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Toward citizenship science education: what students do to make the world a better place?

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ABSTRACT

With increased focus on sustainability and socioscientific issues, dealing with issues related to citizenship is now seen as an important element of science education. However, in order to make the world a better place, mere understanding about socioscientific issues is not enough. Action must also be taken. In this study, 35 international gifted students—potential scientists—aged 15–19 were interviewed to investigate what they were doing to make the world a better place. The interviews were analyzed using qualitative content analysis with focus on students' actions toward a better world, their rationalizations for such actions, and the role of science in the rationalizations. The analysis shows that students consciously take a wide range of actions, and that they see citizenship as a process of constant self-development. The three categories created to highlight the variation in the ways students take action were personally responsible actions, participatory actions, and preparing for future. Although many students saw that science and scientists play a big role in solving especially the environmental problems, most of them also discussed the structural causes for problems, as well as the interplay of social, economic, and political forces. The results indicate that citizenship science education should take the variety of students' actions into consideration, give students the possibility to take individual and participatory action, as well as give students opportunities to get to know and discuss the ways a career in science or engineering can contribute to saving the world.

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In science education standards and research there has been a growing interest toward socioscientific issues and moral aspects of science education. In particular the concept of sustainable development has found its way to the science curricula around the world. In fact, science education is now often seen as part of wider citizenship and sustainability education (see Vesterinen, Manassero-Mas, & Vázquez-Alonso, 2014). This study contributes to discussion of the strategies for such citizenship science education.

Several studies have charted the goals of citizenship education and the ways science education can contribute to it. Most of the studies discuss the issue mainly from the

perspective of the teachers, administrators, researchers, and curriculum designers (e.g. Kiwan, 2008; Pedretti & Nazir, 2011; Westheimer & Kahne, 2004). The few existing studies on how students perceive themselves as citizens have focused on certain aspects of socioscientific action, such as on the consistency of students' choices as consumers with their moral beliefs (e.g. Sternäng & Lundholm, 2011). Thus, there is need for more studies on students' perceptions of science and good citizenship as well as on their actions toward a better world.

This study focuses on the intentional and purposeful actions of students interested in science and sustainability, students' rationalizations for such actions, and the role of science in their rationalizations. It is based on the interviews of 35 high-performing students from 21 countries participating in an international science camp.

Models and visions of citizenship

At the level of rhetoric, there seems to be consensus that education should develop students' capabilities as 'good citizens'. However, when defining what a good citizen is or what should be done to promote such citizenry, the consensus seems to fall away. Researchers have described sometimes complementary, sometimes competing visions of citizenship, influencing the goals, strategies and methods of citizenship education.

For example, based on the views of the 'key players' involved in the policy and curriculum development process of citizenship education in England, Kiwan (2005, 2008) described four models of citizenship. The main categories of conceptions were moral, legal, participatory, and identity-based. The moral conceptions focus on the discourse about ideas of shared and common values. The legal conceptions place emphasis on individual and human rights. The participatory conceptions were the most dominant ones, and promote active participation in democratic decision-making as well as in voluntary and community activity. The identity-based conceptions are concerned with identity, or forms of identification at different levels, and include a cluster of concepts, such as diversity, anti-racism, multiculturalism, nationality, and global aspects of citizenship. Kiwan (2007) saw these identity-based conceptions as especially important if education wants to advocate a more inclusive model of good citizenship. Also the recent discussion on the concept of global citizenship (see Andreotti & Souza, 2011; Dower, 2003; Peters, Briton, & Blee, 2008) typically focuses on these aspects of citizenship.

Examining school-based programs that aim to teach democratic citizenship, Westheimer and Kahne (2004) described three visions of responsible citizenship: the personally responsible citizen, the participatory citizen, and the justice-oriented citizen. A personally responsible citizen acts responsibly in the community, obeys laws, and contributes to charity. Programs based on this vision of citizenship hope to build character and personal responsibility by emphasizing virtues such as honesty, integrity, self-discipline, and hard work. Educational programs designed to support the development of participatory citizens focus on the importance of planning and participating in organized efforts to care for those in need or in efforts to guide school policies. The participatory citizen vision of citizenship is based on the core assumption that to improve society, citizens must actively participate and take leadership positions within new and established systems and community structures. The vision of the justice-oriented citizen is based on questioning and

changing established systems and structures, which reproduce patterns of injustice over time. Education toward justice-oriented citizenship focuses on critical assessment of social, political, and economic structures to solve the root causes for injustice.

Research has also shown that the approaches we use for citizenship education have an effect on students' engagement in societal issues. For example, recent studies on political engagement and participation of young people have shown that youth are especially interested in political actions which emphasize self-expression and self-actualization, such as direct forms of lifestyle politics and community-based work (Dalton, 2008; Kahne & Westheimer, 2006; Quintelier, 2007; Sloam, 2014; Zukin, Keeter, Andolina, Jenkins, & Delli Carpini, 2006). Kahne, Crow, and Lee (2013) refer to such strategies as 'little p' politics. They argue that because of the seemingly ineffectual nature of the traditional political process involving state institutions, politicians, and interest groups, young people are losing interest in 'big P' political acts such as voting and working on an election campaign. Based on the examination of the school-based projects, both kinds of political acts can be influenced through education. More specifically, service learning based on active participation in projects promotes expressive, youth-centered, and community-based engagement in 'little p' politics, and structured discussion of societal issues promotes more formal and electoral forms of engagement in 'big P' politics (Kahne et al., 2013; Westheimer & Kahne, 2004).

Citizenship science education

Dealing with issues related to citizenship is seen as an important element of science education. Discussions on how science education should contribute to the development of citizenship have mainly concentrated on various conceptualizations and re-conceptualizations of 'scientific literacy' (see Vesterinen et al., 2014). Closely related to the concepts 'public understanding of science' and 'science for all', the term scientific literacy has developed into an umbrella term covering most aims of science education, and has become a central educational objective of science education worldwide (e.g. DeBoer, 2000; Dillon, 2009; Hurd, 1998; Laugksch, 2000).

The common rhetoric in definitions of scientific literacy is that science education should contribute to the development of 'informed citizenry' so that students will be able to participate in decision-making about personal and political issues that have a scientific dimension (Jenkins, 1999). However, the models of informed citizenry are mainly based on deficit frameworks for democratic participation, which

can be characterized as the public needing to be educated to understand the opportunities and constraints of contemporary science and technology so that they might realize their benefits, do not have unrealistic expectations and generally support government and corporate funding into promoting the fruits of science and enhancing the economic base. (Levinson, 2010, p. 79)

Different conceptions of the role of science education in citizenship education have been presented mainly in the humanistic perspectives of science education (see Aikenhead, 2006; Pedretti & Nazir, 2011). Working under various slogans, such as science-technology-society education (e.g. Aikenhead, 1994), science-technology-society-environment education (e.g. Pedretti, 2003), socioscientific issues approach (SSI) (e.g.

Ratcliffe, 1997), indigenous science education (e.g. McKinley, 1996), and urban science education (e.g. Barton & Tobin, 2001), the advocates of humanistic perspectives have been active in re-conceptualizing scientific literacy (Vesterinen et al., 2014). For example, approaching the issue from the domain of socioscientific issues, Zeidler, Sadler, Simmons, and Howes (2005) describe the elements of 'functional scientific literacy' promoting both cognitive and moral development. With roots in the environmental movement, the humanistic perspectives are also closely connected with environmental education and education for sustainable development (e.g. Colucci-Gray, Perazzone, Dodman, & Camino, 2013).

In their review of 40 years of research, Pedretti and Nazir (2011) identified six currents of humanistic science education. Some of these currents, such as the logical reasoning current and the value-centered current, place explicit emphasis on decision-making about socioscientific issues. Within these currents educational activities target students' knowledge as well as moral and emotional identities to stimulate cognitive and moral development. Some of the proponents of this approach, which Pedretti and Nazir have named the socio-ecojustice current, go even further and assert the production of activists working to refashion a more just and sustainable society as the ultimate goal of science education (see Hodson, 1999; Santos, 2009). Influenced by a broad array of work from science studies, feminist studies, sociocultural theory and critical pedagogy, the followers of this current have re-conceptualized science education as an instrument of social and political engagement and sociopolitical action (Vesterinen et al., 2014). The examples of enacting the socio-ecojustice current in classrooms include both place-based activities addressing local, societal or environmental problems, as well as activities directed toward tackling more general socioscientific issues such as climate change (Pedretti & Nazir, 2011).

The aforementioned studies have discussed citizenship and science education mainly from the perspective of teachers, administrators, researchers, and curriculum designers. In these studies, students are perceived mainly as future citizens or citizens in the making, not as active citizens (see Alderson, 2000). Thus, there is a need for studies that approach the vision of the good citizen from the students' perspective and focus on students' current actions. To better understand how to support sociopolitical action through science education, this study focuses on students' actions directed toward making the world a better place and students' perceptions on the role of science and scientific practice in such sociopolitical action.

Students' actions to make the world a better place

In educational research the notion of action has been discussed in several ways. The way actions are seen in this study is based on the concept of action competence (e.g. Jensen & Schnack, 1997; Mogensen & Schnack, 2010). Action competence is a formative ideal for education, which is defined by the student's capability to take action and deal with unforeseen situations (Jensen & Schnack, 1997). Inspired by philosophical psychology and critical theory, Mogensen and Schnack (2010) describe how human actions differ from mere behavior and activity. They argue that intentions, motives, and reasons have intrinsic relation to action. If the motivation or intention is different, similar behaviors

can be seen as different actions. In line with their view, in this study action is defined as intentional, conscious, and purposive behavior. Such definition of the notion of action links it to humanistic concepts of personhood, responsibility, democracy, and education.

In line with the concept of action competence, knowing the intention and motivation for behavior is crucial for recognizing actions directed toward making the world a better place. To recognize such actions, one has also to acknowledge that actions can have a multitude of various motivations. According to the definition of the notion of action, this study focuses only on conscious and purposive behavior, which the students themselves consider responsible in improving or preserving the world. Thus any behavior, such as riding a bike to school, might or might not be of interest depending on the intentions of the student. For example, one student may choose to ride their bike to school because it produces less emissions than driving a car, while another rides their bike simply because they do not have a car or a driver's license.

Very few studies in science education have concentrated on students' sociopolitical or socioscientific behavior or actions. These studies have mainly concentrated on pro-environmental actions, and the relationship between environmental awareness or knowledge and taking environmental action. Most of the studies are quantitative studies based on questionnaire data (e.g. Zsóka, Szerényi, Széchy, & Kocsis, 2013) or qualitative case studies focusing on students' perspectives and reasoning on a specific issue (e.g. Sternäng & Lundholm, 2011). One of the main results of these studies has been that knowing the most beneficial way to act does not always lead to acting accordingly (e.g. Grace & Ratcliffe, 2002; Kallgren & Wood, 1986). In addition to knowledge about the environmental problems and the action strategies for impacting them, several other factors influence pro-environmental behavior. These variables include both personal factors, such as the sense of personal responsibility and the perception of whether one has the ability to bring about change, as well as situational factors, such as the complexity of the issue, opportunities to choose different actions and social pressures concerning the issue (see Kollmuss & Agyeman, 2002). Boyes, Skamp and Stanisstreet (2009) have also shown that on climate change issues, strength of the relationships between students' professed willingness to act and the belief that an action would be effective varies from issue to issue. The gap between knowledge and action was widest in indirect actions, such as voting for pro-environmental legislation. This is in line with the results on students' general lack of interest in big-P politics (see Kahne et al., 2013).

According to a study by Sternäng and Lundholm (2011), students also tend to interpret actions and responsibility differently based on whether they are thinking about their own actions or actions of others. They tend to suggest more environmentally friendly actions to others than they are willing to do themselves. The researchers point out that depending on who makes the decisions, contextual frameworks bring forth different ways of moral reasoning. When they make decisions concerning themselves, students tend to weigh the costs and the benefits of an action (see Spash, 1997). If a certain action seems to have a great cost (e.g. on well-being, status, wealth), and the benefits of action are not apparent or do not seem to compensate for the cost, the action may not be taken. When the individual is someone else, students were not as prone to weigh the costs and benefits on the individual level, and were more concerned with the common good and environmental considerations.

Method

Participants

The data for this study was collected from 35 participants of the Millennium Youth Camp held in summer 2013. The interviewed participants came from 21 countries (15 European, 9 Asian, 4 South American, 3 African and 4 North American) and included 20 boys and 15 girls. As the study seeks to describe the variation in the ways students act to make the world a better place, an international group of highly motivated, interested and active students was seen as a way to provide rich data to chart the variation, as they were expected to be both active and articulate.

The camp had been marketed globally through social media, newsletters, teachers, personal contacts and diplomats. The main focus of marketing had been to inform gifted programs around the world about the camp. The 59 campers participating in the 2013 camp were chosen through a two-stage selection process from 973 applicants.

In the first round of the selection process, the applications were evaluated based on motivation and previous accomplishments. Success in competitions, personal projects and social participations were valued. Out of the first stage applications, 200 applicants were selected for the second round. In the second stage, each student was asked to do an individual project task on the theme they had selected in the first stage of application. The 2013 camp had 10 theme groups: applied mathematics, biosciences & biotechnology, climate and climate change, energy, ICT, food sciences and technology, material sciences and technology, renewable natural resources, urban planning, and water. Each theme group had different instructions for their tasks, but the thing that all projects had in common was the possibility for students to express their knowledge and create something new. Experts in the given fields evaluated the projects and interviewed the best applicants from each group. The evaluation focused the depth of student's knowledge, scientific research skills and scientific writing skills. Based on their work and the interviews, five to six applicants from each theme group were chosen as participants (for more details, see Tolppanen, 2015; Tolppanen & Aksela, 2013).

Consensus has not been reached on the definition of giftedness, but most researchers agree that giftedness typically correlates with performance and is related to motivation (e.g. Subotnik, Olszewski-Kubilius, & Worrell, 2011). Due to the aim of the marketing and the rigorous selection process of the camp, all of the participants in this study could be described as gifted and highly motivated. The application process also ensured that the participants were adequately proficient in English to be interviewed in English.

Data collection

Previous research on student perspectives on responsible citizenship have been either qualitative case studies focusing on students' perspectives reasoning on a specific issue (e.g. Sternäng & Lundholm, 2011) or quantitative studies based on questionnaire data from a large sample of students (e.g. Kahne & Sporte, 2008). Although qualitative studies focusing on a specific topic or issue can contribute to our understanding of reasoning related to responsible action, it does not provide an overview on the different ways students contribute to solving various problems. And on the other hand, the problem with the

use of large-scale survey studies is that the richness and complexity in the way students act and rationalize their actions is difficult to capture by preconceived questions.

In this study, semi-structured theme interviews were used to collect the data. The interviews focused on two interconnected main themes of discussion, as well as on several tangential themes. The two main themes were: (i) the biggest problems facing humanity and (ii) what students had done and do to make the world a better place. Tangential themes included discussion on questions such as:

- Can humanity solve the problems humanity is currently facing?
- Who is responsible for solving the problems?
- How do students contribute to solving these problems?

During the interviews, the interviewers asked clarifying or additional questions until they felt that the main themes were discussed in adequate detail.

Researchers created a set of questions and themes of discussion, which went through two stages of piloting. In the first stage, the researchers responsible for the development of research protocol (first and second authors) interviewed four university students doing master's degrees in science education. The students also participated in the second round of piloting, during which they interviewed, together with the responsible researchers, 10 gifted upper secondary school students. The upper secondary students were chosen amongst international students studying in an International Baccalaureate program in one of the most prestigious upper secondary schools in Helsinki. These students were between the age 16 and 18, representing the same age group as the subjects of the study. Pilot interviews were audio recorded and discussed. Based on the discussions, the interview protocol was refined to better support discussion on the main themes, for example, by regrouping the questions, and by adding new suggestions for clarifying questions.

Prior to the camp, campers and their parents were informed about the interviews. During the camp, each participant was interviewed by one of the three university students involved in the piloting working as research assistants or by one of the principal investigators (the first author). As the interviewing took three days, after the interview the interviewee was asked not to talk to their fellow campers about the questions or their answers. This was done to ensure that the interviewed participants would not influence the answers of the participants not yet interviewed.

Analysis

The interviews were transcribed verbatim and then analyzed in two phases. In the first phase, the data from the interviews was reduced by forming categories using inductive content analysis (see Elo & Kyngäs, 2008; Mayring, 2000). Each idea of an action toward making the world a better place was considered as a unit of analysis. In the second phase, the reduced data was organized and assembled to develop conceptual categories. The phase combined inductive and deductive analysis, as the formed categories were constantly evaluated to the views presented in the research (see Miles & Huberman, 1994). During this phase the reduced data was organized into three categories, which were particularly helpful in making sense of variation in students' descriptions of their actions

toward a better world. The categories are described in the next section. The results include also a more detailed qualitative description of students' rationalizations for their actions and of students' descriptions of the role of science in such rationalizations.

To evaluate the reliability of the main categories, a researcher not directly involved in the creation of the categories independently analyzed the transcripts using the descriptions of the three main categories of the first cycle of analysis. Comparing his analysis to the analysis of the first author, Cohen's kappa coefficient for each category was calculated. The intercoder agreement for the three main categories was high, with percentage agreements of 94, 94 and 91, and corresponding Cohen's kappa's of .88, .88 and .80. After these individual screenings, the researchers discussed differences in judgment until agreement was reached.

Results

This study focuses on what students had done to make the world a better place, students' rationalizations for such actions, and the role of science in the rationalizations. The interview and the analysis focused first on descriptions of intentional and purposeful actions. As students' perceptions about what would make the world a better place have an influence on what they see as desirable action, during the interviews students were also asked to describe the biggest problems facing humanity and possible ways to solve them. Most students recognized both humanitarian (e.g. poverty and racial discrimination) and environmental issues (e.g. climate change and scarcity of clean water). Several students acknowledged the way problems are interconnected, and discussed the root causes for these problems. A few students also discussed the structural causes for problems, as well as the interplay of social, economic, and political forces.

During the analysis, three categories were formed to describe the students' intentional and purposeful actions. Each of the following categories included both actions directed toward solving humanitarian issues as well as pro-environmental actions (see Kollmuss & Agyeman, 2002):

- (1) Personally responsible action: This category included actions in which students acted responsibly toward the environment or helped other people on a personal level, for example, helping friends in need, recycling, and giving money to charity.
- (2) Participatory action: This category included actions in which students organized or took part in school and community efforts for making a world a better place. Sample action includes actions such as mentoring fellow students, taking part in charity projects and volunteering in community development groups.
- (3) Preparation for future: This category included occasions in which students were doing things to prepare for future actions toward a better world. Such preparatory actions included aspiring to do well in studies, learning new skills, and making new friends and contacts. Students did these things, for example, to prepare themselves for work in which they could achieve things currently out of their reach.

Sample actions including rationalizations are presented in [Table 1](#).

Most students described actions in at least two of the following categories (see [Table 2](#)). The ways to act toward a better world are described in more detail in the following three

Table 1. Description and sample actions for each category of analysis.

	Personally responsible actions	Participatory actions	Preparing for future
Description	Acting responsibly toward the environment or personally helping other people	Organizing or taking part in school and community efforts	Doing things to prepare for future actions toward a better world
Sample actions	Buys ecologically produced food to minimize impact on environment	Organizes an event collecting money for charity organization	Aspires to do well in school to become a medical doctor who can help the people in her/his community
	Recycles actively to act as an example for others	Mentors fellow students to help them in reaching their potential	Works to learn the knowledge and skills needed to design more sustainable technology
	Lends money for a friend who needs it to study abroad	Volunteers in a community group which cleans nearby beaches	Seeks to acquire new experiences, to be able to write a book persuading others to act more responsibly

subsections. Each subsection documents one category of action. To make sense of the ways actions were intentional and purposeful, students’ rationalizations for their actions and students’ ideas-about-science affecting the rationalizations are described in more detail in the following three subsections.

Personally responsible actions

Out of 35 students interviewed, 20 expressed that they were currently making the world a better place through personally responsible actions. These included actions both within their immediate social realm (e.g. by helping friends in need) as well as with a goal of preserving the environment (e.g. by recycling). The rationalizations of concrete actions within the immediate social realm often placed emphasis on virtues such as kindness and honesty. Some of the students also perceived that the lack of such virtues was the root of many large-scale societal and environmental problems (e.g. lack of honesty leads to corruption which in turn causes poverty).

The environmental actions included both direct actions (e.g. picking up plastic bags from the beach) as well as consumer choices (e.g. choosing ecologically produced food). Often these actions, such as recycling, were rationalized by a sense of communal responsibility in which everyone had to do their part to solve the problems at hand. Some students also expressed what type of responsible actions they plan to take in the future, when they have more decisions to make (e.g. using public transportation instead of buying a car).

A few students argued that even though such personal actions might seem like rather small deeds with little or no consequence on a global scale, acting in a responsible way also raised awareness about the issues and inspired others to act more responsibly (see Excerpt 1),

Table 2. Numbers of students describing actions in each category.

Categories identified	Number of students
Personally responsible actions + participatory actions + preparing for future	6 (17%)
Personally responsible actions + participatory actions	4 (11%)
Personally responsible actions + preparing for future	5 (14%)
Participatory actions + preparing for future	9 (26%)
Only personally responsible actions	5 (14%)
Only participatory actions	2 (6%)
Only preparing for future	4 (11%)

Excerpt 1 (Interview 23): Boy, 17 years

Student: Yeah, like my school has a lot of recycling bins around, and I make it a point whenever I like drink, like tetra packs, when I drink tetra packs, I make it a point not to throw inside a normal industrial trash shredder. I take the effort, I make the effort of like emptying out the tetra, drink, after I drink and if some of it is left and then crushing it, folding it and then put it in the recycle bin. We are, like most of the people would just dump it in the normal bins, but for recycling you need to like fold it and stuff before you can recycle. So yeah, I think, I mean if, if I truly feel for the cause then only I think I'm responsible enough to tell others about it. So I started it first, then spread to my other group of friends, and then it's now like a class thing. Everyone in the class does that.

Interviewer: So you are hoping to affect the people around you?

Student: Yes, precisely.

Participatory actions

During the interviews, 21 (60%) students spoke about their participation in various organized actions, mostly within a school or local community setting (e.g. church groups). Participation in these activities was categorized as participatory actions. Activities were usually carried out within their immediate social realm and directed toward the wellbeing of other students or other members of the community (e.g. mentoring other students, or participating in projects to build houses for poor families). Local projects also included environmentally directed actions in the near vicinity (e.g. planting trees in a nearby nature reservoir). Most of the projects aimed to help people or environments located further away were charity projects, in which money was collected to help the people in need. One of the students had also participated in volunteer work abroad.

Some projects were concentrated solely on raising awareness on the issues in question. Most projects, however, were combinations of raising awareness and direct action or charity (e.g. improving the recycling facilities of the school was seen as a way to boost students' and teachers' awareness of the importance of recycling). In some cases, the participation in projects lead to highly personal ways of utilizing the experiences in raising awareness and inspiring others (see Excerpt 2).

Excerpt 2 (Interview 8): Girl, 18 years

Interviewer: Is there something you are doing to make the world a better place?

Student: Umm ... Like right now I'm doing a lot of environmental outreach. I traveled last year to Antarctica. I explored the Polar Regions and I was able to see a bit of climate change. So when I came back, I put together a book of my experiences to raise money, and I also give speeches at different, like, schools and community events both in like States and Canada just to raise awareness.

In their rationalizations for participatory actions in socioscientific issues, students described how research supports a more sustainable future, by proving information about the problems and the feasibility of possible solutions (e.g. understanding about the mass extinction of species and ways to alleviate it). Such knowledge was seen especially important in raising awareness and communicating the imperative for action. However, the process of producing knowledge for more informed action was not seen as unproblematic. A few of the students discussed how social and economic factors have influence on the production of knowledge, as well as the need for collaboration and interdisciplinary approaches in solving sustainability issues (see Excerpt 3).

Excerpt 3 (Interview 1): Boy, 17 years

Student: I think one of the other issues is how we use the renewable resources in a sustainable way. (...) For example science is going, I think, in a negative way in some parts, because they are researching about different topics. They are not considering that the use that we can make of science is not good. So I think that we should work together as teams. (...) Not only team of the same area. We should work together with physics, chemistry, biology, but also philosophy and other social science. I think, it is very important. (...) We should start solving or analyzing the social and political problems.

Students' description of their actions included both projects that they had initiated themselves as well as projects in which they had merely participated. A few students also described how they had gradually taken more responsibility in the projects. For example, a student taking part in the Science Olympiads began to recruit and coach future participants. Although most students were already taking some part in such participatory actions (see Table 2), some of them also had plans to be even more active in the future. They pointed out that to make a change, one has to learn how to successfully carry out such projects, and get to know the right people. Thus some of the participatory actions were also part of preparing for the future.

Preparing for future

During the interviews 25 (69%) students described actions which they rationalized as preparing for activities in the future. These preparatory actions included choosing an appropriate line of study, doing well in their studies, as well as gathering experiences, making contacts and learning skills for their future professional life. The students were interested and focusing wide variety of issues and disciplines, and found out wide variety of ways to make the world a better place (see Excerpt 4).

Excerpt 4 (Interview 35): Boy, 18 years

Interviewer: Is there something that you are doing to make the world a better place?

Student: I think by studying urban planning. Well like urban planning, I think really has a lot ways that could help the world, because so many issues are related to our cities and umm ... You know, the majority of the

world population now lives in cities. So, there's a lot of different aspects that have to do with climate change, war, resource usage or social issues with housing and food scarcity that all, sort of, revolve around cities. And urban planners can do a lot to help solve those problems. So I think that by pursuing that as a career, I hope to help the world.

Several students hoped to contribute to scientific and technological development which would alleviate or solve some of the major environmental problems humanity is currently facing (e.g. alleviate climate change by coming up with new renewable ways to produce energy, or come up with new medical treatments). Some students also discussed, how societal values and economic factors often complicated such production of new technologies (e.g. to protect their financial interests, owners of oil companies are not willing to invest in research for more environmental ways of producing energy). The development of new technologies was not seen as solely beneficial. Few students perceived that many of the problems we face are caused by the technological development, and most new technologies imply risks that need to be considered before they are taken into use (see Excerpt 5).

Excerpt 5 (Interview 11): Girl, 18 years

Student: Well, as I'm going to be genetic engineer, of course I've got a lot of chances to change something. And working as a genetic engineer means creating some genetically modified organisms and creating new organism, means that you can give them features you want. And this is a tool, which can be used in different ways. And maybe everything powerful in our world may be used in different ways. We have got an example of nuclear power, which can be used in nuclear stations to produce energy, and it can be used to create a nuclear bomb.

Although many considered direct involvement in politics as an efficient way to promote change, only a few interviewees expressed plans to get involved in politics themselves. The students interested in the possibility of running for a public office described how they would start on a local scale, and move from there toward involvement in national politics. Some of the students described other ways to make a difference in their community, such as becoming teachers or medical practitioners. Some students also had plans to raise awareness about the most critical problems (e.g. through writing books about environmental issues). Few students saw science studies and career in science as a way to acquire credibility in other fields such as in politics (see Excerpt 6).

Excerpt 6 (Interview 20): Boy, 19 years

Interviewer: What do you think that you are doing to help solve these problems?

Student: Right now I'd say, that I'm not doing much. Because I do not have the power to do much right now.

Interviewer: Okay. Why you don't have power?

Student: As in, with time I would actually get into a position and to influence as in, be to exact necessary influence to do more, with time as I, you know, go for that.

Interviewer: So do you have plans in the future?

Student: Sure, but basically my plans are not actually worldwide. It's more Africa wide.

Interviewer: Well, that's okay too, You can give me examples of ...

Student: The examples I'll give ... It's, like I said, Africa wide. So it's more like fighting corruption because that's more or less the sort of problem in my country, corruption. As in, if we can actually stamp out corruption, it is actually going to bring a lot of changes including alleviation of poverty. Because even if the government actually concedes, yes, we alleviate poverty, and they deal out billions of dollars, the corrupted officials are still sticking it into their pockets and it doesn't actually get into the grass roots. So that's actually where I want to fight. I already said that the main problem is greed. Greed leads to the corruption. So if we can actually stamp out corruption, which is what I actually want to do probably through politics, because I'm surely going into the politics. And that will be my major motivation. To stamp corruption, bring the responsibility into government. So that government would be responsible for the people.

Interviewer: So you want to be in the government?

Student: Yes.

Interviewer: How you could there influence the things?

Student: That's why I actually want to still go on forward in life with my career and, you know, university and everything. The current president of my country was actually a university lecturer.

Discussion and implications for practice

During the past decades, science education has increasingly focused on socioscientific issues and sustainable development. However, understanding about sustainability and socioscientific issues is not enough. In order to change the world, action must be taken. Thus there is need for citizenship science education supporting socioscientific action. This study set out to chart what 15–19-year-old students interested in science—potential scientists—do to make the world a better place. The analysis focused on the intentional and purposeful actions, rationalizations for such actions, and on the role of science in these rationalizations.

Actions toward a better world

During the analysis, we constructed three categories, which were particularly helpful in making sense of variation in what students did to make the world a better place. These three categories of actions were personally responsible actions, participatory actions, and preparing for future. Most students described actions in more than one category (see Table 2). The categories of actions were also related to each other. For example, participatory actions within school settings provided students with skills and experiences, which in turn supported them in preparing for the future.

The creation of the main categories combined inductive and deductive analysis in which the categories and their descriptions were constantly compared with views

presented in previous studies (see Miles & Huberman, 1994). Out of the previous research, the main categories share most resemblance to the visions of responsible citizenship described by Westheimer and Kahne (2004). Westheimer and Kahne created the three visions of citizenship—personally responsible citizen, participatory citizen, and justice-oriented citizen—to highlight the differences in citizenship from an educational perspective (see Westheimer and Kahne, 2004, pp. 239–241). In contrast, this study describes categories that correspond to the ways students claim to behave in and out of the school environment. And although two of the main categories of this study (personally responsible actions and participatory actions) are parallel to two of the visions of citizenship described by Westheimer and Kahne (2004), there are some notable differences. For instance, they described participation in community-based efforts as actions of personally responsible citizens, and organizing such efforts as actions of participatory citizens. In this study, in the students' descriptions of participation in community-based efforts, the line between participation and organization seemed very thin, if not non-existent. Experience of participating in community-based efforts prepares students to take more responsibility in organizing them. Thus, in this study, all actions within community-based efforts were seen as participatory actions, and, based on the rationalizations given, sometimes also as preparing for the future. Westheimer and Kahne also give examples of actions, which would fit the third vision of citizenship: the justice-oriented citizen. In this study, such actions would have been categorized mainly as participatory actions or preparing for the future. For example, actions such as researching an issue to find out the best way to influence it would have been analyzed either as participatory action (e.g. when it was done as a part of a communal or school project) or preparing for the future (e.g. when students were finding out what to study to support a more sustainable future).

In addition to personally responsible and participatory actions most students described the ways they were preparing for future. They see themselves both as citizens who actively participate in making the world a better place, right here and right now as well as future citizens or citizens-in-the-making (see Alderson, 2000; Levinson, 2010). With students' interest so firmly on the possible, probable, and preferable future scenarios, futures studies as a field studying and exploring such scenarios (Amara, 1981) could contribute to the design of more engaging science education. Some of the students were even capable of identifying of global trends, such as urbanization, and took them into account while working toward a more just and sustainable future (see Excerpt 4). Students' interest in future scenarios could be utilized in discussing socioscientific issues by exploring possible and probable futures, and envisioning ways in how students could contribute to achieving preferable futures (see Jones et al., 2012).

Preparing for the future might also seem like a less concrete action than the other two types of actions, as it gives the opportunity to postpone taking action to a later date, as well as to modify the action if necessary. For instance, a student preparing to become an environmental engineer may be doing so partially because they want to contribute to making the world a better place, but there may be other interests at play as well, such as a job that pays well. While still studying, the student does not yet have to decide what is their primary driving force for their studies, as that decision can be postponed until she or he is applying for work. This may imply that some of the 11% of students who described only actions with the intent of preparing for the future are delaying taking responsibility. There might be several reasons for this. For example, they may not be capable of taking

action at this point in time, because they do not know where to start, or they do not feel that their actions would make a difference. Postponing of action opens the door for weighing the costs and the benefits of an action, and not acting if the action would have a great cost, for example, on personal status or wealth (see Spash, 1997; Sternäng & Lundholm, 2011). Lack of responsiveness through postponing actions and shifting responsibilities to other stakeholders has also been documented in environmental politics (Pellizzoni, 2004). Thus, research on how and why students postpone their actions might be needed.

There is already a series of programs in science education, which seek to encourage students to take action (see Hodson, 2003; Pedretti & Nazir, 2011). The categories created could be used to analyze or improve the existing programs. One way to use the main categories is to utilize them in the planning of science programs, courses and lessons. For example, science lessons and courses could include tasks, which support each of the main categories described in this study. Such tasks could include: discussions on topics within the realm of personally responsible actions, such as environmentally aware choices as a consumer; arranging school-supported participatory activities, such as a project improving recycling practices in school; and opportunities to discuss issues related to preparation for the future, such as meeting professionals working in science and engineering fields. Within issues or context-based approaches to science education, the categories offer three practical to approach the issues in focus. For example, in science education based on the socioscientific issues, tasks could be based on questions such as: what I, we as a group, as well as decision-makers and experts in different fields can do to help to solve the issue in question.

Rationalizations for actions

In this study, the notion of action was defined as intentional and purposeful action (see Jensen & Schnack, 1997; Mogensen & Schnack, 2010). Thus the analysis focused on both the described behavior of the students as well as on students' stated intentions and motivations for their behavior. Students rationalized their actions in various ways. In many cases, students' rationalizations were based on a perspective according to which everyone as members of society and their local community shared responsibility to make the world a better place. Thus their actions toward a better world were part of being responsible consumers, community members, students, and citizens. Some of the students also described how they contributed (or were preparing to contribute) to making the world a better place in ways, which go beyond the basic responsibilities of most consumers, community members, or citizens. They took a more active, personal, and purposeful role in changing the world, for example, by making the world more just through political action, or by contributing toward a more sustainable way of living through technological innovation (see Excerpts 2, 5, and 6).

Engaging and inspiring others was also an important rationale for many described actions; through their actions students hoped to achieve change in the behavior of others (see Excerpts 1 and 2). In fact, raising awareness was often seen as one of the most efficient ways to solve these problems, and the lack of awareness was sometimes perceived as the root reason for problems—especially in environmental issues. In addition to such participatory conceptions, rationalizations also included moral conceptions (e.g. seeing the lack of virtue as the root problem), as well as identity-based conceptions

(e.g. having the desire to help the home community by becoming a physician) (see Kiwan, 2007, 2008). These variations within the rationales of action presented in this study should be taken into consideration when planning citizenship science education. One way to support the commitment to change is to support students' self-expression, self-actualization and student autonomy by the use of student-centered strategies (see Darner, 2009; Jonassen, 2000; Kahne et al., 2013; Niemiec & Ryan, 2009). For example, during citizenship science education, projects and tasks should support the development of more personal ways to contribute in making the world a better place by giving students the autonomy to decide the goals of their projects and the ways they carry out the projects (see Hannafin, 1992; Jonassen, 2000). The hope to engage others and inspire change was also a crucial part of rationalizations for many actions. Thus, providing students opportunities to share the products of their projects with their peers, members of the local community, or with researchers or other experts working in the field of their project could also be a good way to support students' commitment (see Tolppanen & Aksela, 2013).

Regardless of their career plans, most of the students had thought of ways to contribute to making the world a better place in their future occupation (see Excerpt 4). Many perceived that almost everyone could contribute in one way or another. Thus, taking part in solving the problems humanity is facing was not seen as incompatible with desires such as self-expression and self-actualization. In fact, most students' actions and plans for action seemed to be motivated by the power of direct action and community-based work. Such strategies are referred to by Kahne et al. (2013) as 'little p' politics. They argue that there is also a need to encourage students to take part also in 'big P' politics, for example, through active participation in politics. However, some of the interviewed students saw 'little p' politics, such as setting an example and inspiring awareness, as prerequisites for more gradual and bigger changes in social, political, and economic structures. This is in line with the result of studies on political engagement of young people (e.g. Dalton, 2008; Quintelier, 2007; Sloam, 2014), which show that young people are moving away from mainstream electoral politics toward alternative forms of participation which have more immediate relevance to their everyday lives. Social, economic and technological drivers have caused a transfer of power to expert groups and international organizations as well as diversified political engagement, for example, in the form of social-movements, issue groups, expert groups and other social networks facilitated by online technology (Sloam, 2014). Thus, although student acknowledged the power traditional political institutions, they did not feel compelled to participate in electoral politics. The few students who had plans to be involved in conventional electoral politics discussed it as a part of their career plans (see Excerpt 6). This makes sense, as in most parts of the world being a politician is considered a profession. Thus the plan to get involved in electoral politics might not solely be an indication of a student's commitment to do good, but also about the student finding the profession of politician personally suitable for him or her.

To solve the root causes of the societal and environmental problems, there is a need for a critical assessment of the underlying social, political, and economic structures and the traditional political process involving state institutions, politicians, and interest groups. Some of the students understood that to make an impact, they must actively participate and take leadership positions within community structures and systems (see Excerpt 6). For citizenship science education, with the goal of not merely understanding but

solving the socioscientific problems through action, such agency should be one of the main goals of science education (cf. Pedretti & Nazir, 2011). Thus, in addition to place-based activities addressing local problems, there is a need for science education activities, which addresses the root causes of the wider scale problems by structured and open discussion of socioscientific issues and the decision-making processes (e.g. Kahne et al., 2013). According to previous research (e.g. Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2008), science teachers sometimes find such approaches uncomfortable, as they worry about their own competence and ethical implications. Thus there is need for more studies, which could inform how such approaches can be used successfully in science classrooms.

Representations of science in rationalizations

As the data was collected among the participants of a science camp, it is not surprising that many students were working toward becoming scientists or science-related professionals such as medical practitioners, teachers, architects and engineers. Many students also saw focusing on science and technology as one of the most efficient ways to solve the problems humanity is currently facing. Expertise in science and engineering was seen both as a way of understanding the problems as well as a tool to create solutions (e.g. environmentally friendly materials or new medical treatments). Thus, in the rationalizations of students' actions, science was discussed mainly from two perspectives. The first one focused on the production of knowledge for more informed action and the second one on the development of new technological applications of science.

Although several students described ways that science could contribute to producing knowledge for more informed action, the production of such knowledge was not always perceived as unproblematic. For example, one student also pointed out, that finding feasible solutions sustainability issues requires collaboration between the disciplines (see Excerpt 3). According to him, producing knowledge about more sustainable ways to use the natural resources requires an interdisciplinary approach to science, which also takes into account the societal aspects of the socioscientific issues. Studies in sustainability science have highlighted the need for such inter- or transdisciplinary approach for solving the 'wicked' nature of sustainability problems (e.g. Jerneck et al., 2011; Thompson & Whyte, 2012). Proponents of issues or context-based science education have also highlighted the need for such approach (e.g. Aikenhead, 1994; Colucci-Gray et al., 2013; Pedretti, 2003; Ratcliffe, 1997). This alignment of student interests with the recommendations of educational experts gives further support that student-centered education could deal with issues that are not only relevant to the individual, but also to society and to the students' future vocation (see Stuckey, Hofstein, Mamlok-Naaman, & Eilks, 2013).

Some students also questioned the faith in the benevolence of technological progress and discussed technology and science also as a source of new problems (see Excerpt 5). This is in line with the results of a previous study, which showed that high-achieving students are interested in moral issues related to science (Tirri, Tolppanen, Aksela, & Kuusisto, 2012). Thus, discussing and critically assessing which issues technology can and cannot solve, how feedback loops diminish gains from technological development (see Goklany, 2009), and how professional communities in science and science-related fields can both suppress and support injustices, might be topics especially suited for advanced science courses.

Such discussions could be supported by providing students with opportunities to meet and talk with expert practitioners such as scientists and engineering. Previous research has shown that such encounters can provide students with role models, who may influence how students perceive science, themselves, their future, and active citizenship (see Cook, 2015; Kiwan, 2007; Tolppanen & Aksela, 2013; Vesterinen & Aksela, 2009).

Conclusions

This study describes the ways students claim to behave in and out of the school environment to make the world a better place. The results of this study also show that at least some of the 15–19-year-old students are able to take an active, personal and purposeful role in changing the world. Even the ones, who were already contributing to making the world a better place, were often preparing to do even more. This indicates that students see citizenship as a process of constant self-development (cf. Alderson, 2000; Levinson, 2010).

The richness and complexity in the ways students take action was evident in the wide variety of behaviors and rationalizations students described during the interviews. The previous studies on students' environmental actions have concentrated on a limited number of actions or issues (e.g. Sternäng & Lundholm, 2011). Our results show that students take action in so many various ways, that forming of an overview of students' pro-environmental and humanitarian actions through limited number of closed questions is a challenge. For example, most of the existing questionnaire studies on environmental actions have focused on things such as consumer choices and recycling (e.g. Boyes, Skamp, & Stanisstreet, 2009; Zsóka et al., 2013). Thus they do not measure the more proactive actions such as participation on community development projects.

Although the results presented are based on a relatively small number of highly selected group of informants, we believe that by helping a reader to see more deeply in the eyes of our future scientists and decision-makers, the results are of relevance for developing ways to support citizenship science education. Based on the results of the analysis of students' actions, their rationalizations for actions, and role of science in the rationalizations, we suggest that citizenship science education should include activities, which provide students ways to participate in solving the socioscientific issues, as well as possibilities to discuss the socioscientific issues from various perspectives.

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