Why students enjoy integrated outdoor mathematics activities

That's the question

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Abstract

In this study integrated outdoor mathematics activities were evaluated for children aged 9-12 years, who underachieve in language and/or mathematics. These activities were performed during a Dutch summer school, in which the students received traditional in-class language and mathematics lessons in the mornings and integrated outdoor activities in the afternoons. The results of this study show, just like other outdoor education studies, that students seem to enjoy the outdoor activities. This article focuses on which elements of integrated outdoor mathematics activities enhance students' enjoyment. It seems that students like searching and catching animals and they enjoy collaboration. The results also suggest that students enjoy mathematical assignments that the students experience as difficult. In all students a turning point was observed in students attitude towards nature. Students became more used to, less scared of or highly enthusiastic about nature. This change in attitude could possible influence students' enjoyment.

Introduction

"Look there is a frog!"
"Where?"
"O! I'm going to catch him!"
"There is a frog!"
"I have never in my life seen a frog"

The comments of five students that are searching and catching small animals in a ditch. It's a part of an integrated outdoor mathematics activity that the students did during a Dutch summer school in 2012. This summer school is part of a policy that e.g. tries to enhance students language and mathematical achievements. Hereafter more about this policy and the implementation of it are described. One implementation, the so-called green summer school, used traditional in-class and integrated outdoor activities. This article describes the results of a study that evaluated the integrated outdoor mathematics activities and especially focuses on students' enjoyment and how this enjoyment can be enhanced.

In the Netherlands in 2009 an education policy was created to counteract underachievement of elementary school students in language and mathematics ("Onderwijstijdverlenging", 2012). This policy, called educational time extension, consisted of different methods to extent the effective mathematics and language education time. One way to extent the educational time is with summer schools. Since 2009 different summer schools were designed with the goal to reduce the delays in mathematics and language of elementary school students during a couple of weeks in the summer. Another goal of these summer schools is giving the students the opportunity to spend their summer meaningful. The students are selected, not only based upon their mathematical and language achievements, but also based upon poorer socio-economical backgrounds. These students will probably spend their summer in their own neighborhood, which is most of the time not a stimulating environment for students development.

The two main goals of the summer schools, improvement of mathematics and language achievements and meaningful time use, made the implementation of the summer schools as follows. In the mornings language and mathematics are taught in a traditional in-class way. In the afternoons the students perform learning activities in different contexts ("Onderwijstijdverlenging", 2012). These activities can be a visit to a company, doing the groceries for a meal or an excursion. One

summer school has chosen the history of the city as a theme, in which the learning is situated. Another summer school gave the students the choice between different contexts, like art and photography.

The green summer school in which this study took place, chose nature as the context for learning activities. Learning in and with nature (hereafter referred to as outdoor education) can have different benefits. Outdoor education studies show the trend that students enjoy this learning method and that it has a positive effect on students motivation (American Institute for Research, 2007; Dismore & Bailey, 2005; Mosfett, 2011; Rickenson et al., 2004; State Education Environmental Roundtable, 2000; Waite, 2010); outdoor education can improve students' academic achievements (in general and subject-specific) (AIR, 2007; SEER, 2000); being outdoors can have positive effects on the physical and mental health and on concentration, it can reduce stress (Evans, 2006; Pretty, Peacock, Sellens & Griffin, 2005; Thompson Coon et al, 2011) and can lead to a decrease of behavioral problems (Fiskum & Jacobsen, 2012). Learning outdoors give opportunities to learn a subject like mathematics or language and at the same time students can learn about nature. With less attention and time for environmental education in Dutch elementary schools (Cito, 2011), outdoor education gives a chance for environmental education to (re)gain attention.

For the green summer school, activities were designed that integrated language and mathematics with the outdoor context. Integrated outdoor activities are in this study defined as learning activities in which the learning of a subject is integrated with outdoor (nature) experiences. This study focuses on the integrated outdoor mathematics activities (IOMA). The designed IOMA are evaluated, with the focus on students' experiences. Based on the results suggestions are made about elements that might influence students enjoyment.

Before the methods and results of this study are described, first more background information about the summer school and the integrated activities are given. This is followed by a description of the summer school and the integrated activities. Then the methods that were used for this study are described, followed by the results. In the results suggestions are made about which elements of IOMA might influence students experiences. The article ends with a discussion about the results, the used methods, suggestions for future research and a conclusion.

Background summer school and integrated activities

This study evaluated integrated outdoor mathematics activities that were performed during a green summer school. In this chapter the context of this study, Dutch summer schools, the green summer school and IOMA will be described.

Dutch summer schools

The two main goals of the Dutch summer schools are improving students language and mathematics achievements and giving the students the opportunity to spend their summer meaningful. To achieve both goals, the summer schools are divided in two kind of activities; traditional in-class language and mathematics activities and learning activities in contexts. The latter activities can be described according to the situated learning perspective.

Situated learning

The situated learning perspective emphasizes that much of what is learned, is specific for the situation in which it is learned (Driscoll, 2005; Herrington & Oliver, 2000; Woolfolk, 2008). “When learning and context are separated, knowledge is seen by the students as the final product of education rather that a tool to be used dynamically to solve problems” (Herrington & Oliver, 2000, p. 23). In this way, knowledge becomes abstract and student’s cannot recall the knowledge in real-life situations. Retrievable knowledge has to be taught in real life, meaningful contexts, according to the situated learning perspective. Situated learning can be taught in several ways, like in cognitive apprenticeships, learning communities, anchored instruction (Driscoll, 2005) and with computer-based representations. (Herrington & Oliver, 2000).

Situated learning is a branch of constructivism (Woolfolk, 2008). Constructivism “emphasi[zes] the active role of the learner in building understanding and making sense of information” (Woolfolk, 2008, p.411). The focus of learning in meaningful real-life contexts is also a core element is Dewey’s education philosophy (Rivkin, 1998). In his philosophy, experience is central. With experience, he refers to doing and undergoing the effects or consequences of that doing (Van der Aalsvoort, 2011). Learning through experiences leads to meaningful learning, as Dewey stated “When the child lives in varied but concrete and active relationships to this common world, his studies are naturally unified” (Dewey, 1990, p. 91).

Green summer school

This study was performed in a Dutch green summer school. This summer school did not only focus on mathematics and language but also on nature and the environment. The summer school was located in a forest and grassland rich area. In the mornings the students were taught language and mathematics in a indoor classroom setting. During the breaks, the students could go out in the forest or near a ditch. In the afternoons, the students did outdoor learning activities.

Like mentioned in the introduction, outdoor education can have several benefits on students achievements (AIR, 2007; SEER, 2000), students personal and social skills (Rickenson et al., 2004), student self-esteem (AIR, 2007), and on students motivation and attitude toward learning (AIR, 2007; Dismore & Bailey, 2005; Mosfett, 2011; Rickenson et al., 2004; SEER, 2000; Waite, 2010). Positive effects on students’ motivation could lead to improvements in students’ achievements

(Nundy, 1999; Rickenson et al., 2004). “There can be reinforcement between the affective and the cognitive, with each influencing the other and providing a bridge to higher order learning” (Rickenson et al, 2004, p5).

Integrated Outdoor Mathematics Activities

For the green summer school, outdoor learning activities were designed. In these activities, learning mathematics and language are integrated with outdoor experiences. This study focuses on the integrated mathematics outdoor activities.

The integrated outdoor mathematics activities were designed for students aged 9-12 years who underachieve in language and/or mathematics. The activities focus on a mathematical subject that these students found difficult and that could be integrated with outdoor experiences. Based on interviews with elementary school teachers and elementary school mathematics experts, the subject multiplication was chosen. With mathematical assignments that were integrated with outdoor activities, the students practiced multiplication in a meaningful real-life context, namely nature.

This study focuses on students’ enjoyment during integrated outdoor mathematics activities. Outdoor education studies show the trend that students enjoy outdoor education and find it a motivating teaching method. Fägerstum & Blum (2012) argue that students value outdoor education because it’s a variation of their regular daily routine. Students also value the social interactions and the authenticity that outdoor education provides (Fägerstum & Blum, 2012; Mosfett, 2011). These elements can also play a role in the integrated activities that are evaluated in this study. This article especially focuses on which elements of integrated outdoor activities enhance students’ enjoyment. These elements can, after further research, be used for the development of IMOA and other (integrated) outdoor education activities. With these developed activities, the effects of IMOA as a teaching method can be tested. For example the effects on students’ motivation, their mathematical achievements and their social-emotional development.

Summer school and the integrated outdoor mathematics activities

Below a description is given of the IOMA that were evaluated in this study. These activities were performed during a green summer school in 2012 in Apeldoorn (the Netherlands). The summer school lasted two weeks. In the mornings the students received traditional in-class language and mathematics education and in the afternoons integrated outdoor mathematics activities (together with integrated language activities). In total there were eight days (summer school from Monday to Thursday), with six afternoons (the Wednesday afternoons were free).

In the integrated outdoor mathematics activities a nature-based question was central; the question if three kind of animals, a deer, fox and hedgehog, could live at the location of the summer school (a region with different sorts of forest and grassland). The students had to do all kind of assignments and researches to answer this question. Below the different activities will be shortly described.

The first day activity consisted of an introduction to the central question and the location. The students had to find a place indicated on a map and mark a square. In this square they counted the amount of trees and bushes. Later that afternoon the students calculated how many trees and bushes are in the whole region, by multiplying their found amount with the times the region is bigger than their square (with the help of a ratio table).

In the second activity the students were looking for all kind of animals at three different places (in a ditch, in the soil and in bushes). The students looked up what kind of animals they found and also measured the length of the animals. Afterwards the students calculated the ratio of the found animals compared to a deer, fox and hedgehog with the help of ratio tables.

In the third activity the students investigated how far the three animals (deer, fox and hedgehog) can see at five different places (lawn, beech forest, mixed forest, lane of trees and farm land). The students had to look at eye height of the different animals (standing for the deer, sitting on knees for the fox and lying on the ground for the hedgehog). At each location 10 spots per animal were planted. The students counted how many spots they could see and calculated how far they could see. For example for the fox in the mixed forest, the student sat on his knees and could see 8 spots. At the mixed forest the spots were 6 dam apart, so the student could calculate that the furthest spot he saw was 8x6=48 dam away.

The forth activity was about the food web. The students counted and estimated how many small animals and plants there were at different locations (grass, border of forest, two different places in the forest). With this information, and the information how much a deer, fox and hedgehog eat in one day, the students calculated how many of these animals could live there.

In the fifth activity the students made conclusions based on their findings of the previous activities. They had to reason if a deer, fox and hedgehog could live in the area. They also had to think about a location at which they could see these animals. The students wrote down this location in a code, consisting of ratio tables. Afterwards the students built a hut on the location at which they could see the animals.

The last activity consisted of cooking outdoors and the ending of the summer school. No mathematics was included in this day.

Research question

The aim of this study was to evaluate integrated mathematics outdoor activities that were performed during a summer school. The main focus of the evaluation were the experiences of the students, especially if the students enjoyed the activities and which elements of the activities might influence students experiences.

This leads to the following research questions;

I. What are the experiences of students (age 9-12 years old, with low mathematics and/or language achievements) of integrated outdoor mathematics activities during a summer school?

II. What are possible elements of integrated outdoor mathematics activities that lead to students' enjoyment?

Here students' experiences refers to how the students indicated they experienced the activities, for example if they found the activities fun and which activity is their favorite but also if they found the assignments easy or difficult. Students' enjoyment refers to how much the students indicated they liked the activities and assignments.

Method

Participants

The group of participants consists of 30 students (15 boys and 15 girls) between the age of 9 to 12 years old (average age 10.17 years). The students were selected by their schools based upon their school performances and their Cito scores (a national test for elementary students in the Netherlands). Besides students' academic achievements, there was also attention for students social-economical background (the summer school was intended for students with a poorer social-economical background) and one of the selection rules was that the students were not diagnosed with a learning or behavior disorder.

The students that participated in the summer school were diverse in their language and mathematical achievements. The summer school was intended for students with a C or D Cito score (scale from A to E, with A the highest). The mathematical scores were as follows; eight students with a A score, four with a B score, eight with a C score, five with a D score and four students with a E score (the score of one students is unknown). Some students had high mathematical scores but low language scores and were for these reason selected for the summer school.

The integrated activities were taught by two environmental educators, who were supported by the help of volunteers. Every afternoon there were, besides the two teachers, at least three volunteers. The morning in-class activities were taught by two elementary school teachers.

During the summer school at various moments different instruments were used to measure students' experiences. The students filled in a short questionnaire after a mathematical assignment. At the end of each day, the students drew a daily graph (see figure 1 and description below). During the summer school, a diary with observations was kept by the researcher. At the end of the summer school, all students were interviewed about the activities and drew a graph about the whole summer school. All these instruments will be explained below, together with the data collection and analysis of each instrument.

Questionnaire

After each mathematics assignment a short questionnaire[1] is placed in the students' work sheets. This questionnaire consisted of two questions;

I found this	O fun to do O not fun to do
I found this	O easy O difficult

This questionnaire was used to test if the students enjoyed the mathematic assignments and how they assessed the mathematical level of the assignments. The data collection consists of filled in questionnaires in the work of the students. To analyze the data, the frequencies of the given answers were counted.

[1] This short questionnaire is designed by Jan van Nuland (based on the work of Caroll Dweck) and adjusted by Brigitte Witmus for the target group (in this case children).

Daily graph

At the end of each day, the students had to draw a daily graph. In this graph the students could indicate what they found more or less fun during the day. In the graphs, the horizontal axe displays the time and the vertical axe how much the students enjoyed the activities, which is indicated by two emoticons (happy and sad emoticon). The students had to draw or write what they did at several points in the graphs. The data collection consists of a daily graph per student for each day.

To analyze the graphs, the heights of the different points in the graphs were measured (in cm from the horizontal axes). For all indicated points (that were indicated by different students) the average heights were calculated. Some students did not indicate where the points referred to, for this graphs the average for the morning and for the afternoon was calculated.

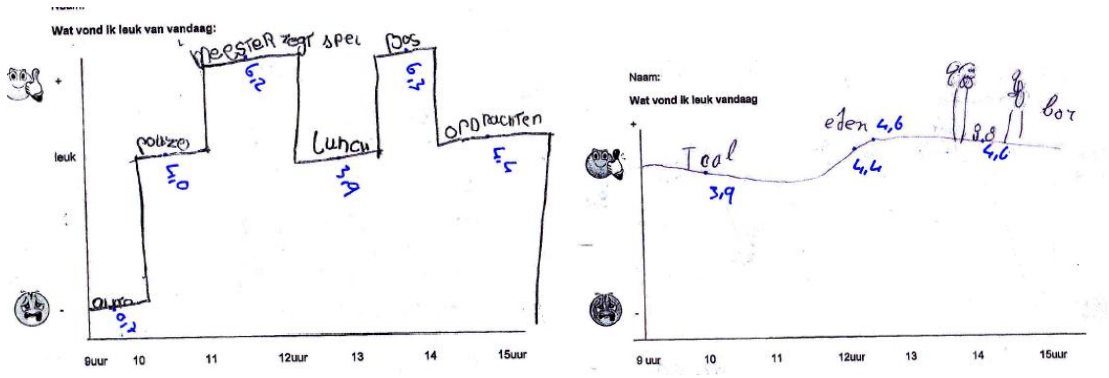

Figure 1 examples of two daily graphs.

Different averages were calculated from the data, like the average of the afternoon (IOMA), by averaging all the points of the afternoon activities. The daily average was calculated by averaging all the points of that day and set to zero. The difference between the daily average (which was set to zero) and the average of the different elements were calculated.

Interview students

At the end of the summer school all students were interviewed. They were asked which integrated outdoor mathematics activity they enjoyed the most. All activities were discussed with the students. The students could comment if they enjoyed the activity and elements of the activity and why, if they found it interesting and what they thought about the mathematics integrated in the activity. The interviews were mostly done individually, sometimes two students were interviewed together. The interviewer wrote down the answers of the students.

The frequencies of answers to the questions like which activity they enjoyed the most were counted. The answers to the open questions (like why they liked a specific activity) were all collected.

Graph whole summer school

At the end of the summer school, the students draw a graph about how much they enjoyed the different days of the summer school. It's the same kind of graph like the daily graph, but instead of the time of the day, the different days were displayed on the horizontal axe. To analyze the graphs, the heights of the points were measured, just like in the daily graphs. The averages of the different days were calculated.

Experiences teacher

During the summer school, a diary was kept by the researcher with observations describing students behavior. Besides this diary, one of the IOMA teachers was interviewed about students experiences.

Results

In this chapter the result of the evaluative study are described. The results of all students that participated in the summer school are used (if there was data for the student). The results show that the students experienced the integrated outdoor mathematics activities as fun. Some activities were more liked then other activities. After the results some suggestions are made about elements of the integrated activities that could influence students enjoyment.

Students experiences

The results indicate that the students experienced the integrated activities as fun (table 1). The students liked the integrated activities more than the activities they did in the morning (traditional in-class activities) and scored the IOMA higher than the daily average (all numbers are above zero). One of the IOMA teachers indicated in the interview, that the students highly enjoyed the activities.

	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5
In-class	-0.2	-0.3	-0.2	-0.1	-0.6
IOMA	0.1	0.2	0.3	0	0.4

Table 1 Results daily fun graphs. The daily average (average of every element named by the students, including breaks and free time, is set to zero. The numbers indicate the difference between the daily average and the average of the given items.

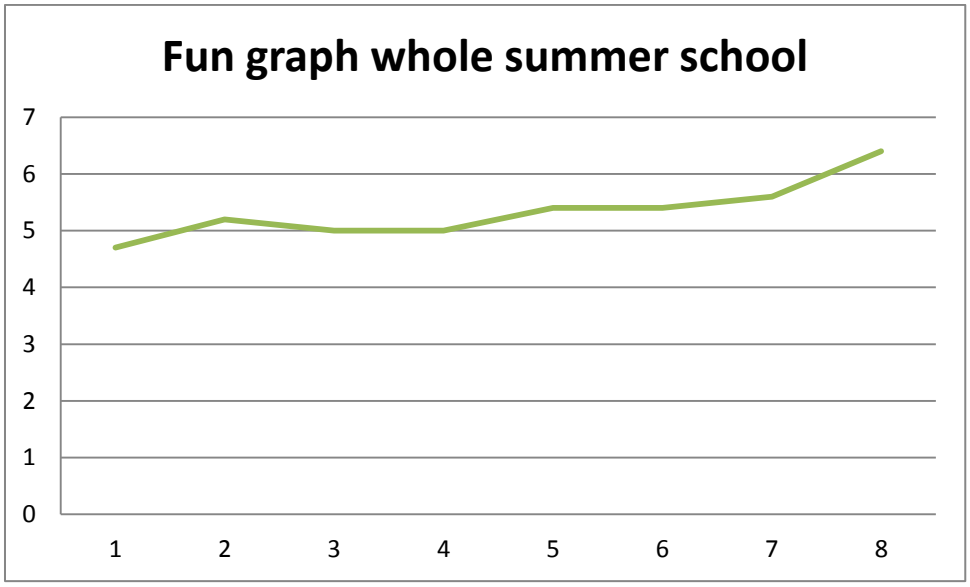

Figure 2 Results fun graph whole summer school. The points in the figure are the averages of all students heights in the graphs for the different days. 25 students drew the graph, day 8 was not indicated by all students (18) because some students made the graph at the beginning of day 8.

In figure 2 the results from the fun graph over the whole summer school are shown. This graph shows that the student's enjoyment grew during the summer school. The results show how students enjoyed the whole day, not just the integrated activities. On day 3 and day 6 there were no integrated activities.

Favorite and less favorite activity

	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5
- nature	-0.8	1.1	0.3	-0.2	0.1

Table 2 continuation of results daily fun graphs. The item 'nature' wasn't named by every student. The items were respectively named 11, 14, 15, 12 and 10 times.

Like mentioned above, the students enjoyed the integrated activities. However, not all activities were liked as much as others. The nature element of activity 2 scored high in the daily fun-graphs (table 2) and was mentioned the most as favorite activity in the interviews at the end of the summer school (by 26% of the students). The nature element of activity 1 scored the lowest in the daily fun-graphs (table 2) and no student named this activity as favorite. The score of the nature element of activity 5 lies between the scores of activity 1 and 3, this activity was named favorite by 24% of the students. These results correspond to the results of the interview question "Was activity x fun or a less fun activity?" (figure 3). Hereafter the results of these three activities (activity 1, 2 and 5) will be described, to focus on the differences between these activities and to make suggestions on which elements of the activities could lead to students' enjoyment.

Figure 3 Results interview students, frequencies of student that named the activity as fun or less fun.

Activity 1

In the first activity, the students had to mark a square in the woods, count the amounts of trees and bushes and calculate how many trees and bushes there are in the whole region. In the interview at the end of the summer school, the students indicated that they liked being in the woods but that they disliked the presence of mosquitoes, ticks and other bugs. The results from the interview with the teacher of the activities and from the diary kept during the summer school, correspond with the experiences of the students.

Activity 2

In the second activity, students searched and tried to catch small animals in a ditch, in soil and in the bushes. Most of the students indicated that they liked the search for animals, although some students disliked this element because they disliked small animals. Some students disliked the fact that they could not find or catch some small animals. The students were very enthusiastic while searching and catching the animals, according to the diary. The interviewed teacher mentioned that

the students became more used to nature. " The students were losing their fear of getting dirty and didn't noticed that it was raining during the activity" (translated by author).

Activity 5

In the fifth activity students had to make conclusions based on all the activities and built a hut. During the interview, the students indicated that they enjoyed the activity because they had to work together while building a hut. "(you learn that) you shouldn't work by yourself but that you have to work together" (said by a student during the interview, translated by author).

Summarizing the above results, it seems that students liked searching and catching small animals and working together. Students disliked the first activity because of the presence of insects, it seems that the students needed to get used to nature and being outdoors. Later in the results, this getting used to nature and the change in students' attitude towards nature will be described in more detail.

Mathematics assignments

Besides looking at students' enjoyment for the integrated activities as a whole, there was especially focus on student' enjoyment during the mathematical assignments. After the assignments students filled in a questionnaire and in the interview at the end of the summer school, some questions were asked about the mathematical assignments.

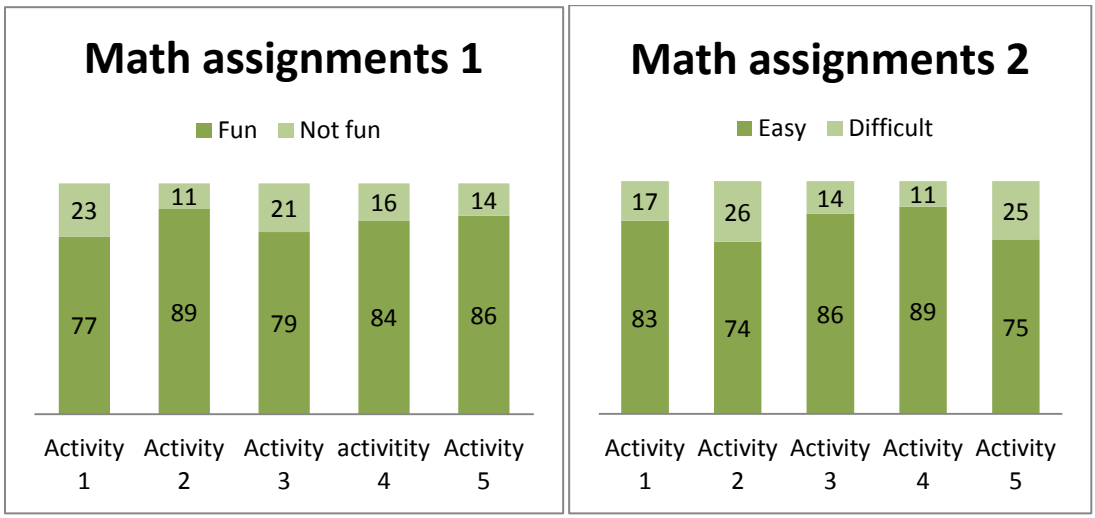

Figure 4 Results questionnaire "I found this fun/not fun" in percentages. The amount of students that filled in this question for the different activities are respectively 13, 27, 29, 19 and 21.

Figure 5 Results questionnaire "I found this easy/difficult" in percentages. The amount of students that filled in this question for the different activities are respectively 12, 27, 29, 18 and 20.

The results suggest that students enjoyed activities that they found challenging (figure 4 and 5, activity 2 and 5). This corresponds with the results from the interviews with elementary school mathematics experts, who indicated that open activities, where students have to think about their own solution methods and more than one solution is possible, not only improve students' mathematical knowledge and skills but also their motivation.

When the results of the questionnaire are analyzed per student, it becomes clear that most students answered that they liked an activity and found them easy. The percentages of students that liked the

activity and found it difficult are respectively 23, 10, 11, 11 and 15% for activity 1 to 5 . These were mainly students who achieved low in mathematics. Only a few students disliked the activities and found them difficult, respectively 0, 1, 1, 0 and 2 students, which were students with both high and low achievements in mathematics.

Elements influencing students' enjoyment

Turning point

As mentioned before, it seemed that the students needed to get used to being outdoors. In figure 2 it can be seen that students enjoyment grew during the summer school. The first day, students were distracted by the presence of mosquitoes and other insects. The other days, these insects were still present, but the students weren't distracted anymore by them.

The results from the interview with one of the IOMA teachers and the diary of the summer school, suggest some kind of turning point in students' attitude toward nature. It seems that during the summer school, the students became more familiar to nature. What kind of turning point it was, the beginning and end point, and the moment when the turning point occurred differ. Some students had (high) resistance to nature at the beginning and were very enthusiastic about nature at the end of the summer school. Some students began with a neutral perspective to nature and became enthusiastic, other students were already enthusiastic and this enthusiasm grew during the summer school.

At the beginning of the summer school, especially on the first day, students were distracted by the presence of spiders, mosquitoes and other bugs. "I see… ieghl… a spider", "I hate mosquitoes" (quotes from students, translated by author). During the summer school, students became used to these bugs and could focus on other things. At the second day, the students got the assignment to search and catch small animals. Some students found this scary, other students were very enthusiastic . "Little frog, little frog, I want to catch you", "I found a caterpillar!", "He is scary! A spider!", "Ieghl I found another insect" (quotes students, translated by author).

From that day on, some students were looking for animals and tried to catch them, during their free time. The change in the students behavior also became clear at the end of the summer school, when the parents visited them. Students showed the environment with enthusiasm to their parents and siblings.

Other elements

Based on the results of the interviews with the students and with the teacher, some other elements that influenced students' enjoyment are suggested. Students indicated that they liked activity 4 less, because of the weather. That day was a very hot day, students seemed to be less concentrated because of this. At the first day it was raining and students indicated they wanted to go inside. The second day, it also rained, but the students were too busy to notice it. It seems that the weather influence students experiences. Another element, mentioned before, was the distraction by the presence of insects and spiders, especially on the first day. This clearly influenced students enjoyment. Activities 1 and 4 were on Mondays, the activities could be liked less because it were the starting days of the week.

Discussion

The goal of this study was to evaluate integrated outdoor mathematics activities. Outdoor education studies show the trend that students enjoy this instruction method and find it motivating. However, these studies do not explain which elements of the outdoor activities influences students' enjoyment and their motivation. This study found, just like other outdoor education studies, that the students enjoyed the activities and focused on possible elements that could influence students enjoyment.

Based on the results of this study, it seems that students enjoy activities were they have to work together and they like searching and catching (small) animals. An observed turning point could potentially effect students enjoyment and motivation. During the summer school, students attitudes towards nature seemed to change. At the beginning some students had resistance to nature, some were neutral and some were already enthusiastic. From the second day a change was visible. Students became (more) enthusiastic about nature or at least lost their fears. Another suggested element for students enjoyment, is that the assignments need to be challenging.

Limitations

Different instruments were used in this study, each instrument with its limitations. Students made the daily graphs in diverse ways. Some students indicated a lot of the elements of the activities, others only indicated the morning and afternoon. Activity specific elements were named only a few times, no conclusions can be made about them. The graphs can be adjusted to get better results. For example instead of time, the different elements of the activities could be presented on the horizontal axe. In this way, students know the different elements to indicate in the graphs. On the vertical axe no scale was present, only two emoticons that represented 'do not like' and 'like'. An numeral scale on the axe which indicates how much the students liked or disliked the element could be used for more reliable results.

A limitation of the questionnaire was that it might not be clear for the students what the questions were about. Instead of answering the questions about the mathematics assignments, it could be that the students answered it, with the whole activity in mind. The results from the questionnaire could be made more reliable by changing the questions from "I found *this*…" to "I found *the mathematics assignment*…". A limitation of the interviews was that they had to be very quick and sometimes with two or more students at the same time. To get more insights about the experiences of the students, more follow-up questions are needed.

Besides the limitations of the different used instruments, there are other limitations like the amount of data and participants. 30 students participated in the integrated outdoor mathematics activities. However, not all students were present every day and useful data could not be gathered from every student who was there. For example, after activity 1 only 13 students filled in the questionnaire about the mathematics assignment.

Another limitation is the extend to how much the activities are really integrated. During the design process of these activities it became clear, that it is difficult to really integrate outdoors with mathematics education. In addition to the design process, the difficulty of integrated activities also plays a role in the implementation. Whether the focus of the activities lies with nature or mathematics depends on the teacher. In this study the IOMA were taught by environmental

educators. They probably focus more on the outdoor elements, because this is their expertise. Elementary school teachers are more experienced in mathematics education and will probably focus more on the mathematics.

Implications and further research

Some suggestions can be made based on the results. Below these suggestions are described together with the implications of these results and suggestions for further research about the topic.

Some suggestions are made about elements of the activities that might have influenced students experiences and their enjoyment during the activities. It seemed that students enjoyed searching and catching animals. Another element that the students enjoyed was working together. Collaboration was also found by Mosfett (2011) and Fägerstam & Blum (2012) as a motivating factor, but seems to be not specific for IOMA or outdoor education, but for all kinds of instruction methods. Further research is needed about the impact of these and other elements of IOMA on students' enjoyment

The results of this study suggest that student enjoyed challenging mathematical assignments. Further research is needed about which elements make mathematical assignments challenging for different students and how challenging mathematical assignments can be designed

During the summer school a turning point in students attitude towards nature was observed. This turning point, can have some implications for IOMA and other teaching methods. The teachers focused on the activities during the summer school, and chose to ignore (most) of the comments that students made about their resistance to nature. The students had to overcome the negative impulses, by focusing on other things like the activities. The turning point in students' attitude could influence students enjoyment and their motivation, but also students social-emotional development, because of the negative impulses they had to overcome. Although the turning point was observed, the exact trigger was not clear. More research is needed about what triggers this turning point and if and how this differs for different students. Also the effect of the change isn't clear. Questions like what is the effect of such a turning point, on what does this effect depends, and does the effect differ with different beginning and ending points need to be studied. Further research is also needed about how the teacher can influence students attitudes toward nature and changes in this attitude.

Concluding, it seems that students enjoyed the integrated outdoor mathematics activities, especially catching animals, working together and challenging mathematics assignments. A possible element that could influence students enjoyment, is an observed change in students attitudes towards nature. Further research about the suggested elements is needed, for more understanding about integrated outdoor mathematics activities and their possible effects, but also for the implementation of this teaching method.

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