy) take place when you make a marble painting. In the Big Bang exercise conducted by the drama educator, the student teachers' movements were instructed by following the hypothetical energy transformations between mechanical and heat energy in the Big Bang.

3) Planning the functional or experimental tasks for the energy game (student teachers). In this phase the students planned multidisciplinary tasks that approached energy from different perspectives, as in phase 2. One such multidisciplinary task was to felt small pieces of textiles for potholders and to

discuss their purpose, the insulation of heat energy, with the pupils. The tasks were also evaluated and discussed together. 4) Planning the teaching model, that is, the energy game (student teachers). The student teachers created the roles and the board for the energy game. 5) Playing the energy game in the school (student teachers). The students developed the energy game for a class of fourth graders (10-year-olds). 6) Concluding with a discussion about the final version of the game (all).

Methods

Because the study includes multi-level cooperation and planning, carrying it out utilised the views of developmental work research (Engeström 2001, 2013; Galison 1997; Gorman and Clayton 2005) and the method of the design-research approach (Baumgartner et al. 2003). Collaborative developmental work research means cross-border interaction and trading zones (Galison 1997), which involve a common space, shared objectives, joint language and a mutual exchange beneficial to all participants (Engeström 2013; Galison 1997; Gorman and Clayton 2005), as well as the joy of sharing knowledge with one another. This study follows the themes, ‘the joy of sharing’ and ‘becoming animated’, which mean that the designers have planned the different phases of the study with open minds, keeping the joy of sharing (thoughts and information) as the leading thread in every step of the study.

In design research, the general goal is to unite empirical educational research and the theory-driven design of learning environments (Baumgartner et al. 2003; Juuti and Lavonen 2006). The aim is to find out ‘how, when, and why educational innovations work in practice’, so both parties – designer (we as researchers/educators and student teachers) and practitioner (here, student teachers and school pupils) – play an essential role in the process (Baumgartner et al. 2003, 5). Moreover, the third party, the design artefact (the new teaching model, the energy game in this case), is developed during the cooperation. In this study, the success of the design work is evaluated by answering the second research question about the student teachers' own learning during the course.

The data used in this article was gathered in the form of learning diaries. The student teachers were guided to write personal learning diaries during the course and write about the following topics: 1) their understanding of the concept of energy, 2) their conception of the multidisciplinary teaching of physics, crafts and drama from the perspective of the concept of energy, 3) descriptions of the four game tasks designed in their small group and of their learning during the course. They were asked to reflect on all of the topics. The data used to analyse the learning diaries and present the results of the content analyses were anonymous, so it was not possible to identify any of the student teachers.

The data was analysed in the following way: 1) the learning diaries of the student teachers participating in the course were read several times; 2) different descriptions about learning were selected from the data; 3) similar types of descriptions of learning were classified into the same categories; 4) these classes were named, and their contents were reduced; and 5) classes of similar content were included in the same table, and their common meaning was named. This process followed the general principles of an empirical-based content analysis (Patton 2002; Tuomi and Sarajärvi 2009) and was inductive by nature. This means that the researchers' reasoning process was directly based on the empirical data in the learning diaries (Tuomi and Sarajärvi 2009, 95–100). In the case of the other data, the multidisciplinary teaching model created during the course, a descriptive analysis was performed.

Results

The following sub-sections present the answers to the research questions. As stated in the introduction, the main research question on the impact of the multidisciplinary training course implemented in the spirit of becoming animated on the student teachers' learning outcomes is answered through the sub-questions : 1) What kind of multidisciplinary teaching model did the student teachers produce as an end product of the course? 2) What kind of learning did the student teachers experience during the multidisciplinary course?

Results 1: The energy game as a teaching model

The energy game that the student teachers designed together was played on a large board. One classroom, a corridor and a back room of the school functioned as the space for the game board, where the routes to be travelled were marked with circles and other shapes representing the routes to the task points. The game was played by five teams of pupils. Before the game started, one student teacher gave a short presentation on energy and its different forms, which included a dramatisation by another student acting out different forms of energy. The starting presentation on energy was displayed on the classroom screen, so students could use it as a source of information during the game.

At the starting point, the pupils drew a task card and proceeded along the routes to the task points, where a group of student teachers would direct a task. At each task point, the pupils drew lots to find out the task each group would perform. The tasks typically dealt with different aspects of the concept of energy, integrating physics, craft and drama in experimental and hands-on activities. After finishing a task, each small group was given a certain number of marbles (points) that had to be brought to the scorekeeper at the starting point of the game. The marbles were dropped into each small group's own measuring glass, which was filled with coloured water. Then lots were drawn again to determine where each group would go next. The game took two lessons; later on, the scores for each small group were calculated.

Examples of applying task points in integrative teaching

The following examples from the participants' learning diaries are their own choices of successful task points in the energy game.

The first task point integrated the teaching of physics and crafts:

Our task showed the scientific nature of both subjects, physics and crafts. The pupils made a potholder through which an important theory [of heat energy] could be explained. The pupils designed the potholders themselves, which was a typical part of learning crafts. (P4)

The second task was situated in the interface of drama and physics/chemistry:

At one point, the states of water were taught through drama. Every state, solid/liquid/gas, was modelled by varying the velocity of the particles. The pupils pretended to be molecules and moved according to [each] state [on a specific platform designed for this purpose]; for example, when pretending [that they were] gas, the[ir] movement was very quick. (P9)

The third task point focused on integrating the teaching of drama and physics:

[The] 'living machine' [was used] as a method of drama and energy production and transfer. [The] children presented energy production by acting like living machines. (P3)

Results 2: What kind of learning emerged?

To answer the second research question (What kind of learning did the student teachers experience during the multidisciplinary course?), the student teachers' reflections in their learning diaries were reviewed from the aspect of how they described their own learning process during the course. The analysis uncovered the following three aspects of learning: 1) learning skills, 2) new pedagogic thinking and 3) a change in attitude towards multidisciplinary teaching. These aspects are discussed in detail in the following sub-sections. Although the aspects clearly differed from one another, they partially overlapped, as is typical when classifying broad-based concepts.

Learning skills

The first aspect of learning was the emphasis on different learning skills. Because the practical task of the course was to plan and implement a game that integrated the teaching of physics, crafts and drama, the designing process pushed the student teachers to collaborate to find the best content and practices for the game. The diary entries from the original data (Table 1) showed that some student teachers found the *cooperation* enjoyable and the best aspect of the course and that they appreciated this opportunity to work together. In addition to learning to cooperate, the following specific phrases revealed signs of sociocultural animation in one of the small groups of student teachers. Expressions such as ‘enjoying’, ‘joy’, ‘succeeding’, ‘innovativeness’, ‘courage’ and ‘fellow student teachers were motivated to plan’ were all positive signals of becoming animated during the task and collaboration.

The data also showed that the collaboration particularly facilitated the creation of the multidisciplinary tasks for the game. Second, the skills of focusing on *learning to integrate teaching, and learning to plan, teach and evaluate* this kind of teaching appeared throughout the data. The course participants seemed to appreciate the possibility to deepen the different phases of multidisciplinary teaching to enable all of them to gain experience. The third skill that was found in the analysis involved *understanding* the whole course as a major task of *inquiry-based learning*, where the problem to be solved was how to integrate the teaching of physics, crafts and drama.

Table 1. Learning skills.

New pedagogic thinking

The second analysis (Table 2) focused on the new pedagogic thinking uncovered in the process. The participants often wrote about how the course had affected their pedagogic thinking. First, *teachership and didactic thinking* had *developed* when they were teaching and observing others teaching. Moreover, the meaning of the language used in teaching was found essential. The possibility to experiment on a new and creative working strategy had also helped in developing their teachership and didactic thinking.

Second, the student teachers reported learning about the broader perspective of teaching, such as the principle of ‘from the general to the particular’. Furthermore, *pedagogic processes can proceed in opposite directions*, for example, in physics, concrete observations are converted into models and theories, whereas in crafts, the process begins from an idea that is formed into a concrete product. Third, learning new pedagogic thinking also manifested itself in what the student teachers’ realised or were *pedagogically inspired* by, “creativity needs space but not too much”, and how to make learning “fun or unexpected” in future teaching.

Lastly, the analysis gave strong evidence that the student teachers’ pedagogical thinking had developed from the perspective of the course’s main aim, multidisciplinary teaching. The course had pushed them to deeply consider the purpose of multidisciplinary thinking. One participant clearly expressed the aim: ‘in integrating different subjects, features of varied disciplines should be revealed’. Furthermore, the student teachers learnt that the purpose of integration would be to support learning, not only to add something fun to the lessons. *Deepening one's conception about multidisciplinary teaching* was also perceived in a pupil-centred reflection; the contents of everyday life appeared as an integrated whole to the pupils, not as separate subjects. Moreover, the course had raised the students' awareness of the pedagogical relevance and activation of the tasks created for the game.

Table 2. New pedagogic thinking.

Changing attitudes towards multidisciplinary teaching

The last aspect of learning showed by the content analysis was the change in attitudes towards multidisciplinary teaching (Table 3). This aspect appeared in the form of two sub-categories. First, the student teachers reported their *positive experiences about multidisciplinary teaching* during the course; second, they honestly admitted how their attitude had changed *from criticism to acceptance*. The positive comments mentioned aspects such as the possibility to integrate the teaching of unusual pairs, the positive effect of drama and craft on learning physics, the complete success of the course, their joy in the children's reaction, the possibility to deepen her or his knowledge when integrating different subjects as a teacher, and a decreased prejudice against multidisciplinary teaching. Those who had been critical at the beginning of the course confessed that the openness in implementing multidisciplinary teaching had at first been a negative issue for them, but through the course, they had learnt to tolerate uncertainty better. Moreover, their feeling of being directionless at the beginning of the course had changed to one of joy in creating good tasks that were multidisciplinary in an authentic way. Lastly, the success of implementing the planned energy game in the school and the children's request that they 'come back next year' had shifted the critics' attitude towards understanding the positive meaning of multidisciplinary teaching.

The success of one pedagogic aim of the study, fostering the sociocultural animation of the student teachers, could be observed particularly in the last aspect of learning. Enjoyment, success, delight in an extraordinary course, satisfaction from the children's positive reaction, happiness in the chance to deepen one's learning, joy in the increased encouragement to put one's pedagogical thoughts into action in a more innovative way, and pleasure in the authentic nature of the planned tasks were distinctive features of sociocultural animation among the student teachers.

Table 3. Changing attitudes towards multidisciplinary teaching.

Conclusions

This article presents an effort to increase the comprehensiveness of learning in the education of pre-service primary teachers. Here the impact of a multidisciplinary teaching course was analysed from the perspective of the student teachers' learning outcomes. The study resulted in a new multidisciplinary teaching model, an educational game that the student teachers designed and implemented for a class of fourth graders in a primary school. The game was multidisciplinary by nature and showed the value of the integration of teaching; it enabled the concept of energy to be observed and learnt in a wider scope than is typical. The game's functional and experimental tasks connected the aspects of crafts, drama and physics in an insightful way. Furthermore, the course stimulated many aspects of learning among the student teachers. The analysis uncovered how they had learnt skills and new pedagogic thinking, as well as changed their attitude towards multidisciplinary teaching.

In this study, sociocultural animation took place on many levels. On one hand, the course was planned in close cooperation between the authors and educators in physics, crafts and drama, disciplines that do not normally cooperate. In fact, the whole process of planning the course was based on the sociocultural interaction between us, the educators. The close interaction and collaboration animated us and encouraged us to implement this new kind of experimental course. On the other hand, our role was to act as animators to encourage the student teachers to design a new multidisciplinary teaching model, the energy game. The student teachers inspired one another as well and worked as active agents. Directing the course required strongly motivating the student teachers to start designing the practical teaching experiment. The task was demanding and required much creativity, imagination, cooperation, initiative and sensitivity. Gaming and gamification were shown to fit well with the sociocultural method because it is natural to become animated while playing. The pupils were very keen to play the designed game; in turn, this animated the student teachers, even those who were the most critical at the beginning of the course. At the end of the course, the enthusiasm of the pupils and student teachers strengthened our own animation.

References

Anttila, P. 2006. *Tutkiva toiminta ja ilmaisu, teos, tekeminen* [Reseach-based action and expression, work, making]. Hamina: Akatiimi.

Arendt, H. 1958. *The Human Condition*. Chicago: University of Chicago Press.

Baumgartner, E., P. Bell, S. Brophy, C. Hoadley, S. His, D. Joseph, C. Orrill, S. Puntambekar, W. Sandoval, and I. Tabak. 2003. "Design-based Research: An Emerging Paradigm for Educational Inquiry." *Educational Researcher* 32:5–8.

Bergen, D. 2002. "The Role of Pretend Play in Children's Cognitive Development." *Early Childhood Research and Practice* 4(1). Accessed January 10, 2013. http://ecrp.uiuc.edu/v4n1/bergen.html

Braund, M. 2015. "Drama and learning science: an empty space?" *British Educational Research Journal 41 (1), 102-121*.

Bresler, L. 1995. "The Subservient, Co-equal, Affective, and Social Integration Styles and their Implications for the Arts." *Arts Education Policy Review* 96(5):31–7.

Cantell, H., ed. 2015. *Näin rakennat monialaisia oppimiskokonaisuuksia* [How to Create Multidisciplinary, Study Wholes]. Jyväskylä: PS-kustannus.

Drake, S. M., and R. C. Burns. 2004. *Meeting Standards through Integrated Curriculum.* Alexandria, Virginia: Association of Supervision and Curriculum Development.

van Eck, R. 2007. "Six Ideas in Search of a Discipline." In *The Design and Use of Simulation Computer Games in Education,* edited by B.E. Shelton and D.A. Wiley, 31–60. Rotterdam: Sense Publishing.

Engeström, Y. 2001. "Expansive Learning at Work: Toward an Activity Theoretical Reconceptualization." *Journal of Education and Work* 14(1):133–56.

Engeström, Y. 2013. "Foreword: Formative Interventions for Expansive Learning." In *The Change Laboratory: A Tool for Collaborative Development of Work and Education,* edited by J. Virkkunen and D. Newnham, xv–xviii. Rotterdam: Sense Publishers.

Fernström, P., S. Karppinen, and M. Ojala. 2014. "Eheyttävä oppiminen ja käsityön suunnittelun opetus." ["Unified Learning and Teaching of Designing Crafts"]. In *Suunnittelusta käsin. Käsityön tutkimuksen ja opetuksen vuoropuhelua [Phase of Designing. Dialogue Between Research and Teaching in Crafts.]*, edited by A. Nuutinen, P. Fernström, S. Kokko, and H. Lahti, 100-116. Helsinki: Helsingin yliopisto Käyttäytymistieteellinen tiedekunta. Opettajankoulutuslaitos.

Finnish National Board of Education. 2014. *Luonnos perusopetuksen opetussuunnitelman perusteiksi 2014* [The Draft for the National Core Curriculum of Basic Education 2014]. Helsinki: Finnish National Board of Education.

Foth, M. 2006. "Sociocultural Animation." Accessed February 2, 2015.

http://eprints.qut.edu.au/1909/1/1909_1.pdf

Frantz-Pittner, A., S. Grabner, and T. Kern. 2011. “Fridolins Forschungsabenteuer – Forschendes Lernen in einem narrativen, puppenunterstützten Kontext” [Fridolins Research Adventure - Learning by research at a narrative dolls assisted context]” In *Science Center Didaktik – Forschendes Lernen in der Elementarpädagogik,* edited by A. Frantz-Pittner, S. Grabner, and G. Bachmann, 109–44. Baltmannweiler: Schneider Verlag Hohengehren.

Galison, P. 1997. *Image & Logic: A Material Culture of Microphysics*. Chicago: University of Chicago Press.

Gardner, P. L. 1998. “The Development of Males’ and Females’ Interest in Science and Technology.” In *Interest and Learning. Proceedings of the Second Conference on Interest and Gender,* edited by L. Hoffmann, A. Krapp, K. A. Renninger, and J. Baumert, 41–57. Kiel: Institut fuer die Paedagogik der Naturwissenschaften (IPN).

Gee, J. 2003. *What Video Games Have to Teach us About Literacy and Learning*. New York: Palgrave Macmillan.

Gorman, G. E., and P. Clayton. 2005. *Qualitative Research for the Information Professionals: A Practical Handbook.* London: Facet Publishing.

Gunstone, R., P. Mulhall, and B. McKittrick. 2009. “Physics Teachers’ Perceptions of the Difficulty of Teaching Electricity.” *Research in Science Education* 39(4):515–38.

Hast, M. 2011. *Konstruktio käsityön teknologiasta: analyysi- ja tulkintaprosessi teknologiasta yleissivistävän käsityön oppiaineen osana* [Construction of technology in crafts: analysis and interpretation of technology as part of crafts subject in basic education]. Acta Universitatis Lapponiensis 208. University of Lappland: Rovaniemi 2011.

Heikkinen, H. 2002. Draaman maailmat oppimisalueina: draamakasvatus vakava leikillisyys [Drama education and serious playfulness]. *Jyväskylä studies in Education and Social Research. University of Jyväskylä. Scientific Dissertation.*

Henderson, J. G. 2001. *Reflective Teaching: Professional Artistry Through Inquiry*. Upper Saddle River, N.J.: Merrill/Prentice Hall.

Husu, J., and A. Toom. 2010. "Opettaminen neuvotteluna – oppiminen osallisuutena: opettajuus demokraattisena professiona" ["Teaching as Negotiation – Learning as Participation: Teachership as Democratic Profession"]. In *Akateeminen luokanopettajakoulutus: 30 vuotta teoriaa, käytäntöä ja maistereita*, edited by A. Kallioniemi, A. Toom, M. Ubani, and H. Linnansaari, 131–146. Jyväskylä: Suomen kasvatustieteellinen seura.

Järnefelt, H. 2007. "Luovia opetusmenetelmiä ja uusia oppimisympäristöjä" ["Creative Teaching Methods and New Learning Environments"]. In *Luovuuspedagogiikka*, edited by M-L. Visanti, H. Järnefelt, and P. Bäckman, 51–65. Helsinki: Educational Board of Finland.

Johnson, L., R. Smith, A. Levine, and K. Haywood. 2010. "2010 Horizon Report: K-12 Edition." Austin, Texas: The New Media Consortium. Accessed January 11, 2013. http://www.nmc.org/pdf/2010-Horizon-Report-K12.pdf

Juuti, K., and J. Lavonen. 2006. “Design-based Research in Science Education: One Step Towards Methodology.” *Nordina* 4:54–68.

Kangas, M. 2010. “Creative and Playful Learning: Learning through Game Co-creation and Games in a Playful Learning Environment.” *Thinking Skills and Creativity* 5:1–15.

Karppinen, S. 2005. “What Does Art Make from Craft? Conceptual Analysis of Basic Crafts Education.” Research Report 263. Helsinki: University of Helsinki.

Karppinen, S. 2008a. “Craft-art as a Basis for Human Activity.” *The International Journal of Art & Design Education* 27(1):83–90.

Karppinen, S. 2008b. “Innostamisen pedagogiikkaa käsityössä ja taiteissa” [“Socio-cultural Animation in Crafts and Arts Education”]. In *Nuoret ja taide – ilolla ja innolla, uhmalla ja uholla. Kirjoituksia murrosikäisten taito- ja taidekasvatuksesta*, edited by S. Karppinen, I. Ruokonen, and K. Uusikylä, 101–11. Helsinki: Finn Lectura.

Karppinen, S., Kallunki, V., Komulainen, K. and Kairavuori, S. Forthcoming. "Opetuksen integroinnin ja eheyttämisen dilemma yliopistopedagogiikassa" ["The dilemma of integrating and unifying teaching in university pedagogy"]. *Yliopistopedagogiikka.*

Karppinen, S., K. Komulainen, V. Kallunki, S. Sintonen, and A. Kaasinen. 2012. “Reflecting Concept of Design Learning in Collaborative Development Work – Towards Integrative Teaching Practices in Finnish Teacher Education.” *Lifelong Learning in Europe* 4/2012. Accessed June 10, 2015. http://www.lline.fi/en

Karppinen, S., V. Kallunki, S. Kairavuori, K. Komulainen, and S. Sintonen. 2013. “Interdisciplinary Integration in Teacher Education.” In *Interaction in Educational Domains,* edited by K. Tirri and E. Kuusisto, 149–58. Rotterdam: Sense Publishers.

Kinnunen, P., L. Penttilä, J. Rantala, K. Salonen, and T. Tervo. 2003. *Innostuskirja. Nyt. Sosiokulttuurisen toiminnan polunpäitä* [Book of enthusiasm. Now.] Vantaa: Opintokeskus Kansalaisfoorumi.

Klisch, Y., L. Miller, S. Wang, and J. Epstein. 2012. “The Impact of a Science Education Game on Students’ Learning and Perception of Inhalants as Body Pollutants.” *Journal of Science Education & Technology* 21(2):295–303.

Koskenniemi, M., and K. Hälinen. 1970. *Didaktiikka lähinnä peruskoulua varten* [*Didactics for Schools*]. Keuruu: Otava.

Kurki, L. 2000. “Sociocultural Animation in Learning” *Lifelong Learning in Europe* 5(3):162–67.

Kurki, L. 2010. “Nuorisokasvatus sosiokulttuurisen innostamisen kehyksessä” [“Youth Education in the Frame of Sociocultural Animation”]. In *Nuorisokasvatuksen teoria: perusteita ja puheenvuoroja*, edited by E. Nivala and M. Saastamoinen. Nuorisotutkimusseura/Nuorisotutkimusverkosto. Julkaisuja 73. Helsinki: Nuorisotutkimusverkosto.

Kurki-Suonio, K., and R. Kurki-Suonio. 1994. *Fysiikan merkitykset ja rakenteet* [Meanings and Structures in Physics]. Helsinki: Limes ry.

Ødegaard, M. 2001. “The drama of science education. How public understanding of biotechnology and drama as a learning activity may enhance a critical and inclusive science education.” PhD diss., University of Oslo.

Ødegaard, M. 2003. “Dramatic science. A critical review of drama in science education.” *Studies in Science Education 39 (1), 75-101.*

Patton, M. Q. 2002. *Qualitative Research & Evaluation Methods.* Thousand Oaks: Sage.

Pivec, M., and O. Dziabenko. 2004. “Game-based Learning in Universities and Lifelong Learning: ‘UniGame: Social Skills and Knowledge Training’ Game Concept.” *Journal of Universal Computer Science* 10(1):14–26.

Poling, D. A., and J. M. Hupp. 2009. “Active Learning through Role Playing.” *College Teaching* 57(4): 221–226.

Puurula, A. 1999. “Taideaineiden opettaja monikulttuuriseksi muuttuvassa koulussa” [“Art Teacher in Multicultural School”]. In *Moni- ja interkulttuurinen taidekasvatus*, edited by A. Puurula. Studia Paedagogica 21. Helsinki: University of Helsinki.

Rantala, J., J. Salminen, and J. Säntti. 2010. “Teorian ja käytännön ristiaallokossa – luokanopettajankoulutuksen akatemisoituminen ja sen heijastuminen opettajaksi opiskelevien praktisiin valmiuksiin” [”Tension between theory and practice in class teacher education”]. In *Akateeminen luokanopettajakoulutus: 30 vuotta teoriaa, käytäntöä ja maistereita*, edited by A. Kallioniemi, A. Toom, M. Ubani, and H. Linnansaari, 51–76. Jyväskylä: Suomen kasvatustieteellinen seura.

Rieber, L. P. 1996. “Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games.” *Educational Technology Research and Development* 44:43–58.

Sarkar Arani, M. R. 2008. “Japan’s National Curriculum Reforms: Focus on Integrated Curriculum Approach.” Accessed June 10, 2015. http://files.eric.ed.gov/fulltext/ED505389.pdf

Säljö, R. 2004. *Oppimiskäytännöt. Sosiokulttuurinen näkökulma* [Learning Practices. A Sociocultural View]. Helsinki: Sanoma Pro Oy.

Sefton-Green, J. 2003. “Informal Learning: Substance or Style?” *Teaching Education* 4(1):37–52.

Simola, H. 1988. *Kognitiivinen oppimiskäsitys, opettajien täydennyskoulutus ja koulun todellisuus* [Cognition, Teachers’ In-service Education and Reality of School]. Raportti elämänkatsomustiedon opetuksen kehittämiskokeilusta Vantaalla 1985–87. Turun yliopiston Kasvatustieteiden tiedekunta. Julkaisusarja A: 126. Turku: University of Turku.

Smith, D. R., and E. Munro. 2009. “Educational Card Games.” *Physics Education* 44(5):479–83.

Smith, M. 2009. “Animateurs, Animation, Learning and Change.” Accessed February 4, 2015. http://infed.org/mobi/animateurs-animation-learning-and-change/

“Syllabus of Class Teacher Training, 2014–2015.” University of Helsinki. Accessed February 12, 2015. https://weboodi.helsinki.fi/hy/

Tuomi, J., and A. Sarajärvi. 2009. *Laadullinen tutkimus ja sisällönanalyysi* [Qualitative Research and Content Analysis]. Helsinki: Kustannusosakeyhtiö Tammi.

Uusikylä, K., and P. Atjonen. 2005. *Didaktiikan perusteet* [Basics of didactics.] Helsinki: WSOY.

Viilo, M., Seitamaa-Hakkarainen, P., and Hakkarainen, K. 2011. Infrastructures for technology-supported collective inquiry learning in science. In *Orchestrating inquiry learning: Contemporary Perspectives on supporting scientific inquiry learning.* Edited by Littleton, K., Scanlon, E., and Sharples, M. London: Routledge, p. 128-145 18 p.

Visanti, M-L. 2007. “Lähteen osahankkeiden innovatiivisia malleja ja vakiinnuttamisen haasteita.” In *Luovuuspedagogiikka* [*Creative Education*], edited by M-L. Visanti, H. Järnefelt, and P. Bäckman, 42–50. Helsinki: Educational Board of Finland.

Vygotsky, L. S. (1931) 1997. “The History of the Development of Higher Mental Functions.” In *The Collected Works of L. S. Vygotsky (Vol. 4),* edited by R. W. Rieber. New York, NY: Plenum.

Wallenius, T. 2009. “Sociocultural Animation in Youth Work. Survey of Sociocultural Animation in the Work of the Youth Coordinators in Districts of Finnish Red Cross.” Final Project for Bachelor of Social Services, Helsinki: Metropolia University of Applied Sciences. Accessed February 2, 2015. http://publications.theseus.fi/bitstream/handle/10024/4679/Sociocultural%20animation%20in%20youth%20work.pdf?sequence=1

Webster’s Encyclopedic Unabridged Dictionary of the English Language. 1994. New Revised Edition. Rh Value Publishing.

Wood, E., and J. Attfield. 2005. *Play, Learning and the Early Childhood Curriculum.* London: Paul Chapman.

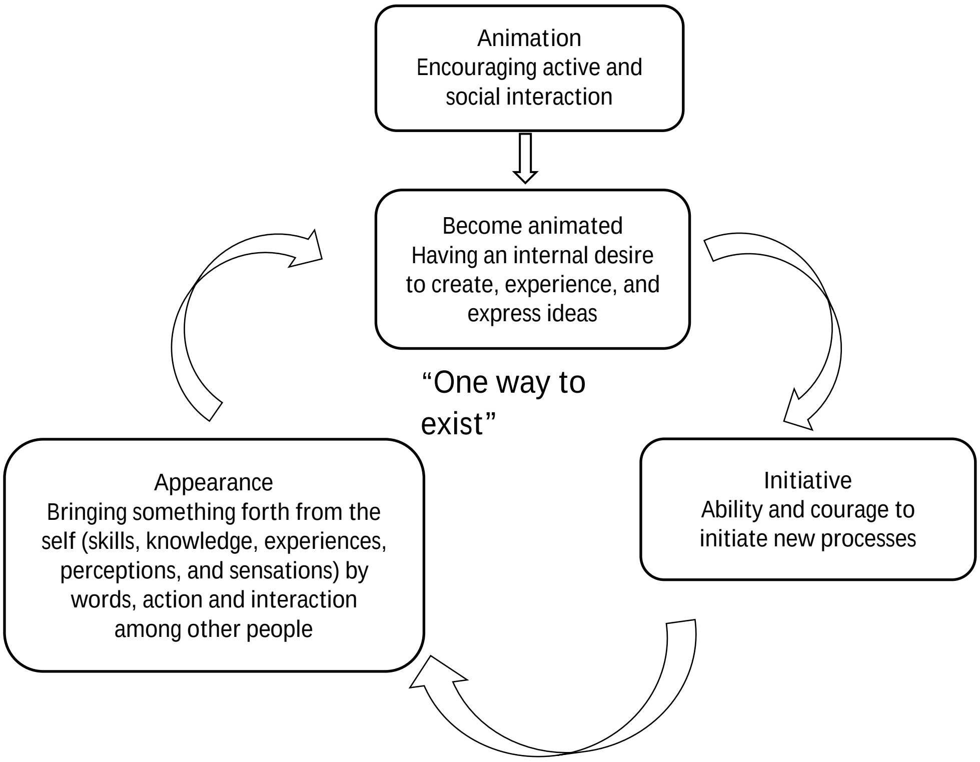

Figure 1. Frame of the sociocultural animation (Karppinen 2008a).

Table 1. Learning skills.

Original data	Reduced expression	Meaning
I learnt about cooperative skills. P1 I have never before enjoyed collaboration this much. We experienced joy, success, debate and innovativeness. We had the courage to be creative, and everybody could express his or her own ideas, so we designed interesting points for the game. P6 […] the finest [aspect] was that fellow student teachers were motivated to plan the given tasks together. This made it possible [to obtain] a good result that was meaningful for students. P2 When I planned the game, I learned mostly about collaboration and the difficulty of integrative teaching. I also learned that integrative teaching succeeds even with not so common pairs, such as physics and drama, or crafts and physics. P4 The goal of integrative teaching is also to learn, not only to have fun. You have to have enough time, and multiprofessional team work is recommended. P5	*Learning cooperative skills* *Meaning of cooperation*	Learning skills
I learned to manage planning and evaluating that relates to integrative teaching. P6 I learned things about integrative teaching and energy; I was trained in how to plan and teach functional tasks. P8 The greatest learning experiences arose from real teaching actions, planning of them and reflections [on] what we created and did. P9	*Learning to integrate teaching* *Learning to plan, teach and evaluate*	
I just found how inquiry-based learning related to this course. The whole course involved inquiry-based learning, so planning the game was part of the process inquiry-based learning. In the beginning, there was the problem of how to integrate the teaching of physics, crafts and drama […]. During the planning, there appeared many new questions that had to be answered in order to answer the original problem [...]. We all worked as a group of experts. P3	*Understanding inquiry-based learning*	

Table 2. New pedagogic thinking.

Original data	Reduced expression	Meaning
It was nice to see fellow student teachers acting as teachers […]. I gained new perspectives on acting in a teacher's role. P2 These kinds of acts challenge student teachers to consider what really develops [their] students' thinking. In the future, these kinds of challenges [will be] easier to solve. P2 I woke up to the fact that it is not completely meaningless how you [the teacher] use concepts. It is essential for the teacher to take notice of her or his own linguistic expression. It can sound like quibbling, but how difficult it can be to correct the misconceptions of the students. The aim of the sciences is to develop children's thinking so that the misconceptions would decrease. P5 I [learned] a lot from this kind of working strategy [...], as well [as] [...] something new regarding subject specifics and pedagogic thinking. P11 [...] the implementation of the course itself [gives] rise [to] a lot [of] pedagogic pondering. I greatly respect the possibility we had to experiment [on a] new and creative working strategy and [the] freedom [...] given to us, even from the beginning, to create a game. P11	*Develop teachership and didactic thinking*	New pedagogic thinking
I cannot [perform] properly if I do not know the big picture. I realize that the same thing goes for every planning of teaching. First, there is the national core curriculum, then [the] local curricula of municipalities and schools […]. From general to particular [...]. P3 In the case of physics also, you do experiments with concrete tools, but at least, it is [equally] important to create models and theories about the world. A concrete reaction and an observation in an experiment are converted into an abstract theory. In crafts, the complete opposite happens; an idea is transformed into a concrete object. P3	*Understand the opposite directions of different pedagogic processes*	
I had a pedagogic inspiration; it is worth giving space for students' creativity but not too much. P3 Perhaps, the idea of the task was not to give [a] ready example [of how] to use [the] energy game in future teaching but ideas and an example of ways to make learning fun and unexpected. P5	*Pedagogic inspiration*	
One student teacher said that drawing a bear in [a] biology lesson is not enough for integrating biology with visual arts. In integrating different subjects, features of varied disciplines should be revealed. I think our point [was that] we managed to make these visible (physics and crafts). By using a felt potholder, an important physical theory could be explained, and creating [one's] own visual image on the table mat belongs to craft teaching. P4 I see integration of teaching strengthening learning because things in students' everyday life are not existing as separate subjects; situations will be handled as [an] overall holistic action. P6 The approach of [the] integrative teaching game [is] very clear through the game; in creating [the] game questions, we should constantly keep in mind the pedagogically relevant and activating ones. This is a real challenge in planning integrative teaching [...]. P7	*Deepening one's conception about multidisciplinary teaching*	

Table 3. Changing attitudes towards multidisciplinary teaching.

Original data	Reduced expression	Meaning
I learned that it is possible to integrate teaching also in not so usual pairs, such as physics and drama, or crafts and physics. P4 I think that craft as a content and drama as a method enrich teaching the energy topic and may make it more interesting for students if compared to traditional approaches of teaching physics. P9 I have never before enjoyed collaborating this much. We experienced joy, success, debate and innovativeness. We had the courage to be creative, and everybody could express his or her own ideas, so we designed interesting points for the game. P6 All things considered, my expectations for the course were fulfilled, and everything was successful although I didn’t expect anything like this. P2 According to the children, the game was fun and a didactic whole, which can be interpreted as direct feedback about our success. P4 I have always thought that to integrate different subjects, a teacher must fully master all subjects. However, the fact is that no teacher hardly feels to be very good in all contents of every subjects. Thus, integrative teaching is important for the teacher, too, for she or he gets an opportunity to deepen her or his knowledge of those subjects that are intended to be integrated. At least, when thinking about the contents of the integrated subjects and pedagogic thinking in general, I felt I gained a lot from this kind of working strategy. P11 After this course, I have less prejudice against integration of subjects. I got encouragement for putting my pedagogic thoughts into action in a more innovative way. I feel that we followed the curriculum in every point of the game and strengthened the development of the students’ knowledge. P6	*Positive experiences about multidisciplinary teaching*	A change in attitude towards multidisciplinary teaching
In the beginning, the course seemed to be too out of control because the task was so open. Perhaps it is natural in this kind of method, and you have to tolerate the uncertainty. P5 After the groping in the beginning, all groups of student teachers started to create good tasks for the game, which were integrative in an authentic way. I was very happy with our tasks. P8 Although we criticized the course a lot, we felt much better after getting very positive feedback from the children: “Come back next year!”. The positive feedback was absolutely the most significant for us! P3	*From criticism to acceptance*	