

The use of drama in secondary education to increase motivation for learning about environmental issues

Master Thesis

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Abstract

Environmental issues like climate change and pollution have become more prominent in our daily lives. Sea levels are rising, weather is turning more extreme and the amount of plastic litter is so immense that it can even be found in our food sources. Both the media and schools give increasing amounts of attention to environmental topics and the importance of these topics becomes clearer every day. In this study a lesson series was developed to see whether using drama in socio-scientific inquiry based lessons about human impact on the environment could increase students motivation for the subject. Two classes served as a control group and received education mostly based on their textbook and making online assignments, while two other classes were asked to write a play and perform it before their classmates. . Data about the students' motivation was gathered using questionnaires that served as pre- and post-tests. During the lessons students were observed and groups of students were interviewed. The results show a trend in which the drama group showed an increase of motivation during the study as opposed to the control group, where no increase in motivation was observed.

Introduction

Topics like climate change, pollution and medical discoveries make it to the news nearly every day. But even though scientific discoveries have great influence on our daily lives, people don't seem to be interested in scientific discoveries (Osborne, *et al.*, 2003; EU Report, 2005). In 2005 an EU report stated that the public is sceptic about science. Only 35% of the European people indicates to be really interested in reading about the latest scientific discoveries. (EU Report, 2005). The problem of a decline in scientific interest can also be seen in schools. The PISA 2015 report (Feskens *et al.*, 2016) showed that students in the Netherlands have become less interested in science over the past decade. Not only the scientific interest of Dutch secondary school students has been declining, their scores have dropped as well. When it comes to questions about scientific topics the Dutch students scored far below average, especially when it came to environmental topics like climate change (Feskens *et al.*, 2016).

Environmental issues like climate change and pollution have received a lot of media attention over the years. Not only is the environment a very visible topic and it affects our daily lives, it is deemed very important by both the media, government and education systems. Because of the scale of impact and the large amount of attention given to the subject of human influence on the environment, themes like climate change have been used as a context throughout both primary and secondary science education. But then, how is it that PISA report showed the Dutch students seem to have so much trouble with the questions about the environment? A possible explanation can be found in the lack of interest the Dutch students show towards science and the environment (Feskens *et al.*, 2016). In order for the Dutch students to score better results in scientific topics, it is important to increase their interest towards science.

The Montessori school in which this research was conducted also observed this same lack of motivation when it came to the environmental chapters in the biology lessons. Over the past few years teachers have tried several teaching strategies in order to increase this motivation, including the use of socio-scientific issues (SSI) as contexts during the lessons and the use of digital assignments. However, until now not with many results. When the teachers were asked about the observations they made during these classes, they all mentioned the students were not interested because they didn't feel related to the topic.

Relatedness is one of the three key aspects that are of importance for motivation: Autonomy, competence and relatedness (Ryan & Deci, 2000). These three key aspects form the corner stone in Ryan and Deci's Self Determination Theory (SDT; Ryan & Deci, 2000). When conditions are not met for all three aspects, the SDT describes motivation will be lower. For example, this means that when students are less interested and feel less related to the topic at hand, their motivation will be negatively affected. If interest and the feeling of relatedness are low, so will the student's motivation be (Ryan & Deci, 2000).

One way that has shown to help increase both understanding and relatedness is the use of socio-scientific issues (SSI) as a focus during classes (Ratcliffe, 1997; Wilke & Straits, 2005). SSI's combine social and scientific aspects, which gives students a chance to place the scientific information in a context that is relevant for them (Ratcliffe, 1997; Wilke & Straits, 2005). By focussing the assignments on much discussed socio-scientific issues, like pollution, students feel more related to the topic and will therefore be more motivated. However, even though the teachers in this school have been working with SSI's in their ecology lessons, the students still didn't show much motivation in regard to the topic. Therefore the teachers would like try other teaching methods that improve the students motivation during the lessons about ecology

In order to try and improve the students motivation further, a teaching strategy other than the use of SSI's was introduced in the school. Socio-scientific inquiry based learning (SSIBL) is a teaching method which combines SSI's with inquiry based learning and citizenship education (Levinson, 2014). When teaching according to the SSIBL framework, active participation is a key factor to success. The more students actively participate in learning activities, the more they will increase their reasoning, argumentation and possibly interest and motivation (Levinson, 2014; Dias & Fonesca, 2017). However, in order for SSIBL to work, much thought has to be given to what these active work forms should consist of.

Over the past eight years one active lesson activity has shown great potential when used in SSI based lessons: the use of theatre in science lessons (Wieringa *et al.*, 2011). In contrast to SSI the use of drama does not only allow students to read or watch information about a topic, but also allows the students to actively participate in class. By letting the students act out their own story line regarding the topic being taught they will be able to think about the topic from different points of view and will be more likely to form their own opinion, improve argumentation and feel more related to the topic (Toonders, *et al.*, 2016; Archilla, 2017). However, until now research about drama has mostly been done with students in higher education. Because of this, not much is known yet about the possibilities of drama in secondary school science education.

For this research a new lesson design was developed for the lessons about the human impact on the environment. This design was based on the SSIBL framework and used drama as the main active lesson activity. The goal of this research was to find out whether or not the use of drama would increase the students motivation. Or in other words: How does the use of drama effect secondary students' motivation towards human impact on the natural environment?

Theoretical framework

Self-determination theory and motivation

Intrinsic motivation is the type of motivation that comes from within and creates a desire to engage in activities for no reason other than enjoyment, pleasure, challenge or interest (Cordova & Lepper, 1996). Humans are naturally curious beings, who tend to be intrinsically motivated to learn from the moment they are born. However, when children grow older and start going to school their intrinsic motivation for discovering and understanding grows weaker (Cordova & Lepper, 1996). This decline in intrinsic motivation can be explained by several external factors, like goals or expectations (Vansteenkiste *et al.*, 2007; Ryan & Deci, 2000).

According to the Self-Determination Theory (SDT; Ryan and Deci, 2000) intrinsic motivation is based on three inherent needs, namely autonomy, competence and relatedness. The first need, autonomy, means that students are the most motivated when they have as much control over their one learning process as possible. The fact that school is a very controlled environment undermines students autonomy and can therefore negatively influence motivation, which can be an explanation for the decrease in motivation children show after they enter school (Ryan & Deci, 2000). The second basic need SDT describes is competence. This refers to whether or not the difficulty of a subject is suited for the student. When a student feel he can't complete a task, he will lose the motivation to even try. On the contrary, when a student feels the task is too easy, it will not be a challenge and the student will not feel motivated to try very hard (Ryan & Deci, 2000; Vansteenkiste *et al.*, 2007). In other words, in order for students to feel competent, there has to be differentiation to match the correct level of difficulty for each students. Better differentiation means higher motivation. The third and final basic need described in the SDT is relatedness. Relatedness can refer to both the effect a certain topic has on the students daily life, but it can also refer to triggers of interest that the student already has (Ryan & Deci, 2000).

When all three basic needs from the SDT are met, students have the highest chance of developing an intrinsic motivation.

Improving relatedness by using socio-scientific issues

As described in Ryan and Deci's SDT (2000), relatedness is one of the three basic needs when it comes to motivation. One way to increase students' relatedness to a topic is to integrate contexts regarding socio-scientific issues (SSI) in the lesson. By linking the topic to a socio-scientific issue, students can be made more aware of the relevance and therefore feel more related to the topic. Previous research has shown that the use of SSI's during science and biology lessons can both improve relatedness and motivation and can also be used to train specific skills (e.g. teamwork and argumentation) (Wilke & Straits, 2005; Ratcliffe, 1997). However, even though previous research has shown that SSI can have a positive effect on student motivation, it also has some down sides (Wilke & Straits, 2005). For instance, when focussing on one specific socio-scientific issue less information can be handled in comparison to direct instruction. Because of this, teachers often choose to not focus entire lessons on SSI, but just some parts (Wilke & Straits, 2005). For example using a SSI as a context for the introduction of the topic.

Several SSI's regarding biology, or more specifically the natural environment, that have gotten a lot of media attention over the past few years are the topics of pollution, global warming and animal extinctions. Not only have these ecological topics received a lot of media attention, they have also been used in several studies about SSI in biology classes and have become a recurring topic in both primary and secondary education biology lessons (Byrne *et al.*, 2014; Feireabend *et al.*, 2011; Fortner, 2001). One of these studies showed that even though global warming and pollution are complex topics, children from the age of 10 were already able to discuss different arguments about it and were able to reflect what kind of impact their own lifestyle would have the environment (Byrne *et al.*, 2014). Seeing as these environmental topics have received a lot of attention over the past few years and have already proven to be effective in young children, the use of human impact on the natural environment has already been used and has proven to be effective as an SSI in biology classes (Byrne *et al.*, 2014; Feireabend *et al.*, 2011; Fortner, 2001).

Socio-scientific inquiry based learning

After finding a suitable SSI for the lessons, in this case the human influences on the natural environment such as pollution, it is important to think about how the SSI will be taught. The use of SSI in lessons can be done in different ways, for instance as a context in the introduction of the topic. However, in the past few years a pedagogical framework has been designed that not only uses SSI's, but also inquiry based learning. Socio-scientific inquiry based learning (SSIBL) is a method that combines the contexts of SSI's with promoting citizenship (CE), the use of inquiry based learning (IBL) and responsible research and innovation (RRI) (Levinson, 2014). By combining the scientific parts of RRI and IBL with the social aspects of CE and SSI, SSIBL allows for a much broader teaching method that can connect several topics at once. This way, a much broader learning experience is created in which student do not only learn science, but also learn how it fits into our social lives (Levinson, 2014).

When teaching according to the SSIBL framework, the topic at hand must be an open-ended inquiry with an open solution. A truly open solution encourages students to increase their argumentation and actively think about a solution by learning about the science needed to understand the topic. During this process the SSIBL framework promotes active lesson activities in which students have the opportunity to learn and discover the topic for themselves (Levinson, 2014). By allowing the students to participate actively not only argumentation and discussion can be improved, but the students will also be able to increase their feeling of autonomy and feel more related to the topic which increases motivation (Levinson, 2014; Dias & Fonesca, 2017). As elaborated above, the feelings of autonomy and relatedness were described by Ryan and Deci (2000) as two of the key factors to improving motivation. Since SSIBL has shown to positively influence these two key factors, the use of SSIBL shows a lot of potential in developing lessons that improve motivation.

The use of drama in science classes

One possible way to use active teaching methods in lessons using the SSIBL framework is the integration of drama in the science lessons (Wieringa *et al.*, 2011). Even though not much research has been done yet about the effect of using drama in science classes, one study has

shown the use of drama to be effective in increasing student's reasoning and argumentation (Archilla, 2017).

Scientific theatre is a method of teaching in which science is explained using a story with a plot line which is focussed on a specific scientific topic. In the past scientific plays were mostly used in theatres to explain to the public about a topic and to give both science and theatre a bigger audience (Shepherd-Barr, 2006). Only recently the use of drama as a teaching method in science classes started to develop (Wieringa *et al.*, 2011). When using drama in an educational setting it can be categorised in two different categories: presentational and experiential (Ødegaard, 2003). In experiential drama the students adopt an opinion or attitude, while presentational drama refers to a learning activity in which students dramatize a scientific topic in front of spectators (Ødegaard, 2003). Experiential drama can be short activities done in the shape of a role-playing or improvisation game, which is why experiential drama is seen as the drama category that is integrated in classes most easily (Ødegaard, 2003). However, over the past few years the possibilities of using presentational drama in science lessons have been starting to get more attention in literature as well, showing that the use of performance drama can have positive effects on both the motivation of the students as well as their understanding (Ødegaard, 2015; Saka *et al.*, 2016; Sarışan-Tungaç *et al.*, 2018).

In presentational drama students have more room to use their own opinions and ideals, instead of adapting according to your role (as is the case in experiential drama) (Ødegaard, 2003). This allows presentational drama to be very useful for engaging students in a creative and physical exercise in which they can learn about moral and ethical issues, while also leaving room for the students' own input in the learning process and stimulating autonomy (Toonders, *et al.*, 2016; Saka *et al.*, 2016; Sarışan-Tungaç *et al.*, 2018). Giving students room to come up with their own plays however, also has some down sides. Sometimes students tend to get lost in their imagination, which makes the play move to far away from the underlying science. For this reason, it is important the teachers keeps in check whether or not the students are keeping to the reality principle as described by O'Neill (1985). Another difficulty when leaving students free to write their own story line can be in the fact that the students are given a lot of autonomy. This means the teacher has less control over the group and the chance of misconceptions and misinterpretations in the students way of thinking about the topic is higher than in a more teacher controlled direct instruction. Time management even furthers the teachers difficulties as performance drama is more time consuming than direct instruction and can have a lower learning output (Ødegaard, 2003; Wieringa *et al.*, 2011, Toonders *et al.*, 2016). These difficulties in time management and control can however partially be resolved by adding structures in the assignment, for instance in the form of requirements in the script. An example of this is the requirement to have several stages in the script (Verhoeff, 2017).

This requirement of stages to add more structure to the lesson as mentioned by Verhoeff (2017) was used during this study as well, by requiring the students' plays to have three specific parts in their play: introduction, occurrence, response. Furthermore, the students were required to put several specific characters in their play, to make sure all important views regarding a topic would be used in the play. In order to help with time management, the students were given a tight schedule up front in which they were told what goals to achieve each lesson.

Method

Approach

During this research, the goal was to see how the use of drama in SSIBL lessons influence students' motivation regarding the topic 'humans and the environment'. For this research a lesson series of nine lessons was designed, in which the final five lessons differed between the control and performing groups. The lessons were part of a quasi-experimental study in which data in regard to the student's motivation was collected before and after the classes using questionnaires, as well as throughout the lessons using observations and semi-structured interviews.

Lesson design

The lesson series was designed for four classes 2HAVO/VWO from a Montessori Lyceum in the Netherlands. The school is a small school of about 900 students in the middle of the Netherlands, close to the city Utrecht. Most of the students attending this school are Dutch born children from parents with an above average income. All four classes participating in this study belonged to the same school, were taught by the same teacher and the topic was the same for all four groups (humans and the environment). The teacher was a young teacher with 2 years of experience and had been teaching these classes for 10 months. All four classes existed of approximately 30 students (see table 1 for exact numbers) and have biology classes twice a week. Before the start of the research, all parents were given notice of the research, received a short explanation and were given the option to withdraw their children from participation. The lessons in this research took 65 minutes each, which was the same length as the biology lessons the classes normally have. The lesson series consisted of a total of 9 lessons.

Table 1. The number of students per class

Class	Number of students	Average age	Number of girls	Number of boys	Control/performing
C	28	14	15	13	Performing
D	30	14	17	13	Performing
E	29	14	14	16	Control
F	30	14	16	14	Control

The first four lessons regarding the topic were the same for all four classes. During these lessons the students received an introduction regarding the topic and learned about several different human influences on the environment (Appendix 1). These lessons were based on the chapter about environment in the biology method 'Biologie voor jou'. The first three lessons were meant to give the students basic information about the environment, in which the first lesson focussed on pollution, the second on energy sources and the third ecological footprint. Each lesson started with an explanation and at the end of the explanation the class watched a short about the subject and had to answer the questions as found in the textbook. During the fourth lesson the students had to calculate their own footprint and come up with a plan to make it smaller. At the end of this fourth lesson the students also received a questionnaire, which served as a pre-test to test the students motivation in regard to science and the human impact on the environment. After these four lessons, in which the students had

already been introduced into the topic of environment, the four classes were divided in two control groups and two performing groups.

At the end of the lesson series the control groups finished with a final presentation while the performing groups finished the topic with the performance of their plays. For both the control group and the performing groups these final presentations were graded by the teachers. During the last lesson the final ten minutes were used for the students to fill out another questionnaire in regard to their motivation, which served as a post-test, and they were asked to write down their thoughts about the lesson series.

Final five lessons for the control group

The second part of the lesson series consisted of five lessons and was different for the control group and the drama group (Appendix 1). During these five lessons the two classes used as a control group received direct instruction from the teacher based on the book 'Biologie voor jou' and a digital assignment which one of the teachers developed a few years ago. During the lesson the control groups made (digital) assignments based on the book they are using. These assignments were meant to check the students' understanding of the topic and to check their progress throughout the chapter. They consisted of questions from the book, but also on rewriting the information learned in a mind map and forming opinions or thinking of solutions after reading a text or watching a short film and. One of the assignments was to form groups and choose a subject for a final presentation, for which the students had two lessons to prepare. This final presentation required the students to make a poster or PowerPoint about the influence of humans on climate change. Finally during the final lesson the students gave short presentations in front of the class, which were graded by the teacher. However, since the students were new to the subject and found writing topics and research questions very difficult, the groups received a list of possible subjects from which they were able choose a topic for their presentation. This list of topics is based on both the digital assignments and on recent news articles and consisted of the following items:

- Designing a green vacation
- Accumulation of medicine in water
- Increased mortality in bee populations
- Influence of non-indigenous animals
- Accumulation of (micro)plastics in oceans
- Increase in bird deaths, caused by the poisoning of their prey (*Cydalima perspectalis*)

Final five lessons for the performing group

In the other two classes the use of presentational drama was tested. As mentioned before, the second part of the lesson series was spread over five lessons (Appendix 2). The first lesson contained a basic instruction about the influence of humans on the natural environment. Several socio-scientific issues regarding humans and ecology were discussed and the students were told that their final assignment was going to be a performing assignment. During this explanation the different regulations for their scripts were also introduced (the required stages, roles and keywords). After the explanation the class was divided in groups of five. Students were allowed to form their own groups to improve motivation and autonomy, but also because it is customary at the school. After the groups were formed, each group had to decide on a subject (a socio-scientific issue concerning humans and the environment) to work on. These

subjects were the same as the topics for the presentations in the control groups. At the end of the first lesson, each group had to hand in both the names of all students in the group and their list of top three choices for the subject. The teacher then divided the topics over the groups.

The second lesson was used for students to search for information on their topic, to divide the different roles in the play and to start writing the script. The script needed to be long enough for the play to last at least 5 minutes, with a maximum length of 15 minutes. The other two requirements for the drama assignment were that the students wrote characters with recognisably different views on the subject and that the script contained the following three elements: first an introduction of the subject, second an occurrence involving the topic and finally how the different characters react to this occurrence. In the script the students were also asked to integrate the most important keywords and concepts regarding their subject in the performance. These keywords could both be based on the book or the guidelines of the teacher and differed per subject. For example, in the topic about bees one of the guidelines stated that one of the roles in the play had to be that of a beekeeper. All of the keywords and guidelines the students received with their topic had to be used in the script and final presentation, so the teachers could see whether or not the students have picked up on the important concepts regarding this chapter. At the end of the second lesson, the students had thought of the different roles that will be in the play and these roles had to be divided over the group members. The students also started writing a rough outline of their script with the three phases in it.

The third lesson was reserved for the students to finish their script. When the students were done writing their script it had to be handed in and checked by the teacher before the actual performance, to avoid misconceptions. If the students were finished writing before the end of class, they were given the opportunity to use the remainder of the time to practise their play. By the end of the third lesson all scripts had to be handed in and the teacher announced the presentation schedule for the next two lessons.

The fourth and fifth lessons were about the actual performances. During these lessons the students performed the plays they had written. Per lesson three groups were performing. Performances lasted a maximum of 15 minutes, after which there was 5-10 minutes time for questions and discussion. Because of privacy and the fact that students can feel vulnerable during the plays, phones and cameras were not allowed out of the students bags. The students in the audience will also be reminded to be supportive of each other's performances. During the performances the groups acting as audience received the task to write short reviews in which they tried to summarize the important aspects of the topic performed in the play (Appendix 3). Every group had to write one review about all of the other groups, meaning the students had to discuss among themselves who would write which review so that in the end all students had written one review and together they reviewed all other groups. Every review had to consist of a short summary of the play, at least two positive points about the play and at least two negative points about the play. These reviews were handed in to the teachers and gave the teacher an opportunity to see whether or not the students paid attention and whether they picked up on all of the important concepts and key aspects regarding the topic which should have been explained in the play. If the teacher realised the students missed important information, this could immediately be mentioned and explained during the discussion time directly after the play.

Data collection

Before the lesson series the students filled in a questionnaire to give an indication about their motivation towards science (Appendix 4). This questionnaire was based on the SMTSL (students' motivation toward science learning) as described by Tuan *et al* (2005). For the pre-test questionnaire existing questions from the SMTSL questionnaire were picked out, translated and where needed adjusted according to the subject 'humans and the environment'. Since the SMTSL questionnaire was too long, a selection had to be made to decide which questions to use in the questionnaire. When selecting questions for the questionnaire the six different categories (self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment stimulation) as described by Tuan *et al* (2005) were all taken into account and are all represented by selecting at least 2 questions from each category based on their relevance for the topic of this research. The questions were all ranked according to a five-point Likert-type scales. The scale is scored as follows: 1 = strongly disagree, 2 = disagree, 3 = neutral or no opinion, 4 = agree and 5= strongly agree.

During the second and third lesson in the lesson series the students were observed by both the teacher and an observer. Observations focussed on the work attitude and motivation of the students. In order to observe as effective as possible, an observation form was developed (Appendix 5). The observations made were categorised according to the different kinds of motivation and regulatory processes as described in the Self-Determination Theory (SDT; Ryan & Deci, 2000).

Table 2. The regulatory processes as described by Ryan an Deci's Self-Determination Continuum (2000) showing types of regulatory styles and corresponding regulatory processes.

Regulatory style	Relevant regulatory process	Possible observed behaviour
<i>Non-regulation</i>	Nonintentional, nonvaluing, incompetence, lack of control	Distracted, doing other things
<i>External regulation</i>	Compliance, external rewards and punishment	Showing minimal effort, only working when told to
<i>Introjected regulation</i>	Self-control, internal rewards and punishments	Putting in effort because others are, wanting to do well
<i>Identified regulation</i>	Personal importance, conscious valuing	Feeling related to the topic, forming an opinion
<i>Integrated regulation</i>	Congruence, awareness, synthesis with self	Realising the importance of the topic, forming an opinion and being able to support it with arguments
<i>Intrinsic regulation</i>	Interest, enjoyment, inherent satisfaction	Wanting to know more, asking question, taking initiative

While the students were researching their topics and writing their scripts, short interviews were held with all of the groups in both the performing and control groups. In these interviews the students were asked about their motivation regarding learning, science and the topic 'humans and the environment'. For instance, students were asked questions about their opinions on the specific environmental topic they were working on, but also what they thought about their assignment and how they were approaching it. These interviews were semi-structured interviews (Appendix 6) and were used as an addition to the observations

made and the answers students give were therefore also categorized according to the different types of motivation as described by the SDT (Table 2). The interviews were audio-recorded so the information could be reviewed at a later moment.

The fourth and fifth lessons, in which the students were showing their final presentations or performances, were entirely filmed using a camera in the back of the classroom. During these lessons, the teacher and the observer also observed the student's behaviour in terms of motivation according to the same observation form as mentioned earlier (Appendix 5), which was also based on the regulatory processes as described in the Self-Determination Continuum (Ryan & Deci, 2000).

Finally, at the end of the final lesson the students answered a post-test in the form of a questionnaire. The post-test consisted of the exact same questions as the pre-test, in order to keep the questionnaires as similar as possible. At the end of the post-test there was also room for any possible remarks or just simply thoughts the students wanted to share regarding the lesson series.

Data analysis

This study contained both qualitative and quantitative data. The quantitative data was gathered through the questionnaires in the pre- and post-test. For the pre- and post-test the Cronbach's Alpha was measured to make sure the questions in the questionnaires were consistent. In order to find out whether or not the students' motivation increased by the use of drama, the results from the pre- and post-test were then compared in all of the different classes (so in both the control groups and in the performing groups). This was done using a paired t-test. After that the difference between the pre- and post-tests of the control- and performing groups was compared using a one-way ANOVA and the differences between every class were analysed using a Tukey post-hoc test.

The qualitative data was gathered using the interviews and observations. As described earlier, the data gathered during observations and interviews was categorised according to the different kinds of motivation and regulatory processes as shown in Table 2. The type of regulatory process was used as an indication of the students' motivation, in which non- and external-regulation were seen as the least motivated regulatory styles and integrated- and intrinsic regulation were noted as the highest motivated regulatory style. For instance, if a student did not actively participate during the lesson and said he didn't care about the topic that behaviour would be seen as non-valuing and listed as non-regulatory.

Finally the qualitative- and quantitative data were compared to see whether the findings and trends seen were comparable. Some of the quantitative data was incomplete, because students did not fill in either the pre- or post-test and some students only filled in only half of the questions. Because of the incompleteness of the data for these students their data was excluded from the research. After the exclusion of incomplete results the complete datasets of ninety-nine students remained.

Results

During the research, both quantitative and qualitative data were gathered. First the results of the qualitative data from the interviews and observations will be discussed. Then the quantitative data that was gathered during the questionnaires used as pre- and post-test will be discussed to confirm the findings shown in the qualitative data.

Qualitative data

During the first three lessons the observations in all classes confirmed the problem as stated by the school: Students did not seem to feel related to the topic at all. In all classes the students were able to tell that humans had an impact in the environment and that humans were probably the biggest cause for climate change because of our carbon dioxide output and pollution. However, the students did not know how their own daily activities influenced the environment. When asked about their opinion during these first three lessons, all of the four classes had three to five students stating things like *“It doesn’t matter what I do, the earth isn’t going to warm up just because I take long showers”* or *“I’m not going to go on less airplane vacations, people flying every week should maybe take it a little slower but not me”*. Remarks like this that imply these students do not feel very related to the subject because they feel they can’t influence what is happening. In terms of regulatory processes, these remarks show non-valuing and lack of control, indicating a non-regulatory process. The other students in the class either nodded in agreement or kept quiet. None of the students felt the need to disagree with these remarks.

The first real changes in regulatory processes between the classes were observed during the fourth lesson, in which the students heard whether they would be performing or doing a regular presentation at the end of the topic. Both of the performing classes (C and D) were really excited when they heard they would be writing and performing a short play. Especially the girls in both classes immediately started coming up with ideas, like playing out a doctors appointment, a murder mystery, or creating a play that was more of a documentary style, quiz or talk show. They also immediately asked questions about whether or not they were allowed to bring and use attributes from home to make their play more convincing and realistic. This showed that the students in these groups were really motivated to do well in the assignment, which means these students were now showing an introjected regulation. In contrast, one of the control group classes (class F) was displeased for not being allowed to perform. They were complaining about the fact other groups were doing ‘fun things’ while they had to do a ‘boring presentation’. After this there was a lot of distraction in the class due to students complaining about the fact they were in the ‘boring group’, showing the students in this class were still in a non-regulation process. About 90% of the students in class E on the other hand seemed a little relieved about doing a final presentation. One of the boys stated: *“Thank god we don’t have to perform some childish play for everyone to see!”* and almost all of the boys fully agreed with him. Two of the girls also stated the concern that doing the drama assignment might have taken more time and effort, so they were happy about not being in the performing group. They just wanted to finish the assignment the easiest way possible, showing compliance and thus an external regulation.

During the following lessons the observations made in both classes in the control group showed a minimal change in motivation. Except for two boys everyone finished their digital assignments really fast, even though they only reached the minimal scores to finish them. However, when working on the presentations students had more trouble concentrating on their

work. Only one group of girls in class F finished the assignment in one lesson, practised for a bit and then claimed to be done. When asked about the topic for their presentation, they showed basic knowledge but very little motivation to gather more in depth material. One of the things they said was: *“We already have all of the information needed to score enough and our presentation skills are good enough to score at least a 7 even if we don’t put in more effort.”* This remark indicates that these girls were only complying and only put in enough work to receive an external reward in the form of a good grade, which indicates only external motivation. The rest of the students in the control groups took longer to finish and actually used all of the time given to work on the presentation, suggesting these students wanted to do well on the assignment, but not necessarily showed more interest in the topic and thus showed an introjected regulation. However, work atmosphere went downhill as the lessons continued, especially in the F group. When asked about their motivation the students replied things like *“This grade will hardly influence our average grade for biology anyway”* or *“I don’t care anymore, I am already failing this year anyway”*, indicating the students felt a lack of control and lack of external reward and thus still showing mostly non-regulation. The E class showed a little more interest, which was observed in the fact that half of the students came to ask about the possibility of making their subject a bit less specific to be able to use a bigger variety of information in their presentation. However, the information they wanted to use was all basic information about the environment which they had learned before this lesson series, instead of actual in depth information on a topic. When asking about it in an interview one of the groups replied: *“Yes we wanted to add something extra to get a higher grade on our presentation and since we already learned that last year it would be easy to add it and maybe get some better grades on our presentation.”* This suggests the students were only motivated to get a higher grade, but did not want to put in the effort of learning new information. This shows they were still only complying and thus showing introjected regulation.

In contrast, both classes in the performing group showed a good working atmosphere during all lessons. Students were helping each other, exchanging ideas and brainstorming about who would be good in what kind of role. The students showed initiative by asking other teachers for help (for instance the chemistry teacher was asked if they could borrow lab coats and some students went to the art teachers for help on their attributes). When the students were asked about their opinion of using drama one of the boys that is normally known by all teachers for showing no interest in any school topic answered: *“This is great! It’s fun, it feels like I’m just fooling around, but for once I actually feel like I’m learning something. I remember what I learned because I learn my lines and when making up my lines I actually have to think about the topic from different views.”* This remark in combination with observations made during the lesson series show that for this boy, who normally doesn’t like school at all, the use of drama instigated a feeling of self-control, internal rewarding and even enjoyment which all indicate forms of more intrinsic regulation. During this interview, when the students around him heard him say that, about half of the boys in his class agreed with him and felt like they had more fun and also learned more during this activity than they would during normal lessons. Of all the groups that were interviewed in the performing classes only one group of girls mentioned they did not like the assignment during their interview. They thought it was ‘way more effort than just giving a presentation’, they did not like having to work together with so many people and they felt they were not learning as much. However, this lack of motivation that only seemed to exist in this group of girls could also be explained

by the fact that they had some trouble working together and had several big arguments while trying to come up with their script, after which their motivation dropped.

The final two lessons of the lesson series consisted of the actual presentations of the final assignments. In the control group everyone worked with a PowerPoint presentation, even though the students were given the option to present in different kind of ways (e.g. poster presentation). When asked about it all of the students replied that their motivation for choosing a PowerPoint presentation was: *“It was simply the easiest”*, which shows complying and thus an external regulation. When looking at the presentations of the control group it was immediately noticed that all presentations only included the minimal required facts and argumentations, which indicates the students only put in just barely enough effort to get the grade they needed. One group said after their presentation that they only put in a little bit of extra effort when searching for pictures and short films, because *“intriguing pictures and film fragments would probably be enough to make an impact and get a good enough grade, even if the presentation was not that great”*. During the discussion round it was also observed that hardly anyone asked any questions, nearly all questions had to be asked by the teachers. If students did have questions it was only about choices in the presentation, not about the actual topic of the presentation. The short reviews the students wrote also showed hardly any information, usually just the topic and the basic information that had also been explained during earlier lessons. All of these observations during the final lessons in the control groups suggest that the students were still only motivated by external rewards in the form of good enough grades or did still not see any value at all, meaning the students in the control groups were still showing an external regulation and therefore their motivation did not seem to have gotten any better during the lesson series.

In contrast, the performing groups showed more in depth arguments in their performances and just three of the twelve groups only put in a minimal effort by only complying with the basic requirements in their play. The other nine groups used a lot of in depth arguments in their plays and worked out a variety of concepts for their plays (Table 3). Two groups did a quiz show in which they highlighted all the important aspects of their subject. Two other groups did talk shows, in which one of the groups even borrowed a camera and made a short film regarding their subject they used as breaks while they changed decor or positions. Another group used the context of a doctor’s appointment and gave a really clear performance about medicine polluting the water in which they not only dug really deep into the subject, they had also asked for help from science and art teachers to think of a way to make water pollution more visible during their performance. And finally, one group of boys that had a play about the high death rate of bees did their entire play from the viewing point of the bees in which one of the boys played a really sassy queen bee and played out several important causes for bee deaths. All these varieties in ideas and concepts showed that the students put in a lot of thought and creativity into their performances.

Table 3. Overview of the types of performances in classes C and D for each subject.

Topic	Class C	Class D
Designing a green vacation	<p>Characters: Scientist, young family, hotel/camping owner, gas station owner</p> <p>Story: A play about a family going on a green vacation, showing all the pros and cons they encounter along the way. Until they finally get back home and based on their experiences review how to best plan their next green vacation.</p>	<p>Characters: Scientist, different types of travellers (young family, single traveller)</p> <p>Story: Step by step walkthrough of different possible green vacations.</p>
Accumulation of medicine in water	<p>Characters: Scientist, fisherman, Greenpeace activist, civilian</p> <p>Story: A story about a fisherman who is going bankrupt because he is catching less fish, a scientist explaining why and finally an activist and civilian discussing with the fisherman what would be the best course of action or the fisherman.</p>	<p>Characters: Scientist (narrator), young parents, doctor</p> <p>Story: A play about a young family going to the doctor because their baby got sick because of polluted water and the resistant bacteria in it, while a scientist narrates how this could've happened and how this should be prevented in the future.</p>
Increased mortality in bee populations	<p>Characters: Scientist, beekeeper, farmer, civilian</p> <p>Story: A play about a beekeeper whose bees are slowly dying and his attempt to convince people why this is a big problem.</p>	<p>Characters: Scientist, beekeeper, farmer, civilian, bees</p> <p>Story: A play about a beehive slowly dying and a beekeeper trying to save his bees.</p>
Influence of non-indigenous animals	<p>Characters: Scientist explaining, quizmaster, civilians participating in the quiz</p> <p>Story: A quiz about the influence of non-indigenous species and their effect on the environment.</p>	<p>Characters: Scientist (narrator), civilian, crayfish, other animals</p> <p>Story: A documentary like play about a crayfish killing of other organisms in the area, with one the scientist narrating what is happening and why this is a problem and should be prevented.</p>
Accumulation of (micro)plastics in oceans	<p>Characters: Scientist explaining, quizmaster, civilians participating in the quiz</p> <p>Story: A quiz about the accumulation of (micro)plastics in oceans and the effect on the environment.</p>	<p>Characters: Scientist explaining, quizmaster, civilians participating in the quiz</p> <p>Story: A quiz about the accumulation of (micro)plastics in oceans and the effect on the environment.</p>
Increase in bird deaths, caused by the poisoning of their prey	<p>Characters: Talk show host, scientist, arguing neighbours</p> <p>Story: A talk show with a scientist and arguing neighbours as guest, talking about the birds in the garden dying after one of the neighbours used poison to get rid of caterpillars.</p>	<p>Characters: Scientist explaining, family eating dinner</p> <p>Story: A play about people dying because the poison accumulated all the way into human food and a scientist explaining what happened.</p>

After the plays in the performance groups, the discussion rounds were also much more lively than in the control groups. After every play at least four or five of the students writing a review asked questions that were both about choices in the play and about the topic. If something was not clear, students would immediately ask or at least write it down in their reviews. For instance, one of the boys wrote down that he missed some information about bee deaths and that he still did not quite understand why the problem is so difficult to solve. These kind of questions about the information shown in the performances showed the students were aware of the importance of the information and showed genuine interest in the topic, which indicates some degree of intrinsic regulation. In writing their reviews the students wrote positive and negative things about the performance they were watching. Observed was that in regard to the topic, only negative remarks would be made. For example, students would write what information they missed, didn't understand or would have liked to see more. In contrast, when making remarks about the performance itself the students would only write positive things and if they did have some negative points on the performance they would write it as a tip for improvement between a lot of positive aspects. For instance, after giving a compliment on the interaction with the public and the loudness of voices the students would give a tip on how to use the room better next time. The student wrote down: *"The actors playing as the farmer and scientist had a really nice loud voice, the story was funny and most players were doing a really good job at looking at the audience. Only next time the beekeeper should be standing somewhere different because he was a bit tucked away in the corner."* This positivity in the remarks showed the students were much more supportive of each other's work in the performance group when comparing to the control group.

At the end of the lesson series students from both the performing- and control group were given the opportunity to give their opinion about the final assignments they were given by either participating in the groups discussion or by writing down their thought on the back of their post-test paper. In the discussion about half of the students actively participated by voicing their opinion, while everyone received a post-test paper to write something down. Only in class F hardly anyone wrote down something on their post-test paper, but in all other groups over half of the students wrote down some remarks. In the control groups no one said to have gained more interest in the topic or feel more related when being asked about this. About 3 students in class F said they did hear a few funny facts during the presentations like the opinion Donald Trump has on some environmental topics, but they did not feel like they had to put much effort in and so they didn't. In both of the control groups classes more than 5 students wrote that they did think they learned enough about the topic, but they did not see the value in making presentations about it. Contrasting, in the performing group about 25 out of 60 students mentioned a slight increase in motivation in regard to the questions in the questionnaire that specifically focussed on the environmental topic. For instance one of the students mentioned: *"My interest in science has not changed, but making a play about the environment has really made me think about it."* Another student also mentioned something similar and wrote on the post-test paper: *"I don't remember my previous answers, but I hope I filled in everything the same as in the first questionnaire EXCEPT for the environment questions. They should be scored better!"*. Both of these remarks indicate these students developed personal interest in regard to the topic. Other than their interest in the topic, several students also mentioned they liked the use of drama in the biology lessons. Remarks like *"It was fun!"*, *"Finally something different than just a boring presentation or test!"* or *"For once I did not mind putting in some effort!"* were found written on the back of about half of

the post-test interviews in the performing groups, indicating that these students showed interest and enjoyment which is consistent with intrinsic regulation.

Quantitative data

Before the lesson series started the pre- and post-test were tested for validity using the Cronbach's Alpha. Since the same questions were used in both the pre- and post-test questionnaires the Cronbach's alpha was only determined for the pre-test. The questionnaire as a whole had a Cronbach's alpha of 0.826, meaning the internal consistency of the questions can be rated as good. When looking at the influence of every question in the questionnaire the Cronbach's alpha varied between 0.796 and 0.864. This consistency in the Cronbach's alpha shows all questions had about the same influence and therefore show that all the questions were of equal influence and the entire questionnaire was consistent.

Table 3. Per class the average score for each of the questions in the questionnaires, before and after the lesson series. Both the average total average score for the environmental impact related part of the questionnaire and the average score of the entire questionnaire are also shown. Class C and D were performing groups, class E and F were control groups.

Question	Class C		Class D		Class E		Class F	
	Before	After	Before	After	Before	After	Before	After
1. In my daily life I try to consciously deal with the environment.	3.41	3.56	3.61	3.61	3.61	3.76	3.56	3.78
2. I find it interesting to know how environmental problems arise.	3.17	2.96	3.25	3.21	3.36	2.84	3.44	3.28
3. I find it interesting to know how research is done.	2.97	2.77	3.04	3.07	2.68	2.64	3.06	3.22
4. I find it interesting to learn more about the environment.	3.17	3.04	3.43	3.48	3.21	2.80	3.44	3.44
5. I think it is important to understand how environmental problems originated	3.62	3.69	3.79	3.89	3.82	4.20	3.89	3.67
6. I think it is important that people handle the environment more consciously.	4.21	3.92	4.25	4.16	4.36	4.20	4.44	4.33
7. It think it would be nice to do research myself.	2.41	2.73	3.04	3.04	2.57	2.08	2.61	3.17
8. If I do not understand how something works, then I want to know why.	3.62	3.58	3.61	3.75	3.32	3.16	3.50	3.50
9. If I find something difficult, then I prefer skipping it.	-3.21	-3.19	-3.08	-2.82	-2.96	-2.88	-3.00	-3.39
10. If I find something difficult, I would like to try to understand it anyway.	3.41	3.46	3.75	3.50	3.79	3.60	3.39	3.61
11. The only reason I pay attention during class is to pass the subject.	-2.93	-3.27	-2.64	-2.61	-2.93	-2.80	-3.06	-3.06
12. I would like to get a better score than my classmates.	-3.24	-3.08	-2.39	-2.39	-3.43	-3.36	-3.50	-3.61
13. I would like to learn how other people think about problems.	3.14	3.15	3.00	2.82	3.14	2.96	3.11	3.28
14. I find it interesting to talk to others about the environment.	2.31	2.88	2.57	2.57	2.18	2.04	3.22	3.33
15. I like prefer doing another final assignment instead of a test	4.07	4.12	4.18	4.14	4.18	3.68	4.06	3.94
Average total score	30.14	30.33	33.39	33.42	30.89	28.92	32.17	32.49
Average total score on questions related to the environment	19.90	20.06	20.89	20.94	20.54	19.84	22.00	21.83

After the lesson series the results of the questionnaires (before and after) the classes were compared for the control group and the performing group. First the mean per question was calculated and listed for every group, as well as the average total scores each group had on both questionnaires (table 3). Not only was the mean per question calculated, the results were also compared using a paired t-test (table 4). When comparing the results of the entire questionnaires no significant differences were found between the questionnaires in any of the groups ($p=0.453$ in the control group and $p=0.375$ in the performing group). When looking at questions in specific categories, some bigger differences showed when comparing the questions related to science and the questions related to the environment. The questions about student's motivation towards science showed little difference between the questionnaires before and after. This was confirmed when looking at the significance, which showed a p-value above 0.6 for both groups ($p=0.695$ for the control group and $p=0.659$ for the performing group).

However, the questions specifically about the topic 'humans and the environment' showed a visible difference between the pre- and the post-test. The control groups showed a trend in which the total score on questions about the environment slightly went down by 0.17 in class F and dropped 0.70 for class E. In contrast, the total scores for the environmental questions in the performing groups went slightly up by 0.16 for class C and 0.05 for class D (table 3). This difference between the results of the questionnaire when looking specifically at the environmental questions was also seen when looking at the p-values shown by the paired t-test, which resulted in a p-value of 0.136 in the control group and $p=0.221$ in the performing group. Even though these p-values do not show significance it does indicate a trend that was also observed in the qualitative data, showing that the use of drama did seem to increase the motivation for the topic. The trend shown in this data is consistent with the observation made during the lessons and the interviews, which also indicated that the students motivation only increased regarding the topic at hand and not for science as a whole. This could be explained by the fact that the students' relatedness only increased in regard to the environmental topic they were working on and their feeling of relatedness in regard to science as a general topic didn't change.

Table 4. Differences between the pre- and post-test questionnaires in both the control groups and performing groups, showing a lower p-value in the question specific about the environment.

T-test	p-value
Difference total pre- and post-test questionnaire for control group	0.453
Difference total pre- and post-test questionnaire for performance group	0.375
Difference environmental questions pre- and post-test for control group	0.136
Difference environmental questions pre- and post-test for performance group	0.221

Finally the change in motivation measured by the questionnaires for the control group and performance group was also compared. This was done using a one-way ANOVA to compare the results from both groups (table 5). The one-way ANOVA didn't show significant dissimilarity when comparing the difference in motivation between the groups ($p= 0.167$) However, just like the T-test, the one way ANOVA showed a lower p-value when looking at just the questions about the environment ($p=0.081$) in which the students in the performing group had slightly more positive differences between the questionnaires, which indicates the motivation regarding the environmental topic has slightly increased in the performing group during the lesson series.

Table 5. Results of the one-way ANOVA comparing the questionnaire results for the performing group and control group.

ANOVA	p-value
Comparing the entire questionnaires	0.167
Comparing the scores of the questions about science	0.308
Comparing the scores of the environmental questions	0.081

In order to get more insight in the differences in the questionnaire results as shown by the one-way ANOVA a post-hoc test was done: Tukey's range test (table 6). Tukey's range test showed the lowest p-value when comparing the data of classes D and E. Classes D and E were very similar classes in regard to grades and pre-test scores. However, during this study class D was part of the performing group and class E was part of the control group. The Tukey post-hoc test showed a p-value of $p= 0.062$ when comparing the results of the questionnaires between these classes, indicating the difference was most significant between these groups, in which the motivation was better in the performing group (class D). This indicates that when comparing classes D and E there was almost a significant difference between the scores regarding their motivation, in which the motivation was the highest for class D. These findings are again consistent with observations made during the lessons and also with the remarks students made on the back of their post-test paper, confirming the visible trend in which students in the performing groups seem to feel more relatedness to the topic and have more motivation than the students in the control groups.

Table 6. Results of the Tukey's range test, showing the p-values of differences when comparing the total questionnaire scores of the different classes with each other.

Class	Compared to	P- value
C	D	0.288
	E	0.875
	F	0.924
D	C	0.228
	E	0.062
	F	0.765
E	C	0.875
	D	0.062
	F	0.565
F	C	0.924
	D	0.765
	E	0.565

Conclusion and discussion

It was expected that the use of drama in SSIBL-lessons regarding the topic ‘humans and the environment’ in secondary education would increase the students motivation regarding the topic. Both the qualitative and quantitative data showed differences between the control- and performing group, indicating a trend in which the control group showed no increase in motivation while the performing group did. In the qualitative data the trend was seen in the fact that during the lesson series the students in the performing group showed more changes in their regulatory processes than the students in the control group. Most of the students in the control groups started out with non-regulatory and external regulatory processes, while in the performing group over half of students showed signs of changing from a non-regulatory or external regulatory process to identified regulatory processes. About 5 of the students in each of the classes in the performing group even showed intrinsic regulatory processes during the final lessons of the lesson series. However, the quantitative data did not show the results to have a significant p-value. Therefore this it cannot be stated for a fact that the use of drama has increased the motivation of the students in regard to the environment during this lesson series. Even though this study did not result in any hard conclusions, the trend seen during this study does indicate the use of drama seems to have a positive influence on the students motivation in regard to the topic of environmental issues.

During this study some difficulties arose that might have influenced the results. First of all an unavoidable factor that influenced the student’s motivation was the timing in the schoolyear. When researching a lesson series, one is always dependent on the school’s schedule. The topic for this research, the chapter humans and the environment, was planned as the final chapter of the school year. Because of this, several students already knew they had no chance left to make it to next year and had already given up. Other students had high average scores and did not care anymore since this grade would hardly influence their average. The timing in the school year also brought along another challenge, namely the pressure of finishing the semester in time (since it is a Montessori school, students are free with their planning as long as they finish by the end of the year which causes a lot of students to panic near the end of the year). This caused the students to see the assignment as less important than the other classes they still had to finish. Both the lack of control about the outcome of the schoolyear and the lack of value regarding the influence of the grade for this assignment caused some students to start out demotivated and stay demotivated throughout the entire lesson series.

However, this decline in motivation only showed in the control groups. The quantitative data for the performing groups did not show a decrease and even showed a slight trend in which motivation increased in regard to the questions specifically focussing on the topic ‘humans and the environment’. The combination of the difference in the data combined with the observations and interview results suggests the lesson series did positively influence the motivation regarding the specific topic after all, even though the quantitative data by itself doesn’t show significant results. In the interviews and in the remarks the students wrote on the back of their post-test they admitted to having more interest in the subject and feeling more relatedness to the subject. This increase in relatedness and the visible rise in motivation would in fact also be consistent with the Self-Determination Theory (SDT) as described by Ryan and Deci (2000) since one of the three basic needs has increased.

Another difficulty that was experienced during this research was the fact that some students were really affected by the fact they knew the other class was doing a different, possibly more fun assignment. Especially the F class seemed really affected by this and complained a lot about having to do a 'boring, normal presentation'. Unfortunately, this exchange of information between the groups could not have been avoided at this school, since students from the different classes knew each other and talk about it outside of their classes. Also, since the students from the performing classes asked other teachers for help and ideas it did not take long for most of the school to know that they were doing a different kind of assignment instead of the normal presentations.

Even though the difference in assignments between the control and performing group and the feeling of unfairness this difference created for some of the students in the control group caused some difficulties during the lesson series, the use of drama hardly caused difficulties. The difficulties when it comes to having less control over the student, unrealistic lines of thought and the increase of misconceptions when using drama as described by Ødegaard (2003), Wieringa *et al.* (2011) and Toonders *et al.* (2016) did not show during this lesson series. None of the students got lost in their imagination, because the students were tasked to stick to the reality principle as described by O'Neill (1985). The students were also able to see their topic from different points of view and give arguments for each of the roles in the play, while still being able to stay close to all the important information in the book because of the regulations and obligatory roles in each play. These regulations also helped in avoiding misconceptions in the plays. This avoiding misconceptions was done by the teacher as well by checking the script before the actual play and by commenting on the play directly after it finished and before the discussion started. The use of different stages in the play as described by Verhoeff (2017) also helped the students to get a better idea of the requirements for the assignment and it also gave them a direction when it came to building a story and eventually writing their play. The lesson series did turn out a bit more time consuming than regular lessons. However, only one group of students five students complained about this. All of the other students in the performing group mentioned in either interviews or on their post-test paper that they did not mind putting in this little bit of extra time since they enjoyed themselves (even though not necessarily having developed a higher motivation towards the topic).

Finally another possible explanation for this research not showing any significant differences in the data is the short time span of the lesson series. The separated part of the lesson series only took place over a time span of five lessons, which means there were not even three weeks between the pre-test and the post-test. Some of the students also complained about having to fill in another questionnaire so soon and some even left half of the questions blank, so the data for those students was not complete and could not be used which caused a loss of data. A possible solution for this could be to keep more time between the pre-test and post-test. For example, asking the students to fill in the pre-test at the end of the chapter before or letting them fill it out previous to starting the new chapter, instead of only giving them the post-test during the first drama lesson. Another solution might be to use all of the lessons regarding a chapter for drama lessons, instead of only a few. Whether or not that is an option is dependent on the school, the topic and the teachers time schedule.

Even though the study did not show a significant result, the results showed that with the exception of one group all of the performing groups enjoyed themselves during the assignment. The fact that a group of boys indicated that for once they did not only have fun, but also felt like they learned something shows that the use of drama during these classes had a positive effect on their learning. All in all, this research has shown clear trends regarding an increase of motivation with the use of drama in SSIBL lessons regarding the topic 'humans and the environment'. Even though more research has to be done to get any conclusive results, this research has shown that using drama does have a lot of potential in increasing students' motivation in biology classes.

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Appendix 1: Lesson goals lesson series control group (Lesson 1 to 9)

Lesson 1:

Topic: Introduction in the environment

Lesson goals:

- Students know that people are depending on the environment for water, oxygen, food, energy, raw materials and recreation
- Students know that people influence the environment by, among other things, waste and emissions

Lesson 2:

Topic: Energy and food provisions

Lesson goals:

- Students can name the most important energy sources along with their advantages and disadvantages
- Students must know the difference between organic and non-organic food
- Students must know the difference between chemical and biological crop control

Lesson 3:

Topic: Waste and sustainability

Lesson goals:

- Students can distinguish biodegradable and non-biodegradable material
- Students can name the different ways of waste collection and waste processing
- Students can describe how recycling works

Lesson 4:

Topic: Measures to protect the environment and ecological footprint

Lesson goals:

- Students calculate their own ecological footprint
- Students can reason how they could reduce their ecological footprint
- Students can name the consequences of climate change
- Students can describe how the environment in the Netherlands is protected

Lesson 5:

Topic: Finishing digital assignments, introduction of the final assignment

Lesson goals:

- Students know what the final assignment is
- Students have formed learning teams
- Learning teams have chosen a topic
- Learning teams have written an approach

Lesson 6:

Topic: Last chance to complete digital lessons, to specify subjects and start working on presentations

Lesson goals:

- Learning teams have a clear division of tasks
- Learning teams have a clear plan of action
- Learning teams have immersed themselves in (literature behind) their subject
- All students have done, checked and completed the digital lessons.

Lesson 7:

Topic: Finish working on presentations

Lesson goals:

- Learning teams complete their presentation and make a distribution of tasks for the presentation

Lesson 8:

Topic: First round of presentations (1 to 3) and discussions

Lesson goals:

- Learning teams 1 to 3 give their presentations
- Learning teams can justify their choices regarding their argumentation and interpretation
- Learning teams can answer any questions from fellow students (in response to their performance)
- Students write and hand in their reviews

Lesson 9:

Topic: First round of presentations (4 to 6) and discussions

Lesson goals:

- Learning teams 4 to 6 give their presentations
- Learning teams can justify their choices regarding their argumentation and interpretation
- Learning teams can answer any questions from fellow students (in response to their performance)
- Students write and hand in their reviews
- Students fill out the final questionnaire

Appendix 2: Lesson plans performing groups (final 5 lessons)

Lesson 5: Introduction

Topic: Finishing digital assignments, introduction of the final assignment

Lesson goals:

- Students know what the final assignment is
- Students have formed learning teams
- Learning teams have chosen a topic
- Learning teams have written an approach

Time	Phase	Teaching activities	Student activities	Teacher activities	Utensils	Evaluation
10-15 min	Introduction: - Planning - Explaining assignment - Introduce different topics	Explanation	Listen, take notes	Give information	Pen and paper	
35-40 min	Groups: - Form groups and pick a topic	Work in groups	- Make groups of 5 - Pick a topic - Start planning	Observe, help when necessary, write down groups and topics	Pen, paper, List of topics written on the schoolboard	All students are in groups and picked a topic
5-10 min	Review	Group discussion	Listen and participate	Lead the discussion, listen and participate	-	

Lesson 6: Start script

Topic: Last chance to complete digital lessons, to specify subjects and start working on presentations

Lesson goals:

- Learning teams have a clear division of tasks
- Learning teams have a clear plan of action
- Learning teams have immersed themselves in (literature behind) their subject
- All students have done, checked and completed the digital lessons.

Time	Phase	Teaching activities	Student activities	Teacher activities	Utensils	Evaluation
5-10 min	Introduction: - Planning - Explaining requirements for the script	Explanation	Listen, take notes	Give information	Pen, paper	
40-45 min	Work in groups: - Working on assignment	Work in groups	- Gather info - Work on script	Observe, help when necessary, write down groups and topics	Pen, paper	
5-10 min	Review	Group discussion	Listen and participate	Lead the discussion, listen and participate	-	

Lesson 7: Finish script

Topic: Finish working on presentations

Lesson goals:

- Learning teams complete their presentation and make a distribution of tasks for the presentation

Time	Phase	Teaching activities	Student activities	Teacher activities	Utensils	Evaluation
5-10 min	Introduction: -Planning -Checking how far along all of the groups are on their assignments	Explanation	Listen, take notes	Give information	Pen, paper	
40-45 min	Work in groups: - Working on assignment	Work in groups	- Gather info - Finish script - Practise play	Observe, help when necessary, write down groups and topics	Pen, paper	All groups finished their script
5-10 min	Review	Group discussion	Listen and participate	Lead the discussion, listen and participate	-	

Lesson 8: Presentations (group 1 to 3)

Topic: First round of presentations (1 to 3) and discussions

Lesson goals:

- Learning teams 1 to 3 give their presentations
- Learning teams can justify their choices regarding their argumentation and interpretation
- Learning teams can answer any questions from fellow students (in response to their performance)

Time	Phase	Teaching activities	Student activities	Teacher activities	Utensils	Evaluation
5-10 min	Introduction: - Order of presenting - Reviewing goals - Explain review assignment	Introduction	Take note	Give information	Pen, paper	
40-45 min	Presentations: - Three times 5-15 minute presentations followed by 5-10 minute discussion	Performing plays	Perform play/ write review	Observe, help when necessary, take notes, lead discussions	Review: pen, paper Play: Depends on the presentation	
5-10 min	Review	Group discussion	Listen and participate	Lead the discussion, listen and participate	-	

Lesson 9: Presentations (group 4 to 6)

Topic: First round of presentations (4 to 6) and discussions

Lesson goals:

- Learning teams 4 to 6 give their presentations
- Learning teams can justify their choices regarding their argumentation and interpretation
- Learning teams can answer any questions from fellow students (in response to their performance)
- Students write and hand in their reviews
- Students fill out the final questionnaire

Time	Phase	Teaching activities	Student activities	Teacher activities	Utensils	Evaluation
5-10 min	Introduction: - Order of presenting - Reviewing goals - Explain review assignment	Introduction	Take note	Give information	Pen, paper	
40-45 min	Presentations: - Three times 5-15 minute presentations followed by 5-10 minute discussion	Performing plays	Perform play/ write review	Observe, help when necessary, take notes, lead discussions	Review: pen, paper Play: Depends on the presentation	All students performed their plays and the plays all met the requirements
5-10 min	Review and post-test	Group discussion	Listen and participate	Lead the discussion, listen and participate	-	All students filled in the post-test

Appendix 3 : Instruction audience (review assignment)

Review assignment

During the presentations of other groups you will write reviews. The intention is that everyone writes a review about another group. You write these reviews individually and are not only intended to make you pay more attention during other people's performance, but also to make the follow-up discussion smoother.

About which drama you write a review you decide within your group. It is the intention that in the end your group has reviewed all other groups at least once. In other words, you have to divide within your group who writes which review.

Your review must consist of the following three parts:

- Brief summary
- Tips
- Compliments

At the end of the lesson you deliver the reviews to me, so that we can also use them during the evaluation.

Good luck!

Group number:

Writing a review about group:

Tips:

Compliments:

Short summary:

Appendix 4: Questionnaire (motivational part)

Student information:

Name:

Gender:

Age:

The purpose of this questionnaire is to find out what your views and opinions are on the lessons about people and the environment. We do not only ask for theoretical knowledge, but especially for your motivation. Therefore there are no right or wrong answers, the point is that you fill in how you feel about the different questions.

The questionnaire consists of two parts, part 1 mainly about motivation and part 2 is about argumentation. The first part contains statements where you have to circle the extent to which these statements apply to you. There is a scale of 1 to 5, where the 1 means that you totally disagree and 5 that you fully agree with it. In other words:

- 1: Absolutely disagree
- 2: Mostly disagree
- 3: Neutral / no opinion
- 4: Mostly agree
- 5: Totally agree

Fill in all questions. The list not only contains questions about the environment, but also some more general questions. Some questions may be more difficult than others, but just try to give the best possible answer. Good luck!

Part 1: Motivation	disagree					agree
1. In my daily life I try to consciously deal with the environment.	1	2	3	4	5	
2. I find it interesting to know how environmental problems arise.	1	2	3	4	5	
3. I find it interesting to know how research is done.	1	2	3	4	5	
4. I find it interesting to learn more about the environment.	1	2	3	4	5	
5. I think it is important to understand how environmental problems originated	1	2	3	4	5	
6. I think it is important that people handle the environment more consciously.	1	2	3	4	5	
7. It think it would be nice to do research myself.	1	2	3	4	5	
8. If I do not understand how something works, then I want to know why.	1	2	3	4	5	

9. If I find something difficult, then I prefer skipping it.	1	2	3	4	5
10. If I find something difficult, I would like to try to understand it anyway.	1	2	3	4	5
11. The only reason I pay attention during class is to pass the subject.	1	2	3	4	5
12. I would like to get a better score than my classmates.	1	2	3	4	5
13. I would like to learn how other people think about problems.	1	2	3	4	5
14. I find it interesting to talk to others about the environment.	1	2	3	4	5
15. I like prefer doing another final assignment instead of a test	1	2	3	4	5

Appendix 5: Observation form

REGULATORY STYLE	RELEVANT REGULATORY PROCESS	POSSIBLE BEHAVIOUR	POSSIBLE REMARKS
NON-REGULATION	Nonintentional, non-valuing, incompetence, lack of control	Distracted, doing other things	'not interested' 'not important'
EXTERNAL REGULATION	Compliance, external rewards and punishment	Showing minimal effort, only working when told to	'only want a good grade' 'as long as I don't fail this class'
INTROJECTED REGULATION	Self-control, internal rewards and punishments	Putting in effort because others are, wanting to do well	'I don't want to let the others down' 'I want to feel like I did my best'
IDENTIFIED REGULATION	Personal importance, conscious valuing	Feeling related to the topic, forming an opinion	'I see how it is important for me'
INTEGRATED REGULATION	Congruence, awareness, synthesis with self	Realising the importance of the topic, forming an opinion and being able to support it with arguments	'I see how it is important for...'
INTRINSIC REGULATION	Interest, enjoyment, inherent satisfaction	Wanting to know more, asking question, taking initiative	'I want to know more' 'I like learning about this'

Appendix 6: Semi-structured interview

Topic in the conversation	Questions asked
Human impact on natural environment	<ul style="list-style-type: none"> - Do you think it is important people change their lifestyle to help reduce the impact on the environment? - Do you think you should change your lifestyle to lower your ecological footprint?
Specific topic of assignment	<ul style="list-style-type: none"> - What are your thoughts on the topic at hand? Is it a problem caused by humans? And should we solve it? - How do you think this problem might be solved?
Drama assignment	<ul style="list-style-type: none"> - What do you think about the drama assignment? - How is your approach on this assignments?
Group work	<ul style="list-style-type: none"> - How do you like working in groups? - How is the co-operation in the group coming along?
Input lesson series	<ul style="list-style-type: none"> - Has this method of teaching changed your view on the topic? - Is there anything you like about the lesson series? - Is there anything you would like to change about the lesson series?