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Socio-scientific issues and Citizenship Education: from theory to the classroom

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Often in citizenship education, the theory of citizenship being used and the kind of good citizenship that is promoted, is not discussed. In this article, an epistemic theory of deliberative democracy and group problem solving as CE is argued. These theories are considered suitable for citizenship education as they foster students' autonomy, taking into account an open-ended future. These theories are translated into four educational principles. Furthermore, the content and the organisation of the tasks are defined. Using socio-scientific issues as content is considered relevant to help students understand societal issues.

Keywords: citizenship education, Socio-scientific issues, theory of deliberative democracy

1 Introduction

Education, such as citizenship education (CE), is ideologically driven (Kennedy, 2008; van der Ploeg & Guérin, 2016). Different conceptions of democracy and good citizenship lead to different educational approaches and content. When the underlying theoretical framework, which sets out the direction for the curriculum, is not discussed and justified, we speak of 'hidden curriculum': "Ideology is not always immediately apparent in citizenship curriculum documents. It can be easily overlooked without a deeper examination of the theory behind the recommended practice" (Kennedy, 2008, p. 11). Seldom does a policy maker or researcher openly discuss such a theoretical framework. A good example of this hidden curriculum is the Crick report released in 1998 by the Curriculum Authorities, describing the kind of CE to be made compulsory. A few years later, Crick (2007) acknowledges that the theory underlying this CE was civic republicanism. This hidden goal of the curriculum limits students' and teachers' autonomy as they are only confronted with one idea of democracy and a single conception of good citizenship (van der Ploeg & Guérin, 2016).

Translating a chosen theory of democracy into suitable learning activities is a complex enterprise; several steps have to be taken. Firstly, it is necessary to justify the theoretical framework used in defining citizenship; secondly the demands such a democracy places on citizens need to be detailed. This enables us to define the aims of CE. In order to develop lessons, further constituents that guide this translation have to be defined: educational principles and content. Then, the organisation of the task enables the sequencing of the different phases of the lessons allowing students to work through the content in a logical way. As mentioned by Künzli (2007), the curriculum should ideally construct content in an organised and reflective way and aim to gradually increase its complexity as students progress through the years. The choice of which societal problems to deal with, depends on the context, the school and on student characteristics.

In this article, a deliberative framework of democracy is chosen, with group problem solving as the main competency to be developed in CE, and with socio-scientific issues providing content for CE. Socio-scientific issues are open-ended with no unequivocal or uncontested solutions; expert views regarding such solutions are often contested and opinions are generally divided within society (Day & Bryce, 2011). Such issues call for the integration of different kinds of knowledge, for instance scientific knowledge, understanding, reasoning, moral reasoning and reflective judgement (Zeidler, Sadlers, Simmons & Howes, 2005). The leading questions are: *How can an epistemic theory of deliberative democracy be justified and translated in the classroom? And why are socio-scientific issues so relevant for CE?* In the first part of this article, the chosen epistemic theory of deliberative democracy will be justified and the process of deliberation, with group decision making as its main goal, will be expounded. In the second part, the demands placed by deliberation on citizens' thinking capacities will be described and subsequently translated into four educational principles, drawing on cognitive developmental and educational psychological research. And finally in the third part, socio-scientific issues as content for CE will be discussed and illustrated with an example.

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2 Justification of a theory of deliberative democracy

The chosen theory of democracy should take into account the complexity of reality and its openness, as well as the openness of students' future and stimulate students' autonomy (Benner, 1991, van der Ploeg & Guérin, 2016). Societal issues are complex, controversial and open. An interesting theoretical framework that would fit, is deliberative democracy. If the essence of democracy is collective deliberation and decision making, then in order to make a significant contribution to this, citizens must be able to deliberate on all sorts of issues, to evaluate these, find solutions and ideally reach shared agreements (Goodin, 2008; Kymlickla, 2008). According to this view, group problem solving could be classified as fitting deliberative theories of democracy (Van der Ploeg, 2015). Group problem solving, as an educational approach to CE, is not only linked to proponents of a deliberative democracy, but has also been supported throughout the last century by educationalists such as Dewey, Kohnstamm and has been implemented in the U.S. social studies curriculum, as well as in Politische Bildung in Germany (Van der Ploeg, 2015; van der Ploeg & Guérin, 2016). Black (2012) distinguishes two aspects of deliberation that occur in conjunction: an analytical process and a social process. Both processes are relevant to optimal deliberation; the second, the social process, enables and supports the first, the analytic process. However, even under optimal social conditions, this analytic process can be inadequate (Bächtiger, 2010). This means that improving these social aspects is insufficient to attain the best solution for the problem at hand.

Some advocates of a deliberative democracy argue in favour of enhancing the epistemic quality of the discussion. This entails identifying which cognitive processes hinder deliberation and how such limitations can be overcome. In this context, epistemic quality means that "deliberation should enable one to unravel new evidence, share knowledge and improve existing knowledge and should lead to the most "correct answer", or at least, to the best possible answer to a given collective problem." (Bächtiger, 2010, p. 21). Landemore and Page (2015, p. 3) describe an epistemic approach to deliberation in roughly the same way as Bächtiger: "By epistemic approach, we mean that we are not as concerned about the procedural values attached to consensus—the way consensus expresses respect for other people's interests and judgements for example—or even the instrumental value of consensus that has to do with the generation of a feeling of "belonging" or the reinforcing of a shared identity. We focus instead on the ways in which consensus fosters and indicates better decisions. By better decisions, we mean decisions that are as empirically accurate, socially desirable, and morally correct as possible."

According to Bächtiger (2010), the epistemic quality of discussion will improve by using "productive contestatory techniques" which lead participants of deliberation to deepen their disagreements through argumentation, to search for inconsistencies in others' arguments, to evaluate the validity of claims and ultimately reach a broader understanding of the issue at hand. This means that students should be encouraged to deepen their positions, explicitly discuss their disagreements and share their knowledge thoroughly before embarking on a search for potential solutions and consensus. When consensus is seen as an aim of deliberation, this can give rise to an early and superficial search for common ground, without thoroughly analysing and evaluating disagreements and arguments, avoiding arguments that might lead to conflict, failing to share all information on the issue. The objection raised by Bächtiger (2010), namely that a premature search for common ground may compromise epistemic quality, should be considered when teaching students how to argue during deliberation.

The epistemic variant of deliberative democracy sees the content of the discussion and the epistemic quality of the solution as the goals of deliberation. Offering a setting for students to engage in group reflection with their peers on such issues, increases their autonomy by elaborating their knowledge and by practising their thinking skills. Furthermore, it opens the possibility of discussing this theory of democracy with students and allows them to explore other conceptions of democracy and the concept of a "good citizen" and it teaches them to think and discuss such competing views on democracy and citizenship (Van der Ploeg, 2015; van der Ploeg & Guérin, 2016). Now that the theoretical framework for CE has been chosen and justified, I will first consider the thinking skills citizens require in order to deliberate, then I will proceed to discuss the implications for education. In order to define these thinking skills, I will theoretically describe the ideal process of a deliberation, thereby identifying the steps taken before and during deliberation.

2.1 The process of deliberation

Citizens may deliberate on issues ranging from political to environmental, from local to (inter)national. The goal of such deliberation is to solve problems together and make a decision. Conceivably, the outcome of such deliberation might be that opinions and judgements are irreconcilable and that no consensus is attainable. In this case, citizens have to reach a consensus on how to deal with such differences or to choose aggregative forms of decision making, as suggested by Landemore and Page (2015). The epistemic theory of a deliberative democracy and group problem solving made it possible to define the kind of thinking abilities to be developed and to identify educational principles to guide teachers in developing learning activities for students.

2.1.1 Preparing for deliberation

Deliberating with others entails that individuals are able to justify their point of view on the issue in such a way that others can understand them (Gutmann & Thompson, 2004). There are two requirements: (a) taking a position on the issue and (b) their ability to explain it to themselves and others, even to strangers. Let us examine (a) and (b) more closely. Participating in a deliberation should lead one to reflect on and be able to justify one's own position. Reasons behind opinions need to be made explicit. One engages in evaluating and judging one's own reasons – are these supported by evidence and/or can they be organised and structured as a logical set of arguments? Is there a need for new or further information or evidence? If so, this must be gathered and evaluated to determine its credibility and adequacy. The new information must be interpreted, analysed and evaluated, inferences have to be made and integrated within the argumentation. This process can give rise to improving, revising or changing one's earlier position. The amount of preparation may vary of course, be it the search for additional information or the examination of one's own argumentation. This depends on the complexity of the issue and the level of one's relevant knowledge and expertise, the willingness to do so and the time available. During this process, citizens can take their time to think things through, or choose not to do so. Therefore, they can reason at their own pace and level, practicing internal deliberation.

2.1.2 Explaining one's own position

Once the actual group deliberation commences, there is less time to think and individuals also have to respond to others' reasoning: citizens must react to others' positions, give counter-arguments, deal with others' reactions to their own position and react to these. But first of all, each member should be ready to explain their position. This means they must tailor their explanation and the level of complexity to fit what other members of the group can handle. This evaluation depends on the complexity of the issue and the level of knowledge one believes others possess. Therefore, if a person presents an argumentation too complex for other members to grasp due to their lack of relevant knowledge, then further explanation is called for. This demands an ability to tailor one's explanation to the required level, as well as some degree of pedagogical insight, which is not always easy when dealing with complex issues. Moreover, the issue must often be deliberated with strangers. The arguments not only have to be comprehensible, they ideally should also have a certain validity in order for them to be considered relevant or worthy of discussion. And if he or she fails to convince others of the relevance of their arguments, then they must find new ways of explaining their position. Each group member presents their position, which is then evaluated by the other members, for instance by generating new counterarguments if in disagreement, or, if in agreement, by supplementing the position with new arguments or by leaving it as it is. Ideally, this process gives rise to a deeper insight into the issue at hand, leading to a revision or improvement of one's own position in the light of more valid arguments.

2.1.3 Deliberation and making a decision

In order to reach a justified decision various possibilities have to be developed with regard to resolving the issue. Judgements or points of view brought forward by the participants during deliberation are sometimes insufficient to reach a decision and so new information may be called for. To this end, experts can be consulted, or group members may themselves seek additional information. This new information must then be evaluated and inferences have to be made based on the new evidence and be integrated in a coherent way. In the light of this new information, possibilities can be explored, revised or abandoned. Based on an evaluation and integration of these new insights a decision may then be reached.

Evaluating possibilities also entails an attempt to foresee the various associated consequences. Both direct and indirect consequences have to be considered. In other words, the process involves making predictions and trying to take into account predetermined and undetermined factors. Again, the complexity involved in making predictions varies. Therefore, in some cases, the issue might be relatively easy to solve, whereas in other instances, making any kind of realistic prediction may prove much more difficult. When no real agreement is attainable due to the nature of the issue, such as in the case of abortion, group members must decide on how to deal with such differences (Gutmann & Thompson, 2004).

To sum up, I described the process of deliberation that ideally takes place among citizens. The goal of deliberation is to achieve the best possible solution for the problem citizens are facing. As already mentioned, group problem solving is at the heart of this deliberation. I will turn next to the implications of such deliberation for CE.

3 Educational principles of group problem solving

Although the goal of deliberation is to reach a justified and shared decision, argumentation is at its heart: citizens use argumentation in order to adopt a position, to defend or explain it and to discuss the merits of potential solutions with others (Landemore & Mercier, 2010). Therefore, it is important to give students ample opportunity to practice reaching sound judgements through argumentation. While arguing with each other, students have to be able to take different perspectives regarding the issue at stake. The ability to consider the actors' varying interests and perspectives is necessary in order to develop an understanding of the problem and its possible solutions, given those particular interests. Not only do students have to learn how to connect different interests, but also different kinds of knowledge, as the issues are often multi-dimensional. Therefore, they should practise connecting different perspectives and kinds of knowledge. In addition, these issues may be controversial, with no straightforward solutions. Once several potential solutions have been developed, students have to make a decision. The decision-making process is complicated, as students not only have to come to a decision but must also agree on how they arrive at a consensus and set criteria for potential solutions. After all, deliberation is not an individual process, so students have to learn how to think together, to exchange knowledge and argue about such issues. This means that special attention should be devoted to group work and particularly to sustaining and achieving a good level of exchange and thinking effectively together.

From the process of deliberation described earlier, I deduce four educational principles corresponding to the key aspects of the deliberation process: (1) argumentation, (2) connected learning, (3) decision making and (4) thinking together. In order to define the content of these principles, I used the work of certain cognitive and educational psychologists who have developed concrete learning materials in collaboration with teachers and have researched their educational strategies in primary and secondary schools. For the principle of argumentation, I used the educational strategies of Kuhn, Hemberger and Khait (2013); for connected learning, I drew on the work of Künzli (2007) and Bertschy (2007); for decision making, I used the work of Swartz, Costa, Beyer, Reagan and Kallick (2008); and for thinking together the work of Dawes, Mercer and Wegerif (2004). These educational principles lend themselves to guiding teachers in their efforts to implement group problem solving within CE. I will now describe how a lesson might be organised.

3.1 Organisation of the lesson

The questions still to be answered are: how to organise the lesson units and which choices are to be made when combining knowledge from different domains? First, the organisation of the lesson units will be elaborated. Then, I will embark on a full-scale translation of the four educational principles into detailed lessons, using a casus "Sunscreen and Nanotechnology" as an example. Group problem solving as CE can provide an organisational structure to the lesson. In order to achieve this, Problem Based Learning (PBL) was used as a framework.

PBL is a teaching method in which a learning task is organised in such a way that students acquire the skills and knowledge needed to solve problems, while simultaneously gaining content knowledge on the issue to be solved. This learning should take place in an authentic context (real-world problem), the problem must be unstructured, with no clear-cut solutions and also be complex (Wirkala, 2011). The 'open-ended' nature of the problem must be such as to motivate students to reflect upon it and ask themselves questions, to reach reasoned judgements and develop alternative solutions (Hmelo-Silver & Barrows, 2006). The real-world

problem should be suited to integrate knowledge from different knowledge domains. Therefore, PBL is a cross-curricular activity. This teaching method also sequences the learning process, starting out with a problem, an initial analysis and the formulation of a hypothesis, with students then progressing to a deeper analysis of the problem and subsequently going on to develop potential solutions and, as a final step in the process, reflecting on what they have learned by conducting a debriefing to reflect on the most relevant concepts that have been learned and that were necessary to solve the problem. (Wirkala, 2011). In short, students have to complete four phases: initial problem analysis, deeper problem analysis, decision making and debriefing.

4 Socio-scientific issues and CE

Group problem solving, as CE, involves cross-curricular activities: (1) general educational approaches have to hybridise with subject matter-specific approaches and (2) different kinds of knowledge also have to come together: history, geography, science…However, it is not feasible, within the scope of a single lesson series, to explore in-depth all subject matter relevant to understanding the chosen issue, or to do equal justice to all general and specific knowledge content. Therefore, teachers have to define the societal issues they will be dealing with and choose which subject content the lesson series will focus on. This choice is motivated by the kind of societal issues the teacher plans to address, the subject matter deemed best suited to enrich the students' understanding of the chosen issue and the duration of the lessons.

A large proportion of societal issues are related to sciences and researchers warn that low scientific literacy can lead to citizens developing naive ideas about science and to them being unable to follow current (political) debates (Jenkins, 1994; Mooney & Kirschenbaum, 2009). Citizens require scientific knowledge and skills in order to participate equally and fully in discussions and decision making concerning societal issues such as shale gas, gentech, poverty, nuclear energy and climate change. Even issues as homosexuality or abortion require a certain degree of scientific knowledge. According to Day and Bryce (2011, p. 6), dealing with socio-scientific issues in the classroom enables students "to hold and defend informed views on social, moral, ethical, economic and environmental issues related to sciences". The PISA documents, too, emphasise the importance of scientific literacy: "the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen." (OECD, 2013, p. 7). Dealing with socio-scientific issues offers an educational context supporting the development of scientific literacy (Sadler, Klosterman & Topcu, 2013). By engaging students collaboratively in reflection and argumentation while solving socio-scientific issues, they acquire scientific content knowledge and refine their personal epistemology relating to science (personal epistemology refers to one's personal convictions as to how such knowledge comes about and is justified). Along with argumentative skills, these two elements are considered to be relevant aspects of scientific literacy (Evagourou, 2011). In the following example, science provides the chosen central subject matter. The controversial issue chosen is the use of nanoparticles in cosmetic products.

4.1 Sunscreen and nanotechnology

The problem to be solved was put forward by l'Oréal. L'Oréal asked for help in finding a solution for their sunscreen problem. In sunscreen, nanoparticles are used to block out the sun's rays. Nanoparticles are, in fact, the most effective sun blockers in existence. The problem with nanoparticles is that, at present, their impact on health and the environment is not well understood. In this paragraph ,the learning activities will be discussed and the relationship between the four phased sequence of the learning activities and the four educational principles will be illustrated. This specific project lasted for 10 weeks, with one hourly lesson a week. This project was developed for end primary and begin secondary school students. To ensure good preparation, the teachers were helped by the researchers and experts from the field of nanotechnology. Both provided the teachers with background information. The students' argumentation skills were trained before starting the project and they defined ground rules for the discussion. Before starting the project, the teachers made group of five students.

In the *initial problem analysis*, it is important to guarantee student motivation for the topic. One strategy is to spark prior knowledge and use this to grasp the problem. Students were asked to bring along their own sunscreen. First, they made an inventory of their sunscreen usage as a consumer: which brands they used, how much they paid for them, when and where they use sunscreen and how much. As the students were expected to have little prior knowledge of nanotechnology and sunscreen, they were given information in advance,

comprising of reading material and videos explaining: (1) how sunscreen works, (2) the difference between sunscreen with and without nanotechnology, (3) the INCI declaration on sunscreen. First individually, and then in groups, students were asked to summarise their prior knowledge and what they have since learned. They were then asked to discuss, justify and judge the relevancy of the acquired knowledge and choose the four best leading research questions with which to structure the next lesson.

In the *problem analysis* phase, students deepened their understanding of nanoparticles. Because nanotechnology is so complex, and in order to fully understand the impact of nanoparticles on health and the environment, a second activity in the form of a science lesson on nanotechnology and nanoparticles was organised. An expert in nanotechnology was asked to give a lecture. During the lecture, students experienced how nanoparticles work and how they are used in different industries, for example, on clothing. Then, nanoparticles were explored using experiments and inquiry strategies. Once the concept had been mastered, students moved on to study how sunscreen works and what kind of nanoparticles is used. The focus was on titanium dioxide. Then, during the following activities, the journey of titanium was researched. First, the students studied where titanium is sourced (from the mineral rutile), how it is extracted and produced in Sierra Leone. Information about the environmental impact of extraction using dredging techniques was offered, as well as information on the socio-cultural and economic situation in Sierra Leone. Next, the process of transformation of TiO2 into nanoparticles up until its use in sunscreen was studied. Once again, environmental impacts were discussed. The journey continues with consumers using the sunscreen and what happens with the nanoparticle once it ends up in recreational water. Information on the effects of nanoparticles on water, on plankton and other aquatic organisms, such as fish, was researched. The different players (company extracting titanium, company transforming it, L'Oréal, the consumer) were divided between students within a group. In order to enhance their knowledge, students visited a company working with nanotechnology. During this visit, students prepared questions about nanoparticles and their use in industry and medical research.

In addition, information on different kinds of players was supplied, such as environmental NGO, governmental institutions and industries, with the main focus on their respective roles and interests. A network diagram was created, following the journey of titanium from rutile to its ending up in recreational water. To this diagram, the various different interest groups, along with their actions, were added. Possible alternatives to sunscreen containing nanoparticles were also researched. Once the diagram visualising the network was completed, a "what ..if" game was carried out: what if a certain variable changes, what are the consequences for the rest of the chain of actors. This made it possible to visualise and discuss how actors interrelate.

In the *decision making* phase, each group developed at least two possible solutions and discussed the different consequences (ecological, social, economic). The original problem given by L'Oréal was readdressed. Students had to agree within the group which of their two solutions was the best and to justify their choice. To help the students, handouts were supplied containing written prompts designed to structure the development of possible solutions, such as what are the positive and negative consequences.

Finally, in the *debriefing* phase, the scientific concepts were discussed once again and the different solutions brought forward by the groups were presented and discussed.

CE as group problem solving asks from teachers the ability to scaffold and support group processes. Teachers must also be able to develop cross-curricular activities and sequence these in a logical way, thereby helping students to grasp the problem and its complexities.

5 Concluding discussion

Group problem solving was defined as the core competency of an epistemic theory of deliberative democracy. Socio-scientific issues provide content for group problem solving. This framework was explained, justified and translated into four educational principles: argumentation, connected learning, decision making and thinking together. Argumentation should lead students to reach sound judgements on the issue at hand. Connected learning helps with forming perspectives regarding content, actors and dimensions and with learning how to interrelate these. In this way, students develop different alternatives to solve the issue and make collective decisions. Students must learn how to work effectively together and, above all, how to think together. These educational principles provide teachers with a framework for developing and equipping students with the kind of thinking skills necessary to allow a deliberative democracy

to function well.

Teachers should understand how these educational principles can be implemented in order to support the kinds of skills and knowledge to be developed in their students. This means, on the one hand, that teachers should receive training on how to develop learning activities dealing with socio-scientific issues, involving cross-curricular lessons and integrating the four educational principles. On the other hand, teachers also need to be knowledgeable regarding the issue students are dealing with, they should possess argumentation skills and a certain amount of epistemic knowledge.

Considering CE as group problem solving begs the question as to whether it should be the schools that prepare students for deliberative participation, or that such deliberation skills can better be learned later on as an adult. Research on adult deliberation shows that adults can indeed learn how to deliberate; however it takes tremendous effort, for instance, to organise deliberative polls and to prepare and support the citizens taking part in these. A relevant argument in favour of developing such citizenship in schools, is that the thinking skills involved are hard to learn and require a great deal of practice in many different contexts in order to develop successfully. The purpose of such a CE is not only to develop good thinking skills, avoiding biases and heuristics, but also to make students aware that socio-scientific issues require a great deal of thought with no ideal state to be attained, only striven towards.

References

Bächtiger, A. (2010). *On Perfecting the Deliberative Process: Agonistic Inquiry as a Key Deliberative Technique.* APSA 2010 Annual Meeting Paper. Retrieved https://papers.ssrn.com/sol3/papers2.cfm?abstract_id=1642280

Benner, D. (1991). *Allgemeine Pädagogik. Eine systemisch-problemgeschichtliche Einführung in die Grundstruktur pädagogischen Denkens und Handelns.* Weinheim und München: Juventa Verlag.

Bertschy, F. (2007). *Vernetztes Denken in einer Bildung für eine nachhaltige Entwicklung. Interventionsstudie zur Förderung vernetzten Denkens bei Schülerinnen und Schülern der 1. und 2. Primarschulstufe*. Dissertation der Philosophisch-humanwissenschaftlichen Fakultät der Universität Bern.

Black, L. W. (2012). How people communicate during deliberative events. In T. Nabatchi, J. Gastil, M. G. Weiksner & M. Leighiniger (Eds.), *In Democracy in Motion: Evaluating The Practice and Impact of Deliberative Civic Engagement*. New York: Oxford University Press.

Crick, R. D. (2007). Learning how to learn: the dynamic assessment of learning power. *The Curriculum Journal, 18*(2), 135–153, DOI: 10.1080/09585170701445947

Dawes, L., Mercer, N. & Wegerif, R. (2004). *Thinking Together: a programme of activities for developing speaking, listening and thinking skills.* Birmingham; Imaginative Minds Ltd.

Day, S. P. & Bryce, T. G. K. (2011). Does the Discussion of Socio-Scientific Issues require a Paradigm Shift in Science Teachers' Thinking? *International Journal of Science Education, 33*(12), 1675–1702.

Evagourou, M. (2011). Discussing a Socioscientific Issue in a Primary School Classroom. In T. Sadler (Ed.), *Socio-scientific Issues in the Classroom. Teaching, learning and Research*. Florida: Springer.

Goodin, R. E. (2008). *Innovating Democracy, Democratic Theory and Practice After the Deliberative Turn.* Oxford: Oxford University Press.

Gutman, A. & Thompson, D. (2004). *Why Deliberative Democracy?* New Jersey: Princeton University Press.

Hmelo-Silver, C. & Barrows, H. (2006). Goals and Strategies of a Problem-based Learning Facilitator. *Interdisciplinary Journal of Problem-Based Learning, 1*, 21-39.

Jenkins, E. (1994). Public understanding of science and science education for action. *Journal of Curriculum Studies, 26,* 601-611.

Kennedy, K. J. (2008). The Citizenship Curriculum: Ideology, Content and Organization. In J. Arthur, I. Davies, & C. Hahn (Eds.), *The SAGE Handbook of Education for Citizenship and Democracy*. London: SAGE Publications Ltd.

Kuhn, D., Hemberger, L. & Khait, V. (2013). *Argue with me. Argument as a path for developing students thinking and writing.* Wessex Inc.

Künzli, C. (2007). *Zukunft mitgestalten. Bildung für eine nachhaltige Entwicklung- didaktisches Konzept und Umsetzung in der Grundschule*. Bern: Hauptverlag.

Kymlicka, W. (2008). *Contemporary political philosophy.* Oxford: Oxford University Press.

Landemore, H. & Page, S. (2015). Deliberation and

Disagreement: Problem solving, Prediction, and Positive Dissensus. *Politics, Philosophy & Economics, 14,* 229-254.

Mercier, H. & Landemore, H. E. (2010). Reasoning is for Arguing: Understanding the Successes and Failures of Deliberation. *Political Psychology, Forthcoming*. Available at SSRN: https://ssrn.com/abstract=1707029

Mooney, C., & Kirschenbaum, S. (2009). *Unscientific America: How Scientific Illiteracy Threatens Our Future*. New-York: Basic Books.

OECD. (2013). *PISA Framework 2015.* Retrieved July, 2014, from http://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Science%20Framework%20.pdf

Ploeg, P. A, van der & Guérin, L. (2016). Questioning participation and solidarity as goals of citizenship education. *Critical Review, 28*(2), 248–264.

Ploeg, P. A. van der (2015). Burgerschapsvorming anders: een pleidooi voor zakelijk onderwijs. *Pedagogiek, 35*, 285-298.

Sadler, T. D., Klosterman, M. & Topcu, M. (2013). Learning Science Content and Socio-scientific Reasoning Through Classroom Explorations of Global Climate Change. In T. D. Sadler (Ed.), *Socio-scientific Issues in the Classroom Teaching, learning and Research*. Florida: Springer.

Swartz, R. J., Costa, A., Beyer, B., Reagan, R., & Kallick, B. (2008). Thinking-based learning: Promoting quality student achievement in the 21st Century. New York, NY: Teachers College Press.

Wirkala, C. (2011). *Problem-Based Learning in K-12 Education: is it effective and how does it achieve its effect.* Dissertation: Columbia University.

Zeidler, D. L., Sadler, T. D., Simmons, M. L. & Howes, E. V. (2005). Beyond STS: a research-based framework for socio-scientific issues education. *Science Education, 89*(3), 357-377.

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