Drama in chemistry education

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Drama can be used to engage students with nature of chemistry and Education for Sustainable Development or ESD. Drama utilizes stories of science that can communicate discoveries and controversy in chemistry and society. Drama includes role play which provides a framework for, or leads to, debate and discussion about ethical and moral issues that need to be addressed in ESD. This article describes and gives examples of how drama is used in chemistry education.

Introduction

Students can have a positive impact on their living environment by using skills and knowledge of chemistry. However, this requires understanding of how science and society interact. The interaction between chemistry and society is highlighted in chemistry education in topics of nature of science and education for sustainable development, or ESD. One engaging and multifaceted approach to promote understanding of nature and chemistry and ESD is drama (Eilks, 2015). Drama is based on dramatic processes such as role play, mime, dance, storytelling etc., and imagination, which grant access to phenomena that would otherwise be impossible to enact in science lessons. These imagined situations can then illustrate chemical phenomena or social situations in chemistry (Dorion, 2009).

Drama utilizes storytelling. Through storytelling, an imagined world is enacted that can communicate about concepts, discoveries and controversies of chemistry that are crucial in understanding the nature of science. Learning from stories is familiar from everyday life as we are surrounded by them (books, movies, plays) since childhood. History of science provides a remarkable source for stories that can be transformed into all sorts of drama processes ranging from improvisation to structured plays. (Ødegaard, 2003)

Drama utilizes role play. Extended role plays have been a frequently reported drama process which has been used in ESD. Role plays enable a framework for, or leading to debates and argumentation (McSharry & Jones, 2000). The advantage of role plays is that they enable discussion about sensitive moral and ethical issues. The role initially gives some shelter and distance from the topics before addressing these issues in more personal level. Instead of win or lose debates, drama can be used to enact a role play about consensus-seeking and decision making, where students work together to reach a solution. This type of drama supports listening skills and perspective taking (Colucci-Gray, Camino, Barbiero, & Gray, 2006). Enacting unfamiliar roles and situations can increase students' self-awareness as the reactions and emotions of the character arise from unconscious cognitive processes of the student and reflecting on these reactions and emotions afterwards becomes a source of learning about self.

The essential characteristics of drama are that it engages and promotes dialogue (Dorion, 2009). Drama enables versatile communicative episodes in science education, which has been traditionally dominated by teacher led discussion (Wells & Arauz, 2006). Promoting student talk in science lessons is important, because students make meaning of concepts through collaborative discussion (Lemke, 1990). In drama, students can explore different ways of talking. A role play provides a distance, through which a student can talk like a chemist or try out sustainable and unsustainable actions without risk of immediate social stigma. In addition, drama gives opportunities of success and recognition for students, who are disadvantaged or marginalized in the normal science education. A number of studies of drama in science education often report student engagement and an increase in motivation and attitude towards science. (See e.g. Dorion, 2009; McSharry & Jones, 2000; Ødegaard, 2003).

Dorion (2009) suggests two strategies for drama in science education based on physical simulations and societal simulation, which are often extended role plays. Physical simulations illustrate science phenomena and promote knowledge of chemistry. Societal role plays, in turn, illustrate the interplay between science and society and enable exploring different perspectives in the society. These role plays provide understanding of societal interaction that is useful for example if students are to use their knowledge of chemistry for a positive impact in their living environment. Both strategies are elaborated in the following chapters.

Illustrating scientific phenomena with drama

Different characteristics of scientific phenomena are simulated through role play, mime and dance (Dorion, 2009). Simulations are based on rules that guide action. The aim of simulations is that interaction enabled by the rules reveals or illustrates something not apparent just by looking at the rules. In drama students are also part of simulation instead of just being observers. During participation in the physical simulation, students are activated to reconceptualize their prior knowledge in order to illustrate the scientific phenomena (Ødegaard, 2003).

Participating in drama provides metaphors or analogies that support communicating and the learning of science (Dorion, 2009). Teacher can support students' initial understanding by comparing the similarities and differences of the physically enacted physical simulation to the scientific model. The drama in a scientific phenomenon functions as a foundation for understanding, not as a replacement of scientific explanation. Using metaphors is necessary because students might not have prior experiences on the abstract concepts of science that are being learned. Imagination is the only limit for phenomena that can be enacted with drama. For example it would be possible to engage with systemic models in sustainability through drama although this has not been reported in chemistry education research. The following example of physical simulation is drawn from chemistry.

Dance of matter is an example of how to learn about states of matter in chemistry through drama. In a Dance of matter -activity, classroom is reorganized by moving tables and chairs to the side in order to have enough space for an imaginary container. The students play the role of particles and teacher gives them the movement instructions that resemble the way particles move. The scientific description of solid, liquid and gaseous states of matter includes descriptions of the way particles move, which makes the comparison between the scientific model and the model enacted with students possible. Students are instructed to go into the container and form a solid, which means that students are closely packed, they can vibrate but they cannot move freely. Forces between particles can be illustrated by hands that are placed to other students' shoulders. Teacher instructs that energy is added to the container. This can be done verbally or by using a metronome, where frequency indicates the energy level. The addition of energy means that students form a liquid and can start to move past each other, but still remain in close proximity with each other. Teacher instructs that more energy is added meaning that students now form a gas. Students can now move freely within the container. In every addition of energy the energy of student movement increases. Teacher can also remove energy to get back into the original state. The driving idea behind this activity is that movement and energy connects all entities from atoms to people. This activity enables students to actively think about and express concepts on different states of matter and their relation to energy. The experience about drama and these concepts are reflected afterwards to support learning of the science concepts.

Learning through drama emphasizes the role of body in the science learning process. This aligns with theory of embodied cognition that sees the mind and body as intertwined and as influencing each other. Embodied cognition is still an emergent approach in science education, but some recent studies such as the one conducted by Kontra, Lyons, Fischer and Beilock (2015) report that physical experiences with angular momentum enhance student performance in post-test on the concept. As a conclusion they suggest the offering of physical experiences early as it supports the thinking processes that follow.

Societal role plays in chemistry education

Education for sustainable development and drama share the purpose of preparing students not only with knowledge but also the capability to take action. Indeed, societal discourse can be understood, and is sometimes referred to, as a stage of its own. On this stage, different actors furiously try to support their own causes. Drama methods in science education such as role play (Belova, Eilks & Feierabend, 2015) enables the exploring of the tensions and motives of different actors. Utilizing both drama and science education prepares students to enter that stage as actors equipped with enhanced communication skills and high status scientific knowledge. This combination appears as a prospective possibility in preparing students to take action in the society.

Climate panel –role play is a typical example of societal role play in science education. Preparation for this role play starts by deciding how open instructions are given to the students. Teacher divides different roles to students. The roles can be depicted in role cards or students can do a search about their roles. Detailed role cards enhance the scientific quality of arguments, but limit students own ideas about the topic (Belova et al., 2015). A tension to the drama can be created by selecting roles that can have opposite motives or purposes. For example, critical journalists, environmental ministers, lobbyists, environmental activists, indigenous people, arctic shipping companies and etc. can give their voice to the panel. Students are given some time to prepare before the actual drama begins. This time can be used e.g. to organize the classroom space into "a climate panel". When all is set, a teacher gives a background story to the students to initiate the drama. Teacher can participate and ask questions, but has to keep in mind that their participation influences the amount of students own ideas (Belova et al., 2015). During the drama, students learn about the content by listening to others and by doing their own research and as well practice their interaction skills.

Drama activities can arise strong emotions in students. It is important to notice and discuss these emotions afterwards, because emotions are critically important for learning and psychological health in the classroom (Pekrun & Linnenbrink-Garcia, 2014). In post discussion after drama, students can reflect on the emotions and attitudes of their enacted roles to their own emotions and attitudes in similar situations. This enables developing self-awareness in relation to possible sustainable actions and their influences to other actors in society and hopefully guide students' future actions towards sustainability, while still being sensitive to students own emotions and attitudes.

Finally

While drama is a prospective approach to science education, there is a lack of research on the topic. Therefore, the aim of my dissertation research is to investigate how drama can be utilized in a meaningful way for learning about the nature of chemistry and ESD. Design-based research has been initiated with a survey to science teachers revealing that drama is infrequently used in science teaching and more materials are requested. In order to carve out the essential aspects of both disciplines, experts from drama and science need to sit around the same table. Currently, pedagogical models are being developed in collaboration with drama educators, preservice chemistry teachers and research colleagues. In order to share the results and drama activities, the website below has been established.
https://tiededraamaopas.wordpress.com/.

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References

Belova, N., Eilks, I., & Feierabend, T. (2015). The evaluation of role-playing in the context of teaching climate change. International Journal of Science and Mathematics Education, 13(1), 165–190.

Colucci-Gray, L., Camino, E., Barbiero, G., & Gray, D. (2006). From scientific literacy to sustainability literacy: An ecological framework for education. *Science Education*, 90(2), 227–252.

Dorion, K. R. (2009). Science through drama: A multiple case exploration of the characteristics of drama activities used in secondary science lessons. *International Journal of Science Education*, 31(16), 2247–2270.

Eilks, I. (2015). Science education and education for sustainable development–justifications, models, practices and perspectives. Eurasia Journal of Mathematics, Science & Technology Education, 11(1), 149–158.

Kontra, C., Lyons, D. J., Fischer, S. M., & Beilock, S. L. (2015). Physical experience enhances science learning. *Psychological Science*, 26(6), 737–749.

McSharry, G., & Jones, S. (2000). Role-play in science teaching and learning. *School Science Review*, 82(298), 73–82.

Pekrun, R., & Linnenbrink-Garcia, L. (2014). International handbook of emotions in education. Routledge.

Wells, G., & Arauz, R. M. (2006). Dialogue in the classroom. The journal of the learning sciences, 15(3), 379-428.

Ødegaard, M. (2003). Dramatic science. A critical review of drama in science education. *Studies in Science Education,* 39, 75-102.