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Promoting Participation in Society through Science Education

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Abstract: Participation in society can be promoted through science education. This study considers an example of how a lower secondary school teacher integrated participation in society into physics studies and how students (n = 20) perceived the participation exercise. In the learning process, students exchanged knowledge and tools with others and produced knowledge for the community in the form of a citizen's initiative leading to an action by the municipality: the painting of a pedestrian crossing. The students were keen to exercise participation and produce information through inquiries for their citizen initiative. After the intervention, most of the students expressed their willingness to participate in society and act as active citizens, they perceived that they have the means and opportunities, as well as the possibility to find support to participate and influence. Students were willing to participate particularly in their local communities. Students perceived that they learned and gained competences while participating. Students acknowledged knowledge as a base of the decision, which may promote perceived value of physics and associated careers. Students also highlighted collaboration and shared experiences, which may create engagement and participation concerning the scientific issues to which they relate. Similar participation exercises are possible in other contexts and countries. Further studies should focus on different participation exercises to gain more knowledge about young people's experiences on participation.

Keywords: context-based education; lower secondary school; participation; scenario; science education

1. Introduction

Participatory citizens are essential for the quality of democracy and civil society. Participation is central also in empowerment-oriented Education for Sustainability [1], and could be promoted also through science education. Participation is included in the concept of equity, or justice, which is a central component of the social sustainability framework, other components being urban forms, eco-prosumption, and safety [2]. Eizenberg and Jabareen [2] propose that "participatory justice is significant for developing human spaces that favourably reflect the efforts of sustainability" (p. 7). Participation concerns meaningful involvement in environmental decision-making processes. Also Rogge, Theesfeld, and Strassner [3] define and measure social sustainability through participation, social interaction, and perceived success.

Participation is strongly emphasised in the European Union. The European Union has undertaken a commitment to enhancing quality education by encouraging the participation of young people in the democratic life in Europe [4,5]. Education is claimed to be crucial for young people's integration and participation in society. The Council has approved common objectives to encourage active citizenship among young people by (e.g., providing greater support for various forms of learning to participate) [6].

The EU Youth Strategy [7] has been generated in order to promote dialogue between the youth and policy makers and thereby to increase active citizenship and to ensure inclusion of the young people in EU policy development. Also Council of Europe states that "participation and active citizenship is about having the right, the means, the space and the opportunity and where necessary the support to participate in and influence decisions and engage in actions and activities so as to contribute to building a better society" [8].

Public institutions produce outputs such as regulations or campaigns to citizens who on their part may produce inputs such as data, feedback or consultations for public institutions to the process in order to redirect public policies, or the communication may be mediated through non-governmental organisations (NGOs), media or other mediators [9]. The fundamental importance of participation to notions of citizenship, suggesting sharing power in making decisions relating to children's lives (e.g., [10]), but also learning and gaining important competences while participating (e.g., [11]) has been stressed by Lysgaard and Simovska [12].

This study contributes to the promotion of participation in society by examining through a case study how young people experience participation in society. The study contributes also to the discussion on learning to participate and how science education can promote social sustainability through participation training. Subject teachers of different disciplines consider sustainability issues in different ways in their teaching [13,14]. This study examines a participation exercise in the context of physics education which rarely has been reported.

2. Education to Participate

Checkoway [15] has collected some general propositions about youth participation which are substantiated by research or practice. According to him, youth participation is: (1) a right protected by the UN Convention on the Rights of the Child; (2) a process of involving young people in the institutions and decisions that affect their lives; (3) refers to the active engagement and real influence of young people, not to their passive presence or token roles in adult agencies; (4) assumes that young people are competent citizens, rather than passive recipients of services. Consequently, participation needs to be learned; hence education is a fundamental element of civil society. Citizens have ways to participate in the democratic life, e.g., they can be represented by elected representatives and take part in election debates, or through the action of interest groups and citizens' initiatives. From an environmental perspective, the right of all citizens to be involved in democratic, participatory processes is crucial in attempting to bring about positive change [16].

Education to participate in society needs an out-of-school context in students' everyday life. The term "informal science learning" is commonly applied with reference to activities that take place outside of the formal education system and seek to raise awareness of, interest in, and engagement with science and other Science, Technology, Engineering, and Mathematics (STEM) subjects and careers [17,18]. Participation in informal learning activities that highlight the purposes and effects of science may improve the perceived value of science [18]. But there is no single, shared definition of informal science learning; informal science learning can even happen with-in formal learning environments as an enrichment to school science or to bridge the gap between formal and informal science learning [17,19]. Teachers' need to increasingly to comprise to a wide range of formal, non-formal, and informal learning activities, often taking place within the school and another community of practice [20]. Through integration of formal and non-formal (or informal) science learning, particular responsibility of education to foster the integration of all groups in society, promote social inclusion, and EU common values of freedom, tolerance, and respect of human rights [21,22], can be supported. The expert group on science education [23] recommends that collaboration between formal, non-formal, and informal educational providers, enterprises, and civil society should be enhanced to ensure relevant and meaningful engagement of all societal actors with science and to increase the uptake of science studies and science-based careers to improve employability and competitiveness by encouraging open schooling where for example professionals

from enterprises/industry, civil and wider society are actively involved in bringing real-life projects into the classroom.

Brickell and Herrington [24] have developed a model of learner engagement that places the on-site excursion in the context of a three-phase process integrated with an authentic inquiry-based task—a pre-visit phase in the classroom environment, a fieldwork phase in the excursion environment, and a post-visit phase in the classroom environment. They state that in this context the on-site work takes on a new significance. The teacher's role in this process would be to create an authentic problem or task for students to complete over a sustained period of time [24]. Hohenstein and Uyen Tran [25] underline the learner's support suggesting that the use of guiding questions in association with the labels on exhibits affect visitors' conversations at object-based exhibits. Guiding questions were found to be helpful for increasing both the number of explanations and the number of open-ended questions, which is beneficial to cognitive learning. As is the case for conversations, shared experiences appeared to be an effective means to create engagement and participation concerning for example the scientific issues to which they relate [26].

Most European countries have recommended that science should be taught in a context, which involves teaching science in relation to contemporary societal issues [27]. Context-based science education, using cross-cutting themes, also has the opportunity to connect educational aims to the several key EU areas, such as environment, climate change, and health [28]. Based on the review of research on context-based science teaching, Bennett, Lubben and Hogarth [29] conclude that the use of contexts: is relevant to students' lives and interests at present; is relevant to situations students may encounter at some point in their lives; relates to technological developments and artefacts likely to be of interest to students; is relevant to students' possible future careers; links to recent scientific research and innovations; and forms a link to industry. Furthermore, while students may have specific interests at the individual topic level (e.g., robots, pollution) far beyond domain-level preferences (e.g., engineering, technology), some topics may be much more popular than others, irrespective of their larger domain category [30]. Context-based science education addressing the complexity of real-world issues is closely connected to Socio-Scientific Issues (SSIs) approach [31–34]. A strong connection exists between citizenship education and SSI approach formulated in science education, although citizenship has been criticised for being ambiguously described [35,36]. Johnston [37] suggests that socio-scientific issues should be associated with key concepts of science to form a basic scientific literacy, which is essential for effective education and participation in society's decision making processes associated with many socio-scientific issues.

3. Youth and Participation

Participation studies mainly evaluate the effects of participation on the personal and social development of the participants themselves, such as their knowledge and skills, critical thinking or civic competencies, for example (see [15]). Checkoway [15] states that "it is difficult to involve young people when they do not view themselves as a group that can create change, or when they have ideas but are unsure how to proceed, or when they take action but lack resources for implementation" (p. 342). Roe [38] studied children's (ages 6 to 10) involvement in environmental decisions and their feelings about planning, design and management of neighbourhood landscapes. Children had a strong feeling that their local landscapes were not planned or managed in favour of children, that children had a potentially valuable contribution to make and they were willing to voice opinions given the chance. The findings indicated that young children do have a useful contribution to make in the design and planning of local landscapes. In the study of Mackey [39], young children also saw their responsibilities and seemed confident and competent to make the decision on how to act appropriately within a local context. According to Iversen and Jónsdóttir [40], the out-of-school activities and students' SSI assignments are important factors of promoting citizenship particularly when located in their own district. In their study, supported by the teachers, the students contacted the municipality, comprising the local decision-makers which led to the students being invited to interview planning

managers from the municipality. During the interview, the students incorporated their lapwing observation and explored whether their observation could influence the decision-making process.

University students, in the study of Schroer, Lowman, and Just [41], were largely fascinated by the democratic dialoguing they experienced in public fora, but less so by the classroom training on dialoguing. The researchers support that student attitude, skills, and behaviours improve from a variety of learning activities in and out of class that facilitate student participation. In the study of Reichert [42] concerning citizenship, "all-around citizens" group (30% of the participating young people, ages 19 to 24) had very high probabilities on all citizenship behaviours items which were local community, obey the Law, support a Political Party, Discuss Politics, Learn about Politics, Learn about History, learn about Other countries, peaceful protests, human rights, environmental. The "Engaged" group, representing 42% of the participating young people, was very likely to associate good citizenship with local engagement; participation in the community, promoting human rights, and helping the environment. Members of that group were unlikely to perceive a good citizen as someone who supports a political party or discusses politics.

Few studies concern participation in society through science education. Roth and Lee [43] report a school science project where learning was made possible as students exchanged knowledge and tools with others and produced knowledge for the community, where this knowledge was distributed and which consumed the knowledge. They propose that rethinking science education as and for participation in community life sets up the potential for lifelong participation in and learning of science-related issues. Science education has the possibility to allow students to participate in legitimate ways in community life and therefore provides a starting point for uninterrupted lifelong learning across the presently existing boundary separating formal schooling from everyday life outside schools [43]. They prefer to foster situations that allow the negotiation of different forms of knowledge geared to particular problems as these arise in the daily life of a community rather than privileging disciplinary science. Also Davies [36] emphasises that science education can help students to become responsible citizens. He states that students ought to do the following to enact citizenship in science education: (a) explain views, understandings, and arguments; (b) tolerate, accommodate, include, and reflect upon opinions and views that may differ from their own; and (c) participate in the consideration and debate of ideas in the classroom and (ideally) use this experience and understanding in their life outside school.

This study narrows the gap between the knowledge about participation and science education and presents one model to integrate physics studies and participation exercise. The interest is in how science education can promote students' competence to participate in society, and to examine lower secondary school students' experiences in the participation exercise in science education through the following research questions:

How students experience a scenario leading to a participation exercise in school science?

How students perceive their willingness and possibilities to participate in society?

4. Materials and Methods

The study has been carried out in the context of the European MultiCO-project, which contributes to encouraging youth participation by challenging them to discuss issues related to the EU challenges (food, health, water, waste, energy, digital challenges, and biomass) in the contexts of science-related careers. Through learning environments, comprising scenarios related to careers and challenges mentioned above, the students learn skills to participate, collaborate and reason. In the learning processes, participation in community events is encouraged: students write in newspapers, meet policy-makers, and express their opinions in situations where citizens' views are asked. The consortium, comprising of multi-stakeholder learning communities, enables student interaction with other stakeholders.

In the intervention of this study, lower secondary school students' learning process started with a career-based scenario "Why the pedestrian crossing needs to be reinstated?" The teacher chose a local

problem including a real threat to students' health and life. The students were aware of the problem. The teacher incorporated municipal employee to the scenario and the employee had the opportunity to visit the class at the end of the project. The students presented their inquiry results to the employee and got a real chance to influence to local decision-making concerning their own life. Participation exercise was integrated in the study of the velocity concept in physics curriculum. In the following, the integration of the participation exercise is described in detail.

In the first lesson, teacher presented the scenario "Why the pedestrian crossing needs to be reinstated?" to the students. He took and showed a picture and a map (Figure 1) for the students where the pedestrian crossing used to be.

Figure 1. A picture and a map from the street showed to students.

In general, teachers of that school were wondering why the pedestrian crossing was removed, and they reasoned a nearby pedestrian underpass was the main reason for it. The problem is that few students use the underpass and now students are crossing the street dodging cars and creating dangerous situations. The location has a 30 km/h speed limit but it seems only few drivers obey this limit.

After pointing out these issues, the teacher showed a short video about road safety and pedestrian crossings made by the Finnish Road Safety Council (Liikenneturva). The video reminds motorists about the responsibility to slow down before pedestrian crossings. To improve safety, the students should find a way to influence municipal decision-makers and form a letter to them. Students were asked to find facts supporting the need for the pedestrian crossing. Thus, students were instructed to find out

1. Do motorists obey the local speed limit of 30 km/h?
2. Does a pedestrian crossing sign have an effect on motorists speeding?
3. How many students choose to run across the street or do they use the underpass?

After presenting the theme for research, teacher formed four small groups and the students, and chose which part above they would like to investigate. The aim of the students was to write a letter to the head of municipal engineering. The students should argue why they need to get the pedestrian crossing back near the school. After presenting the scenario and forming the small groups, students had 15 min to make rough plans how they are going to investigate their problem.

Lessons 2 and 3 continued with the inquiry stage where students worked in four small groups. In the first 45 min, two student small groups measured the speeds of vehicles on the street (responding physics curriculum). The two groups worked in different places to answer the research questions 1 and 2 above. One small group interviewed students in the classes as well as teachers to get information how students and teachers behave when they need to cross the street. Fourth group had the task to plan questions for the head of municipal engineer, collect the results from the other groups, and write a document for the official.

The teacher discussed with the two small groups measuring the speed of motorists to find out what they would need for measuring the speed. As radar was not an option, students quickly remembered that they need distance and time to determine the speed. Teacher gave the students the

equipment to measure time and distance and the students planned the measurements. The students used landmarks e.g., trees and traffic signs to determine the distance and a stopwatch to measure the time. After the measurements, the students went back to the classroom to calculate the results and reported them to the group, which collected all inquiry results. During this time, the two other small groups were carrying out the interviews and planning the questions for the municipal engineer.

Students found that the motorist violated the speed limit 80% of times with no pedestrian road painting and sign. The interview showed that only 4.7% of students (n = 150) use the underpass to cross the road. The results that students gathered support heavily the need for a pedestrian crossing and so they progressed to formulate a letter to the officials.

During the last lesson, the representative of the municipality visited the classroom and answered or discussed all the questions and arguments the students had prepared. The visitor presented himself and told about his job description and challenges the position holds. The students proceeded to the questions they had prepared which can be compartmentalised on the basis of information about the work of the municipal engineer and of the missing pedestrian crossing.

Students were interested in the work title, tasks, education, career path, salary, responsibility and opinions about the position the visitor was in. Then the student small group proceeded to ask questions about the pedestrian crossing, which included topics:

1. Why was it removed?
2. Was no one using the crossing?
3. What is the general opinion about the removal of the crossing?
4. How much does it cost to make a new pedestrian crossing?
5. What is your opinion about the speeding in the location of the former pedestrian crossing?
6. Have you thought about adding the pedestrian crossing to the location?

The students presented the results of speeding cars and students who ran across the road and the municipal representative strongly suggested that the students should make an initiative to the municipality for restoring the pedestrian crossing. After the lessons, the students formulated an initiative to the official for restoring the pedestrian crossing and sent it. In this way, students practiced doing a citizen initiative. The scenario, based on this intervention, is presented on the project's website (www.multi-project.eu) and is modifiable to different contexts. Based on the students' initiative, the municipality organized the painting of the pedestrian crossing which the local newspaper reported.

The scenario and the following assignments offered students the possibility to participate in society through social interaction with an engineer and peers as well as through the citizen initiative; through the intervention all participants contributed to social sustainability (cf. [2,3]). Further, the activities out of classroom and SSI assignments were essential components of the intervention giving the possibility to promote citizenship similarly as in the study of Iversen and Jónsdóttir [35]. Moreover, the intervention created by the science teacher, offered students possibilities to learn important competences in the participation process, executing the Preamble of the Revised European Charter on the Participation of Young People in Local and Regional Life. The students were involved in the municipal decision-making affecting their lives, were actively engaged and had a real influence, and thus were practicing to be competent citizens (cf. [3,4,6,7,10]). The students were able to bring about positive change [11] leading to the painting of the pedestrian crossing. This intervention, when including an out of classroom context in students' everyday life, may also raise awareness of, interest in and engagement with physics subject and careers [12,13]. Informal science learning was used within formal learning environments as an enrichment to school science [12,14]. The visit of the official was integrated in the learning process (cf. [15,16]) and the teacher was well able to integrate a range of formal and informal learning activities.

The approach in the intervention is similar than suggested by Brickell and Herrington [19]: activities carried out in class, in field and finally in class. The teacher presented an authentic problem for students to complete over a sustained period of time (cf. [19]) and he used guiding inquiries

and questions that students could find facts for the base of their final task to write a letter to the municipality. The role of guiding questions and inquiries was essential [20], however, the students had the freedom to decide which of the inquiries they carry out. Student groups had to carry out different inquiries and shared experiences, which appeared to be an effective means to create engagement in the scientific issues to which they relate as Meisner et al. [21] have pointed out. Participation in society was completed by writing an initiative to the official.

The context, the pedestrian crossing, was a local societal issue [24,27,29] connecting educational aims to the key EU area, environment [28], but more pointing out societal sustainability in promoting participation in civil society. The context was relevant to situations students may encounter everyday [24]. In the learning process, students exchanged knowledge and tools with others and produced knowledge for the community, where this knowledge was distributed, and which consumed the knowledge [38] leading to an action. The result of the initiative was that the community organised the painting of the pedestrian crossing next summer following this intervention and the local newspaper reported students' initiative and the follow-up. Science education contributed to help students to become responsible citizens [31]. Students participated in the consideration and debate of ideas in the classroom and used this experience and understanding in the community life. The socio-scientific issue was nicely associated with key concepts of physics [32], which is particularly challenging. In the original idea of the MultiCO-project, a scenario starts the study process and includes career presentations. In this solution, the teacher decided to introduce the official in the scenario and ask the official to visit the classroom later after the inquiries.

In this case study, the participants were 20 students (8th graders, 13–14 years) and a science teacher in a rural school in eastern Finland. The teacher and the students had previously participated in two MultiCO interventions being thus familiar with the idea of career-based scenarios. The students answered, after the scenario stage, a scenario evaluation questionnaire including 28 Likert items, all of them in 4-point scale (modified from [44]). All students participating in the intervention were interviewed (about 15 min). In the interview, the students were asked about their perceptions on the participation exercise and their perceptions on their future participation in society.

Interview data was analysed by the aid of Atlas.ti Programme using content analysis [45]. The analysis included two main phases: the preparation phase and the organising phase. The preparation phase included transcribing the data and reading it through to make sense of the whole data. In the organisation phase, thematic analysis to identify themes and categories, seeking to find repeating patterns of meaning or expressions across the material [46] were implemented. The analysis started by looking what the students told concerning the participation activity. Then, all the material was analysed to shed light on the intervention process. In accordance with the thematic analysis steps, our process changed from descriptive analysis, wherein broader themes dominated, to interpretive analysis to seek the deeper meanings and implications of these themes [46]. Additionally, the research that has been initially presented, contributed to the interpretation of the data. The analyses were an abductive process whereby theory and data contributed to identifying connections across the material and themes [45–47]. During this process, two main themes were distinguished: (1) experiences in participation scenario, (2) perceptions on students' own willingness and competence to participate now and in future. The questionnaire was analysed by SPSS Programme and descriptive statistics are presented in the results.

5. Results and Discussion

5.1. How Students Experience a Scenario Leading to a Participation Exercise in School Science?

Nineteen students responded the scenario evaluation questionnaire. Students' perceptions on why the pedestrian crossing needs to be re-instated scenario are shown in Table 1 (only items concerning participation are presented).

Table 1. Students' why the pedestrian crossing needs to be reinstated scenario evaluation (n = 19).

Items	M	SD	% Agree (n)	% Disagree (n)
This scenario enables me to gain new knowledge about the scenarios' topic.	3.1	0.5	89% (17)	11% (2)
The knowledge I gain from the scenario may be useful in the future.	2.9	0.7	74% (14)	26% (5)
I can put knowledge gained from the scenario into practice, to solve problems.	2.9	0.6	79% (15)	21% (4)
From this scenario. I am able to gain new knowledge about possible careers.	2.7	0.7	74% (14)	26% (5)
This scenario enables me to understand the responsibilities of the persons in the career position indicated.	2.5	0.8	58% (11)	42% (8)
This scenario enables me to understand the skills that are necessary in this profession.	2.5	0.8	58% (11)	42% (8)
I find this scenario topic important for me personally.	2.2	0.8	32% (6)	68% (13)
I find this scenario topic important to my family.	2.2	0.6	21% (4)	79% (15)
I find this scenario topic important for appreciating the work of our local community (town, country).	2.6	0.5	58% (11)	42% (8)
I find this scenario topic important for the whole world.	2.7	0.9	63% (12)	37% (7)
I feel my future career may be connected with the topic covered in the scenario.	1.5	0.8	5% (1)	95% (18)
I think my future studies at the secondary school or university level may be connected to the topic covered in the scenario.	1.6	0.8	5% (1)	95% (18)
I predict I will need to perform skills, described in the scenario, in my future.	1.9	0.9	21% (4)	79% (15)
I predict I need to perform science-related skills, described in the scenario, in my future career.	1.8	0.7	16% (3)	84% (16)
The scenario describes the science community, to which I relate.	2.0	0.7	21% (4)	79% (15)
The scenario presents a scientific problem, which is socially relevant.	2.4	0.6	42% (8)	58% (11)
The scenario makes it easy for me to relate with the situation described.	2.4	0.8	47% (9)	53% (10)
I know (?) about the career described.	1.7	0.7	16% (3)	84% (16)
I know (?) about the topics in the scenario.	2.4	0.6	47% (9)	53% (10)
I find this scenario interesting to me.	2.5	1.0	47% (9)	53% (10)
I find the information in this scenario valuable to me.	2.2	0.6	32% (6)	68% (13)
This scenario makes me want to learn more about the topic.	1.6	0.6	5% (1)	95% (18)

The students perceived that they gained new and useful knowledge in the scenario (cf. [6,7,10]), which they can use in future. This knowledge is interpreted to be knowledge about the ways to participate and how to create citizen initiative (see next chapter). However, even that the topic was interesting to students being close connected to their everyday life [24], it was not important to them personally and they perceived that to their families neither [25]. Nevertheless, the topic was perceived more important to the community and even more to the whole world, the problem was seen socially relevant and students were able to relate with the situation. The students understood skills needed in the profession presented in the scenario.

In the interviews, students explained how they perceived the scenario's idea to participate. They perceived it good that they can influence even though they did not perceive the scenario important to them personally. In addition, they were interested in participating in society.

S1: It was quite nice, it was possible to do a thing that we could influence.

S2: It was good that we had the possibility to influence.

S3: It was pleasant, we could ourselves affect something.

S12: It was in a way good that children or those in our age can influence.

S13: That everybody could express his/her opinions about the pedestrian crossing.

S14: I think it is quite good that one can in this age decide those issues or influence things in some way.

S15: I think too that it is good that eight graders are able to influence some things that they can say their own opinion.

The interview data confirms the responses in the questionnaire. The students were keen to exercise participation and produce information through inquiries for that [2,3]. They perceived success through pointing out particularly the influence through the initiative, which indicates experience of social sustainability [3].

5.2. How Students Perceive Their Willingness and Possibilities to Participate in Society?

Students' perceptions on their possibilities to participate, based on interviews after the intervention, were categorized in the school and community level as well as in the future perspective. Examples of the excerpts in the interviews are shown in the Tables 2–4.

Table 2. Students' perceptions on participation possibilities in school level.

Participation Possibilities	Descriptions
Positive perceptions	S4: I am able. S6: I can, if I notice some flaw what could it be, clearly something to be corrected so I can do this kind of initiative myself. S7: Yes, sure. S8: Probably I can in some extend. It could be quite yes if there is a need to that. Well, yes one could influence in some way. Well, I probably would make an initiative. S11: Yes, I could influence well. However, I would not like to do anything different. S16: Yes when we have always sometimes questionnaires about school. S17: Just through these questionnaires we fill in, in some lessons yes.

Table 2. *Cont.*

Participation Possibilities	Descriptions
Conditional perceptions	S1: Perhaps I can but I do not know how. S2: I do not believe that in school environment . . . maybe in some way, but I do not believe that I can influence much at least not alone. S10: One cannot very much, it goes to the board of student council and those, but if there is a very important thing then there is a possibility. S12: I probably can very good . . . They take always ideas all the people there [student council]. S14: Thus I do not know if I have myself influenced but sometimes yes I have suggested to form master what could be there [student council]. S15: I can if there is a need to say something to the student council and they can put it forward.

Table 3. Students' perceptions on participation possibilities at the community level.

Participation Possibilities	Descriptions
Positive perceptions	S1: It seems that it is possible to influence very much and easily and so. It does not insist much that one makes an initiative for example just one wants the pedestrian crossing there. S3: Yes, if one makes an initiative and then so. S6: To my opinion I can. S12: Yes I certainly can at least in some extend to such smaller things. S17: It is so that all can influence things in a way they want then one needs not to watch [outside] what happened and so. S18: Not myself but my mother is working in the municipality yes I quite often tell to her what kind of issues there could be or could be good to be and the she makes such.
Conditional perceptions	S4: In the community level? . . . Well yes in some way. S5: I do not believe that very much but always one can do an initiative or be with in helping to do that and then bring it to the municipality to the decision-makers that there are some facts on the table. But that's it. And of course the more one makes work for that, so of course one has more influence or possibility to influence. S5: Yes, that we with the class, alone it could not be happened at all, but with the class and the teacher I can. S11: But I do not even live here so I live in . . . it is far away.

Table 4. Students' perceptions on participation possibilities in the future.

Participation Possibilities	Descriptions
Positive perceptions	S1: I can if there is something at school then it is nice but probably I do not do it independently. S2: I could talk with a teacher or mother or father and then take the issue out and they would bring it forward. I do not know. S3: I could in principle participate yes. S4: I would like. S7: It would be nice. S9: Yes it would be quite nice. S10: Yes certainly yes, I suppose. S12: Yes, certainly. S17: Yes, if there will be such so yes.
Conditional perceptions	S5: Certainly if there is, but if only not alone to be there who starts but in helping yes, why not, if the issue is interesting. S6: I cannot really say, there is always somebody if not myself I do not go there but if there is a need to measure or something why not if we do it together.

Nearly all of the students (n = 16; 84%) perceived that they have participation possibilities in the school level, through student council or surveys which they answer. Ten students perceived positively their participation possibilities in school level and six students were the opinion that they have the possibility to participate in some circumstances. For example, student S1 stated that he/she is able but does not know how. Student S2 pondered that he/she cannot do that alone. Students 10, 12, 14, and 15 perceived that they can participate or influence through other people in school such as student council or form master. Students' perceptions on the participation in community level are shown in Table 3.

Eight (42%) of the students were the opinion that they are able to participate in society in the community level. Five of them perceived the possibility quite positively. They stated that it can be done easily (S1), through initiative (S3), to small issues (S12) or through acquaintances (S18). One (S12) of the students perceived that he is able to participate in small things. Three students had some conditions for the participation: in some way (S4), lot of work to do an initiative (S5), in collaboration (S5) or the possibility needs to be near the person (S11). While 16 students perceived that they have participation possibilities in school level, half of them perceived that in community level. Students' perceptions on the participation possibilities in future are shown in Table 4.

Eleven students (58%) out of 19 perceived that they could participate in society in the future. According to the students, it may happen at school (S1), through acquaintances (S2), and it would be nice (S7, S9). Two students (S5, S6) perceived that they could participate in collaboration but not alone. Students perceived that they could participate in school or community level in the future.

In the interviews, students handled also knowledge and skills needed to be able to participate. These descriptions are shown in Table 5 as well as the perceptions on what and how to do for the participation.

According to the students, skills such as to write right and clearly (S2), and the ability to present the issue in a reasonable and understandable way (S5, S10) are needed, as well as skills to use computer and email (S1). They also highlighted group working (S1). Further, one should know in which one wants to influence, and what are the benefits of participation (S5, S10). Also, courage is needed (S12). One should also know the facts, why to act (S17). In the questionnaire (previous chapter), the students also pointed out learning of skills, which the interview data now confirms.

Students also pondered what and how to do if one is willing to participate. They pointed out collecting data (S1, S6, S7, S8, S10, S17) and reason the request (S1). Student S2 stated that one needs to identify the problem and try to solve it. Student S4 suggested gathering up a group which starts to ponder (also S7, S9) the issue or ask others (S8, S10) and S5 suggested to find alternatives. Student 11 would like to tell to the municipality and send a letter to them (S12 sends feedback). Also informing an adult was suggested (S14) as well as a municipality initiative(S15).

Table 5. Students' perceptions on knowledge, skills, and activities needed in participation.

Knowledge and skills	S1: That why the pedestrian crossing is taken away or I do not need anything but computer and mail. S1: On the other hand is and can as a group of course. S2: Skill to write. That one can write right and clearly. S5: Certainly one should in some way know that to which issue one wants to influence, what will be benefits if the pedestrian crossing will come and then something that one can present the issue understandable and rationally. S10: Just like now that why it would be good to be it [pedestrian crossing] there and would there be benefits, we did not need much knowledge, when we sent the message there that there is a reason why it [pedestrian crossing] should be. S12: Certainly such that one dares to put the voice audible and dares to tell about the issue I do not know what. S17: Such that one thinks that how many it if we speak about the pedestrian crossing uses it and that how many however walks across the street even there is no pedestrian crossing and how many use really that subway.

Table 5. *Cont.*

What and how to do?	S1: Certainly I would collect all the knowledge what is needed and then try to tell why we need it [pedestrian crossing] and such. S3: One should immediately hear what is the problem and then try to apply and find the solution. S4: It depends on the situation but well I would certainly collect a group with which we would start to ponder. S5: Yes certainly I would try to ponder that why one could or alternatives how one could solve and to suggest those then. S6: If I get it then probably I will inquiry a little bit before it and so. S7: Certainly I would clarify about it all the knowledge and then start to plan. S8: At least what we collected the knowledge how the cars behave there. I am not quite sure, I would ask help form others and so. S9: In the same way, I would ponder at first what to do. S9: It would be in group easier. S10: Certainly I would probably inquiry some time it and then for example ask those or would put an initiative forward. S11: I would tell somebody who knows municipality issues and then myself would send a letter. S12: I would search an address where to send a message. I would search such where to send feedback about it. S14: Probably at first I would inform some adult and then I would search a person whom to send the issues and who can influence then the decision. S15: I do not know, probably I would do that citizen initiative.

For example, student S2 described in the interview his/her perceptions on participation in the following way.

I: How do you perceive your own possibilities to influence road safety? Do you have tools for that?

S2: On the other side I have and one can as a group of course always influence.

I: Yeah, well what kind of knowledge do you need to influence?

S2: I really do not know.

. . .

S2: Initiative.

I: Yeah. To do an initiative. Well, what kinds of skills you need to do that initiative?

S2: Certainly writing skill. That one can write and clearly.

I: Yeah and then a little bit knowledge about that.

S2: Yeah.

I: Related to that what you already collected here. Well, can you influence the safety in the school environment?

S2: I do not believe that in school environment . . . well maybe in some way, but I do not believe that I can influence much, at least not alone.

I: Yeah, well the pedestrian crossing is here near, so one could see it in a school environment level. But how do you feel, can you influence the issues in the community level?

S2: Yeah, if one makes an initiative and then so.

I: How about, would you like to be with further in this kind of participation?

S2: Yeah I could in principle participate, yeah.

I: How would you act in further if you will encounter this kind of problem?

S2: Certainly I would collect all the knowledge what is needed and then try to say why we need it and something like that.

After the intervention, most of the students expressed willingness to participate in society and act as active citizens. They perceived that they have the means and opportunities, as well as the possibility to find support to participate and influence (The Preamble of the Revised European Charter). Students were willing to participate particularly in local community, this finding being in line with the findings of Reichert [37] and Schroer, Lowman, and Just [36]. Students pointed out the citizen initiative but no other means which also were not discussed during the intervention, thus their view on participation in society is still narrow. Students referred to the support from individual adults or generally to groups and did not mention NGOs or other mediators between public organizations and citizens (cf. [4]). Students perceived that they learned and gained competences while participating [6,7,10,33] as is found also among younger ones [34]. Students were proud that their initiative was taken seriously and it had a positive influence [11,38]. They perceived success, which may promote social sustainability [3]. Students acknowledged knowledge (facts) as a base of the decision and this may promote students perceived value of physics and careers [12,13], however, this was not clearly indicated in the interviews. Students also highlighted collaboration and shared experiences, which may further create engagement and participation concerning the scientific issues to which they relate [21].

The SSI context of the intervention was appropriate for the lower secondary level to promote students' willingness towards citizenship [30,31,35]. Interviews and questionnaire data complemented each other. The interviewers were familiar to the students allowing them to discuss openly and honestly.

6. Conclusions

This study can be seen necessary as only little attention has been directed to the practical implications of citizenship in science education. Participation exercises are not previously reported in the connection of physics education. This study shows a way to integrate participation in society exercise to physics studies and even to the studies of basic concepts of physics. The strength of the scenario was that it handled an issue of students' everyday life. The intervention promoted besides of physics knowledge, also skills to participate, thus social sustainability. Field work and a visitor out of school were examples of informal education supplementing formal education.

The scenario of the intervention created by the teacher was perceived interesting and societally important by the students. The students experienced that they learned knowledge and skills how to participate in society and were keen that also they can participate. The students were willing to participate particularly in local community. The perceived value of the participation was high, the municipality took students' initiative seriously and painted the pedestrian crossing after students' request.

As this is a small-scale study, which can be seen as a limitation, new interventions are needed to provide a fuller picture of the topic at hand. This empirical study provides a starting point for other science education researchers willing to further develop this field of knowledge.

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