The impact of an ecology education program on the understanding of ecological concepts of third grade middle school students at the Peperpot Nature Park in Commewijne

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MSc. in Education Biology
The impact of an ecology education program on the understanding of ecological concepts of third grade middle school students at the Peperpot Nature Park in Commewijne

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Foreword

As a master’s student studying biology, I got more aware that educating most of the topics in biology are mainly teacher-centered, where students merely reproduce information. The curriculum requires knowledge of basic principles before understanding ecological concepts. Lack of these pre-knowledge forces them to study these topics by memorizing facts and learning does not occur in a meaningful way. For this reason, I designed an outdoor education program to improve a better understanding in ecological concepts.

Results show that this outdoor education program contributed to improvement in knowledge and skills and the 4 MAT teaching model was a good approach for teaching new ecological concepts. Such programs might have an impact on an individual’s perception of the environment and related problems and issues.

With this research, I hope to inspire teachers using outdoor education as a tool for encouraging students to learn in a meaningful way.

To carry out this research, my thanks go out to:

- My supervisors: Culen, Gerald Ph.D. & Wongsopawiro, Dirk Ph.D.
- The personnel of Peperpot Nature Park
- The teachers and students who participated in this research
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Abstract

Understanding ecological concepts are important to understanding patterns and processes, central to ecological literacy (Coyle, 2005). The book “Biologie voor jou, milieu en natuur van Suriname” explains ecological concepts and is currently used in the third grade of middle schools in Suriname. Most of these ecological concepts are taught in the classroom and lack outdoor experience. For this study, an outdoor education program is designed and conducted at the Peperpot Nature Park, focusing on these third grade middle school students to improve a better understand ecological concepts. The 4MAT teaching model is used to prepare and conduct the learning activities in and outside the classroom. Using two middle schools of Commewijne, improvements of knowledge and skills were measured with a nonequivalent control group design. A paired sampled t-test variance analysis of these data indicated a significant improvement in knowledge and skills of students who participated in the outdoor education program versus a control group that did not participate.

Key terms

Outdoor education, environmental education, 4MAT teaching model, ecological concepts, knowledge, skills
Introduction

Importance of outdoor education

The main purpose of "outdoor education" is to provide meaningful contextual experiences - in both natural and constructed environments- that complement and expand classroom instruction, which tends to be dominated by print and electronic media (Knapp, 1996). Studying biology outdoors teaches students to ask questions, make observations, evaluate evidence, and solve problems. They learn about ecological concepts of how living things work, how they interact with one another, and how they evolve. This helps them address environmental issues on local, regional and worldwide level, such as environmental depletion, threats to human health, and maintaining viable and abundant food supplies (http://www.aibs.org/careers/). Ecological concepts are general ideas of patterns and processes in ecology. These concepts are important because understanding patterns and processes are central to ecological literacy (Culen, Mony & Preethi, 2003).

The biology book “Biologie voor jou, natuur en milieu van Suriname”, written by Goerdayal, Wassink & Marshall, 2002, is currently used in the biology classes in middle schools. Most of the topics in this book are taught within the classroom instead of outdoors and the teaching approaches are mainly teacher-centered, where students merely reproduce the information from the textbook. The curriculum in the textbook requires knowledge of basic principles before understanding ecological concepts. Some concepts such as photosynthesis and the nutrient cycle require students to have some pre-knowledge of chemistry. These third graders lack this prerequisite knowledge because chemistry only is taught after the fourth year (in the senior years of high schools in Suriname). Lack of this pre-knowledge forces them to study these topics by memorizing facts and learning does not occur in a meaningful way. In third grade, students learn about ecological terms and related topics such as (a)biotic factors, levels of ecology, definition of an ecosystem, food chains and the nutrient cycle (see appendix 2).
To understand how teaching ecological concepts meaningfully, we designed an (outdoor) ecology education program (see appendix 3). This outdoor program is designed for the nature education center of plantation Peperpot focusing on the third grade middle school students to improve knowledge and skills in order to understand new ecological concepts. This program is based on the concepts: impacts of biotic and abiotic factors on ecosystems, relationships between organisms at several levels in ecosystems, ecological cycles and equilibriums within them. The criteria for choosing these concepts are:

- in accordance with the formal biology curriculum of the middle school
- applicable on the current circumstances in Peperpot Nature park e.g. during execution of the outdoor program, some concepts were not applicable during this period in the Park because the ditches were dry containing no aquatic life.
- simple learning activities can be designed to carry out within a limited timeframe, with clear and immediate observable facts and with the available resources to gain insight in these concepts e.g. teaching concepts about all aspects of photosynthesis is impossible with no pre- knowledge of chemistry and no advanced equipment such as microscopes, oxygen measuring devices etc.

The intention to teach ecology also outdoors is important because outdoor environmental education (EE) programs seek to encourage environmentally responsible attitudes and behaviors of students (Peterson, 2007). Peterson, furthermore, stated that engagement in outdoor EE programs should start in early childhood on a frequent basis to develop environmental sensitivity (ES). Focusing the EE program on local issues or problems may gain a more powerful influence on ES development. For this reason two middle schools in Commewijne nearby the Peperpot Nature Park are chosen for this research. The students from these schools also live in Commewijne or nearby the Nature Park itself. The study 'Assessing Environmental Literacy (EL) in a Nonformal Youth Program', of Culen, Mony & Preethi (2003) shows that EE programs should support the development of skills related to issue investigation and issue evaluation which contribute to environmental literacy. It is important for students gaining knowledge towards ecological concepts but also in developing
skills related to investigation and evaluation of these concepts, so they will be able to understand their environment. This encourages attitude and behavior changes towards the environment and contributes to environmental literacy. This statement are supported by results in the article ‘Assessing Environmental Literacy in a Nonformal Youth Program’ (Culen et al. 2003) and the Hines model for environmental responsible behavior (Hungerford & Volk, 1990, adapted from Hines et. al. 1986/87).

Several researchers from many parts of the world have stated that outdoor education programs have a positive influence on children’s experiences towards nature (Moseley, Reinke, Bookout, & Veronica, 2002; Smith-Sebasto, N. J., 2007; Kruse, Cara, & Card, 2004; Smith-Sebasto &, Cavern2006; Jordan, Hungerford, & Tomera1986; Dettmann-Easler, & Pease, 1999; Metzger& Mcewen1999). Davis, 2007, also stated in her research” Assessing the benefits of environmental education and its impact on environmental literacy among exiting fifth graders across economic and partition spectrum of Lee Country Public Schools, South West Florida” that outdoor experiences have many instructive moments for children. Every phenomenon in nature inspires creativity because children can use all their senses to explore their environment. It also offers them to reveal freedom, fantasy, privacy and mental healing for a child in a destructive family. Because of the adult world, children are increasingly discouraged from developing a relationship with nature. They have a closer relationship with the television, computers or electronic games instead of exploring nature around them. Due to this behavior, children become ecologically illiterate (Orr, 1992). To provide an opportunity for students using all their senses to explore and develop knowledge and skills to understand ecological concepts, an outdoor program is essential. Because the EE program concerns new concepts, by which students have to perceive, analyze and process knowledge actively by practicing and integrating obtained knowledge to a new situation in order to make knowledge their own (obtain skills), the 4MAT teaching model is used as an instructional tool to design the ecology program. This article contributes to a significant scientific value for outdoor biology education at middle schools in Suriname because results from a previous study (Brevis, as
cited in report by the Outdoor Science Working Group (OSWG), 2011) show that the use of outdoor activities to teach ecological concepts is essential to the quality of science education and enhances the opportunities for students to understand what science has to offer them, both as future citizens and potential recruits to science careers. This adapted ecology program contributes to knowledge improvement and skills (e.g. collecting plant samples in a shaded area and a sunny spot in order to distinguish their adaptations to the environment) in order to understand new ecological concepts.

The 4 MAT learning cycle in education

People have two dimensions of learning, which are perception (how we take things in) and processing (how we make things a part of us) (Durrant, Harp & Terry, 1993; Merrill, 2002). Perception can vary between concrete ways through senses (e.g. seeing, hearing or touching) and abstract ways through ideas, concepts or symbols to perceive information. Processing new information can vary between active or reflective manners. For example applying theoretical knowledge into a real life situation is processing new information actively, which is opposite of reflectively by reproducing theoretical knowledge by reflective questions. Based on how individuals perceive and process information, they learn in different yet identifiable ways when engaged with diverse learning activities (Nicoll-Senft & Seider, 2010). Knowledge can include facts, information and descriptions. Skills are acquired through experience (in education) or learning by doing. To increase ecological understanding through experiential learning the 4 MAT instructional teaching model is chosen as an instructional strategy to design the ecology program, in which all four quadrants of the learning cycle are used.

The 4 MAT teaching cycle model was developed based on how people learn. It highlights the style of each learner and activates the interaction of both the left and right brain parts, which should lead to a complete brain performance (Scott, 1994). Each of the four learning quadrants has specific objectives, which can be
accomplished by learning activities (Durrant, Harp & Terry, 1993). In this teaching cycle, a new experience creates a need for learning which students process to reflective observation of the experience. Reflective observation is followed by the introduction of concepts to integrate the new experience into what is known. Testing is followed by integration and because this testing results in new experiences, the cycle is repeated. The cycle can be taught by answering the questions why ?, what ?, how ?, and what if ? The four questions are based on learning new concepts (Durrant, Harp & Terry, 1993). This learning model was also chosen because it is focused on integrated learning and it is capable for comprehensive use, for middle schools as well as elementary education but also for urban and suburban schools (Nicoll-Senft & Seider, 2010).

The four quadrants in the 4MAT teaching model

Based on learning patterns, McCarthy distinguished four quadrants. These are the quadrant 1, 2, 3 and 4 shown in figure 1.

Figure 1. Adapted from McCarthy, B. (1987).

The characteristics of each quadrant are:

In quadrant 1, learners perceive information concretely and process it reflectively. They learn best by listening, sharing information, demonstrations and integration of their own experiences. They respond best to group discussions, movies, short lecturers with discussions and audio and visual experiences (Scott, 1994).
The learner-centered approach is used with the phase of activation; learners share of what they know and try to find meaning related to what they will learn and the learning style is reflective observation (watching). The ‘Why?’ question is asked to search for meaning and the most common keywords used are: connect, examine, share, dialogue and reflect. In quadrant 1, the teacher is a motivator (Merryl, 2002).

In quadrant 2 the learners perceive information abstractly and process it reflectively. They learn best by continuously analyzing knowledge before accepting it. These learners learn best the traditional way by extensive reading assignments, lecturers, audio tapes and ‘think’ sessions (Scott, 1994). Learners acquire new knowledge and relate it to what they already know. The learning style is abstract conceptualization (thinking). The ‘What?’ question is asked for conceptualizing and the most common keywords used are: acquire knowledge, understand theory, imagine and define. In quadrant 2, the teacher is the expert. (Merryl, 2002).

In quadrant 3 the learners perceive information abstractly and process it actively. They learn best by integrating theory with practice, active learning. They use their common sense and experiments to know what works and why. These learners need workbooks, manuals, demonstrations, hands-on activities and field trips (Scott, 1994). This is the application phase where learners use what they know to do or make something or play with the ideas. The learning style is active experimentation (doing). The ‘How?’ question is asked for operationalizing and the most common keywords are: act, practice, think, try and extend. In quadrant 3, the teacher is a coach (Merryl, 2002).

In quadrant 4, learners perceive information concretely and process it actively. They are dynamic learners, who like games and learn best by self-discovery, problem solving and integrate their experiences with application, simulation and independent study (Scott, 1994). This is the integration phase where learners make knowledge their own. The learning style is concrete experience (sensing, feeling) and the ‘What if?’ question
is asked for renewing. The most common keywords used are: refine, integrate, adapt, represent, share and renew. In quadrant 4, the teacher is an observer (Merryl, 2002).

The activities designed for the ecology program based on the four quadrants

The learning activities for quadrant 1 of the ecology program:

In the preparation within the classroom, the instructor explained the purpose and essence of the EE program and short refreshments on familiar topics were given by asking students about their pre-knowledge and own experiences e.g.: What do you already know about food chains and food webs? Is it important to maintain food chains and webs within ecosystems? Why? What are you already doing to maintain food chains and webs?

Learning activity 5B (see appendix 3) of the outdoor program asks students to answer a reflective question why Nature park Peperpot was established. At the front page of the outdoor program survey, some background information was given about the nature park.

The learning activities for quadrant 2 of the ecology program:

New ecological concepts were introduced by classroom formal and interactive lectures at both middle schools were given accompanied by handouts (for all 3rd graders who participated in this research). Visual material (e.g. adaptations of plants to water and land, sunny and shaded areas) was demonstrated to explain ecological concepts such as adaptation and tolerance. The power point presentation didn’t succeed because of poor facilitations in the classrooms. To remedy this deficiency, examples were adapted to the outside environment of the classrooms, so students could visualize the general ideas of ecological concepts. Students observed the visual material to answer some questions of the ecological concept ‘adaptation and tolerance’ and they also gave feedback on each other’s answers.
Learning activity 3A in the outdoor program concerned relationships between organisms and between organisms and their environment. In this activity, students get new information on life and food patterns of some animals occurring in the Park. Students need to use their abstract conceptualization to analyze which of these animals live in concurrence with each other based on their life and food patterns.

Learning activity 5A concerns equilibriums of populations (eagles and monkey’) within ecosystems (the nature park). To answer this, students received new general information about the relationship between the eagle and monkey populations. Students need to use their abstract conceptualization to analyze what impact the eagle population has on the monkey population, based on their status in the food chain.

The learning activities for quadrant 3 of the ecology program:

Before carrying out the learning acts, students were role playing by constructing food chains with their colleges, using themselves as parts of the chain. This activity was linked with their preKnowledge and also promoted acquaintance of students from both middle schools, because they had to work, observe and discuss together within groups in order to carry out the learning activities. Afterwards, instructions were given how to access the study areas, how to collect vegetation samples out of plots and how to manage field equipment. The outdoor education program survey also provided short theoretical frameworks concerning ecological concepts (adapted from the biology book” Biologie voor jou, milieu en natuur van Suriname”) for every learning activity and detailed “step-by-step” instructions in order to carry out the learning activities by group problem solving and discussions with little to no guidance at all from the teachers. Students were also allowed to use their handouts while carrying out the learning activities.

To carry out learning activity 3B of the outdoor program, concerning case scenario’s which research method the students would use to detect concurrence between the animals as mentioned in learning activity 3A, students had to place themselves “in the shoes” of a young researcher and use their common sense.

Learning activity 4B asks students to observe the nature park and use their common sense to determine if an
open or closed nutrient cycle fits best in the park.

The learning activities for quadrant 4 of the ecology program:

Accompanied with their handouts, the six learning activities concerned learner-centered approaches. All the learning activities are based on collaborative learning by group observations, discussions and hands-on learning. Activity 1 concerned the influence of (a)biotic factors on organisms, whereas students had to apply their theoretical knowledge of (a) biotic factors into a real life situation by observing the environment of a *Heliconia sp.* to distinguish abiotic from biotic factors (adaptation of knowledge).

Learning activity 2 concerned relationships between organisms and between organisms and their environment. In this learning activity, students had to adapt this knowledge into a real life situation by observing the ants walking on a *Heliconia sp.* in order to classify the relationship. They also had to use their knowledge to identify habitats and ecosystems found on and around the *Heliconia sp.* (higher level thinking).

Learning activity 4A concerned nutrient cycles. Students have to apply their theoretical knowledge of nutrient cycles into a real life situation by observing fungi on a stem in order to classify the fungi and the stem in a nutrient cycle (adaptation of knowledge).

Learning activity 6A concerned adaptations of species in ecosystems, whereas students have to observe, analyze and discuss the abundance of ferns. Activity 6B instructs students to collect fresh leaves in sunny and shaded plots to observe and compare morphological features which are linked to their adaptation. Based on the abiotic factors and the morphological features of the leaves, students are asked to explain the functionality of these morphological features (adaptation of knowledge & independent research). Activity 6C concerns adaptations of flowers concerning their reproduction patterns (pollination), whereas students have to observe the morphology and explain the functionality regarding their adaptation to pollination patterns.
Eight education steps how to use the 4MAT model as an instructional strategy

There are eight steps on how to use the 4MAT teaching model according to *Bernice McCarthy* (1987). An education plan would include all eight activities or steps by accommodating each of the four types of learners, using both parts of the brain in each quadrant of the 4MAT model. The shift between left and right brain activities also give the opportunity to each type of learner for different orientations, which lead toward whole brain performance (*Scott, 1994; Nicoll-Senft & Seider, 2010*). The eight steps are:

1. **CONNECT**: The teacher must generate enthusiasm with an activity, define and introduce goals and objectives and connect the subject to student’s previous experience.
2. **ANALYZE**: Discuss the experience from step 1 by reflecting
3. **INTEGRATE** game and discussion by introducing the concept and key terms
4. **INFORM**: In this stage the teacher has to convey the concepts
5. **PRACTICE**: This stage is the activity stage where the group performs an action to apply what they’ve learned. (What will they do to understand what is being taught?)
6. **EXTEND**: The teacher must ask challenging questions to test what they’ve picked up on and engage the entire group in the discussion by asking for personal experiences and opinions.
7. **SUMMARIZE**: Draw it all together (Re-iterate the learned material with a summary)
8. **APPLY**: Challenge them to creatively integrate new material into real life situations.

Application of the eight steps lesson plan according to *Bernice McCarthy* (1987) can be found in appendix 1.

We followed the 8 steps when conducting the ecology program.
Research questions of the study

The research questions for this study are:

*What learning activities can be designed (which approaches and strategies) for the outdoor ecology education program of Peperpot to improve knowledge and skills of third grade secondary school students towards the new ecological concepts?*

*To what degree does the outdoor ecology education program designed for the nature education centre of plantation Peperpot has an impact on the knowledge and skills of third grade secondary school students towards new ecological concepts?*

Research methods

For the first research question that asked *what learning activities can be designed (which approaches and strategies) for the outdoor ecology education program of Peperpot to improve knowledge and skills of third grade secondary school students towards the new ecological concepts* a quantitative research design was implemented. The outdoor program survey, which is based on the biology book “Biologie voor jou, milieu en natuur van Suriname” written by Goerdayal et al., 2002 consisted of 13 multiple choice questions (six learning activities), which concerned learner-centered approaches. The learning activities are designed based on the four quadrants of the 4MAT teaching model by McCarthy (1987) and two multiple choice evaluation questions. In learning activities 1A and 1B, created for quadrant 4 of the learning cycle, students had to adapt their theoretical knowledge of (a) biotic factors into a real life situation by observing the environment of a *Heliconia sp.* to identify (a) biotic factors.

In learning activities 2A & 2B, created for quadrant 4, students had to adapt their knowledge in activity 2A,
about symbiosis into a real life situation by observing the ants walking on a *Heliconia sp.* in order to classify this relationship. They also had to apply higher level thinking in activity 2B to identify food relations within habitats and ecosystems in and around the *Heliconia* sp.

Learning activities 3A & 3B also concerned food relationships, created resp. for quadrant 2 and 3. In learning activity 3A, students need to use their abstract conceptualization to analyze concurrence between animals based on their life and food patterns. In learning activity 3B, concerning a case scenario in which students had to use their common sense to choose a workable research method to detect concurrence between the animals as mentioned in learning activity 3A.

Learning activities 4A & 4B concerned nutrient cycles, and are created for resp. quadrant 4 and 3. In learning activity 4A, students had to adapt their theoretical knowledge of nutrient cycles into a real life situation by observing fungi on a stem in order to classify the fungi and the stem in a nutrient cycle. In learning activity 4B, students had to use their common sense, to determine if an open or closed nutrient cycle fits best in the park.

Learning activities 5A & 5B, concerned equilibriums of populations within ecosystems, and are created for resp. quadrant 2 and 3. To answer learning activity 5A, students received new general information about the relationship between the eagle and monkey populations and they need to use their abstract conceptualization to analyze what impact the eagle population has on the monkey population, based on their status in the food chain. Learning activity 5B concerned higher level thinking (Adapt & combine theoretical knowledge nature reserves/parks and maintaining ecosystems) why the Peperpot Nature park was established.

Learning activities 6A, 6B, 6C concerned adaptations of species to ecosystems and is created for quadrant 4.

In learning activity 6A students had to observe, analyze and classify the abundance of ferns. Activity 6B and C concern adaptations of leaves to their abiotic environment and flowers to their pollination pattern. In both cases, students had to observe the morphology and explain the functionality regarding their adaptation.

To carry out activity 6B, students followed instructions written in the survey and by demonstration to collect
fresh leaves in sunny and shaded plots. For explanations of the functionality of morphological features, adaptation of knowledge & independent research was needed from students in order to improve their skills. The learning activities were scored with 0 (wrong answer) and 0.5 not completely correct) or 1 (correct answer) and analyzed by counting how many groups gave the correct answers per question (see appendix 4). The scores of the questions gave quantitative indications to determine what learning activities satisfied least (on a scale of 0-4 groups who gave the correct answer), moderate (on a scale of 5-7 groups who gave the correct answer) and best (on a scale of 8-10 groups who gave the correct answer) in order to improve knowledge and skills towards the new concepts. The two evaluation questions (7A and 7B) were excluded from these scores.

For the second research question that asked “to what degree does the outdoor biodiversity education program designed for the nature education center of plantation Peperpot has an impact on the knowledge and skills of third grade secondary school students towards new ecological concepts?” Several landscape surveys were done at Peperpot to set up the pretest, posttest and learning activities for the outdoor education program. To determine the reliability of the pretest and posttest, a pilot test was completed among ten fourth grade students from the middle school, whereas five participated in the pretest and five in the posttest.

Within the two middle schools, 92 students participated in the pre- and posttest. Nine students out of 101 were excluded from further participation in this research due to absence during the pretest or education program survey or the posttest. The control group consisted of 50 third grade middle school students from both schools who participated in the pretest and posttest without participating in the outdoor education program. This study group was chosen because at this level, students learn new concepts of biological and ecological concepts. These students attended an 80 minutes classroom course to gain theoretical knowledge regarding three ecological concepts: Impacts of biotic and a-biotic factors on ecosystems; relationships between organisms at
several levels in ecosystems and ecological cycles and equilibriums within ecosystems. The course was presented with visual material and the students received a handout. A week after the classroom course, the students were examined through a one hour multiple choice pretest (see appendix 5). The pretest consisted of ten multiple choice questions and was scored on a scale of one to 10. Two weeks after the pretest an experimental group, consisting of 42 students participated in the four hour long biodiversity outdoor education program at the Peperpot Nature Park. During the introduction, students participated in a role playing game to construct complete food chains, which is part of their pre-knowledge. The instructor also demonstrated how sampling should be done to collect field data. After the introduction, the students were divided into groups of five to carry out the learning activities by means of group discussions and group problem solving to choose the right answers out of the multiple choice questions. Every group got one form to carry out and answer the questions concerning the learning activities. After one week all participants of control group and experimental group also participated in the one hour multiple choice posttests (see appendix 6). The posttest consisted of ten multiple choice questions and was scored on a scale of one to 10. Questions of the pretest and posttest concerned the same ecological topics. The pretest, classroom courses, outdoor education program and posttest were based on the 4 MAT teaching model.

The sampling method is the quasi experimental design because I choose the two middle schools in Commewijne selectively and the sampling group only consisted of third graders from these schools. Students of the control group and the experimental group were chosen randomly out of the sampling group. Quantitative data is collected through a nonequivalent control group design according to Campbell & Stanley (1963) to measure the improvement in knowledge and skills gained from new ecological concepts. According to this design, the experiments need to be under the experimenter’s control. It involved the control group and experimental group. Because both groups did not have pre-experimental sampling equivalence (the sample groups were chosen according to the quasi experimental design), the ecology program including the outdoor
program survey was under the experimenter's control. To measure the improvement in knowledge and skills, the scores from the pretest and posttest were analyzed with the paired sampled t-test variance analysis in SPSS.

**Results**

Evaluation of teaching approaches and strategies that are used and ecological subjects/themes educated in the third grade of both middle schools resulted in the following:

At both schools only theoretical lectures are used to teach biology, drawings on the black board are used as visual material and the third grade students have never been to a field trip. Exams at school 1 are based on reproduction and exams at school 2 are based on reproduction and insight. Students from school 1 were already familiar with the subjects: food chains, food webs and the nutrient cycle of producers, consumers and decomposers. Students from school 2 were already familiar with the subjects: definition of and levels within ecosystems, (a) biotic factors, food chains and food webs. The third graders of both middle schools had some background knowledge of the new ecological concepts taught in this research.

Based on research question 1, *what learning activities can be designed (which approaches and strategies) for the outdoor ecology education program of Peperpot to improve knowledge and skills of third grade secondary school students towards the new ecological concepts?*, an overview is given in table 1A below. Table 1B gives a classification of the learning activities based on their score levels.
Table 1A. Overview of the learning activities, knowledge/skills, quadrant level of the activity and scores from the outdoor education program survey

<table>
<thead>
<tr>
<th>Survey question</th>
<th>Learning activity</th>
<th>Knowledge/skill</th>
<th>Quadrant</th>
<th>Score/ impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Observing the environment of a <em>Heliconia sp.</em> to identify abiotic factors</td>
<td>Adapt theoretical knowledge of (a) biotic factors into a real life situation</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>1B</td>
<td>Observing the environment of a <em>Heliconia sp.</em> to identify biotic factors</td>
<td>Adapt theoretical knowledge of biotic factors into a real life situation</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>2A</td>
<td>Observing ants walking on a <em>Heliconia sp.</em> in order to classify the relationship of symbiosis.</td>
<td>Adapt theoretical knowledge of biotic factors into a real life situation</td>
<td>4</td>
<td>Least</td>
</tr>
<tr>
<td>2B</td>
<td>Identify food relations within habitats and ecosystems on and around the <em>Heliconia sp.</em></td>
<td>Adapt &amp; combine theoretical knowledge of food relations, habitats and ecosystems &amp; apply higher level thinking</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>3A</td>
<td>Analyze concurrence between animals based on their life and food patterns</td>
<td>Analyzing by abstract conceptualization</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3B</td>
<td>A case scenario in which students must choose a workable research method to detect concurrence between the animals</td>
<td>Use common sense</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>4A</td>
<td>Observing fungi on a stem in order to classify the fungi and the stem in a nutrient cycle</td>
<td>Adapt theoretical knowledge of nutrient cycles into a real life situation &amp; use of common sense</td>
<td>4</td>
<td>Moderate</td>
</tr>
<tr>
<td>4B</td>
<td>determine if an open or closed nutrient cycle fits best in the park by observation</td>
<td>Use common sense</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Analyze what impact the eagle population has on the monkey population, based on new information students receive regarding the status of both populations in the food chain</td>
<td>Analyzing by abstract conceptualization</td>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5B</td>
<td>Observe, discuss and use theoretical knowledge of nature reserves/parks and maintaining ecosystems why Peperpot Nature park was established</td>
<td>Apply higher level thinking</td>
<td>3</td>
<td>good</td>
</tr>
<tr>
<td>6A</td>
<td>Observe, analyze and classify the abundance of ferns</td>
<td>Adaptation of knowledge &amp; independent research</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>6B</td>
<td>Observe the morphology and explain the functionality of adaptation of leaves to their abiotic environment</td>
<td>Adaptation of knowledge &amp; independent research</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>6C</td>
<td>Observe the morphology and explain the functionality of adaptation of flowers to their pollination pattern</td>
<td>Adaptation of knowledge &amp; independent research</td>
<td>4</td>
<td>good</td>
</tr>
</tbody>
</table>
Table 1B. Classification of the learning activities based on their score levels

<table>
<thead>
<tr>
<th>Score</th>
<th>Survey question</th>
<th>Ecological concept</th>
<th>Knowledge/ skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least</td>
<td>2A</td>
<td>Relationships between organisms at several ecosystem levels</td>
<td>Adapt theoretical knowledge</td>
</tr>
<tr>
<td>Moderate</td>
<td>3A</td>
<td>Relationships between organisms at several ecosystem levels</td>
<td>Analyzing with abstract conceptualization</td>
</tr>
<tr>
<td></td>
<td>3B</td>
<td>Relationships between organisms at several ecosystem levels</td>
<td>Use common sense</td>
</tr>
<tr>
<td></td>
<td>4A</td>
<td>Ecological cycles and equilibriums within them</td>
<td>Use common sense &amp; adapt knowledge</td>
</tr>
<tr>
<td></td>
<td>4B</td>
<td>Ecological cycles and equilibriums within them</td>
<td>Use common sense</td>
</tr>
<tr>
<td></td>
<td>5A</td>
<td>Ecological cycles and equilibriums within them</td>
<td>Analyzing with abstract conceptualization</td>
</tr>
<tr>
<td>Good</td>
<td>1A</td>
<td>Impacts of (a)biotic factors on ecosystems</td>
<td>Adapt theoretical knowledge</td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td>Impacts of (a)biotic factors on ecosystems</td>
<td>Apply higher level thinking (Adapt &amp; combine theoretical knowledge of food relations, habitats and ecosystems)</td>
</tr>
<tr>
<td></td>
<td>2B</td>
<td>Relationships between organisms at several ecosystem levels</td>
<td>Adapt theoretical knowledge &amp; independent research</td>
</tr>
<tr>
<td></td>
<td>5B</td>
<td>Ecological cycles and equilibriums within them</td>
<td>Apply higher level thinking (Adapt &amp; combine theoretical knowledge nature reserves/parks and maintaining ecosystems)</td>
</tr>
<tr>
<td></td>
<td>6A</td>
<td>Impacts of (a)biotic factors on ecosystems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6B</td>
<td>Impacts of (a)biotic factors on ecosystems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6C</td>
<td>Impacts of (a)biotic factors on ecosystems</td>
<td></td>
</tr>
</tbody>
</table>
Results of approaches and strategies used in the learning activities

Approaches and strategies which had a good impact to carry out the learning activities are:

5 out of 13 learning activities based on using common sense and abstract conceptualization had a moderate score.

7 out of 13 learning activities based on adapting theoretical knowledge into a real life situation, applied higher level thinking (combine theoretical knowledge and adapt to a real life situation) and independent research had a good score, while one out of 13 activities had the least score.

The approach “adaptation of theoretical knowledge” had the least impact on “Observing ants walking on a Heliconia sp. in order to classify the relationship of symbiosis” (survey question 2B). This learning activity has the least impact on understanding the concept “Impacts of (a) biotic factors on ecosystems”.

Results of ecological concept improvement:

- 3 out of 4 learning activities concerning the ecological concept - Relationships between organisms at several ecosystem levels - had a least to moderate improvement on knowledge and skills.
- 1 out of 2 learning activities concerning the ecological concept - Ecological cycles and equilibriums within them - had a moderate to good impact on improvement of knowledge and skills
- 5 out of 5 learning activities concerning the ecological concept - Impacts of (a)biotic factors on ecosystems - had a good impact on improvement of knowledge and skills

Results of the second research question “To what degree does the outdoor biodiversity education program designed for the nature education centre of plantation Peperpot has an impact on the knowledge and skills of third grade secondary school students towards new ecological concepts?” pretest and posttest scores are presented in tables 2A and 2B.
Overview of the results of the pretests and posttests of the control group and the experimental group

**Table 2A: Overview of the quantitative results of the pre-and post test of the control group**

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 Score pretest_controlgroup</td>
<td>4.180</td>
<td>50</td>
<td>1.0915</td>
<td>.1544</td>
</tr>
<tr>
<td>Score Posttest_controlgroup</td>
<td>4.300</td>
<td>50</td>
<td>1.3961</td>
<td>.1974</td>
</tr>
</tbody>
</table>

**Paired Samples Correlations**

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 score pretest_controlgroup &amp; score posttest_controlgroup</td>
<td>50</td>
<td>.289</td>
<td>.056</td>
</tr>
</tbody>
</table>

**Table 2B: Overview of the quantitative results of the pre-and post test of the experimental group**

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 score before outdoor program</td>
<td>4.560</td>
<td>42</td>
<td>1.4021</td>
<td>.2163</td>
</tr>
<tr>
<td>score after outdoor program</td>
<td>6.274</td>
<td>42</td>
<td>1.3980</td>
<td>.2143</td>
</tr>
</tbody>
</table>

**Paired Samples Correlations**

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 score before outdoor program &amp; score after outdoor program</td>
<td>42</td>
<td>.564</td>
<td>*.000</td>
</tr>
</tbody>
</table>

*Significant at p=.05

The correlation between the scores of the pretests and the scores of the posttests is 0.378, which means that there is a moderate positive correlation between the scores of the pretest and the posttest of the control group. Students in the control group who scored higher on the pretest did not score significant higher on the posttest. The mean score of the pretest is 3.89 and the mean score of the posttest is 4.12, which means that the posttest mean scores are higher. But the significance has a value of 0.223, which means that there is no significant improvement in scores between the pretest and the posttest of the control group. With a confidence level of 95% and a significance level of 0.05, there is no significant difference between the means of the pretest and posttest of the control group. Students who participated in the pretest and posttest without participating in the outdoor education program did not gain more knowledge and skills towards the new ecological concepts.

The experimental group consisted of 42 third grade middle school students from both schools who participated in the pretest, posttest and in the outdoor education program. The correlation between the scores of the pretests and the scores of the posttests is 0.564, which means that there is a strong positive correlation between the scores of the pretest and the posttest of the experimental group. Students in the experimental group...
group who scored higher on the pretest also scored higher on the posttest. The mean score of the pretest is 4.560 and the mean score of the posttest is 6.274, which means that the posttest mean scores are higher. The significance has a value of 0.000, which means that there is a significant difference or improvement in scores between the pretest and the posttest of the experimental group. With a confidence level of 95% and a significance level of 0.05, there is significance between the means of the pretest and posttest. Students who participated in the pretest, posttest and in the outdoor education program, gain more knowledge and skills towards the new ecological concepts.

When comparing results between the experimental and the control group using ANOVA, we found a significant difference in these results (p= 0.000)*. This indicated that the experimental group of students benefitted from the ecology program which increased their scores significantly, whereas the control group of students increased their scores somewhat.

Table 3. ANOVA: Compared results of the control and experimental group

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>55,165</td>
<td>1</td>
<td>55,165</td>
<td>27,003</td>
<td>.000*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>185,905</td>
<td>91</td>
<td>2,043</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>241,070</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

Based on the evaluations of teaching approaches and strategies that are used and ecological subjects/themes taught in the third grade of both middle schools, I conclude that the third graders from both schools had some background knowledge, however this prior knowledge was inadequate to understand the ecological concepts. Exams at school 1 are solemnly based on theoretical knowledge, whereas exams school 2 are based on a combination of reflection of theoretical knowledge and higher level thinking.

Approaches and strategies in the outdoor program survey, which had a good impact on improving knowledge and skills are applying theoretical knowledge into a real life situation, carry out independent research (quadrant 4 of the 4MAT model), and applying higher level thinking (quadrant 3 of the 4MAT model). In contrast the approaches and strategies - using common sense (quadrant 3 of the 4MAT model) and abstract conceptualization (quadrant 2 of the 4MAT model) - had a moderate impact on improving knowledge and skills. The approach “adaptation of theoretical knowledge” had the least impact on “Observing ants, walking on a *Heliconia sp.*, in order to classify the relationship of symbiosis” (survey question 2B). This learning activity has the least impact on understanding the concept “Impacts of (a) biotic factors on ecosystems”.

Ecological concept - Relationships between organisms at several ecosystem levels- had a least to moderate improvement in knowledge and skills. Ecological concept- Ecological cycles and equilibriums within them - had a moderate to good impact on improvement of knowledge and skills and ecological concept- Impacts of (a)biotic factors on ecosystems- had a good impact on improvement in knowledge and skills.

A strong positive correlation (0.564) between the scores of the pretest and the posttest of the experimental group and a moderate positive correlation (0.289) between the scores of the pretest and the posttest of the control group indicate that students in the experimental group who scored higher on the pretest also scored higher on the posttest in contrast to the students in the control group. There is a significant improvement in the
means of the pretest and posttest of the experimental group in contrast to the mean scores of the control group. Based on these results, I conclude that the outdoor biodiversity education program designed according to the 4 MAT teaching model significantly improved students’ knowledge and skills towards new ecological concepts from the experimental group in contrast to students of the control group, who just attend a classroom course without participating in the outdoor education program.

**Discussion**

Based on the results from my research, I can conclude that the ecology education program designed for the Peperpot nature park significantly improved students’ knowledge and skills regarding the new ecological concepts. *Mosely et al. (2002)* has also concluded that programs such as the ecology program for Peperpot has a positive influence on the children’s experience towards nature. In understanding this positive impact, the pre and posttests cores are useful to measure the knowledge and skills in ecology, thus, their ecological understanding.

Both test scores of the pretest and posttests of the control group and experimental group improved, but the scores of the experimental group are significantly higher. Reading the handouts for the second time, thinking more clearly about the ecological concepts after the pretest or talking to fellow students about the new ecological concepts before taking the posttest might be the cause for the slight improvement in scores of the control group.

The means scores of the control group and experimental group could have been higher if there was more time available for this informal education program. The 80 minutes during theoretical lecture to explain three new ecological concepts and the four hour outdoor program were in fact too short. This informal education program was carried out within the time schedule of the formal education program, so teachers exchanged their lessons to cooperate in this research.
The pretest and posttest were taken two weeks before the period of exams at both schools, so there is a possibility that students preferred to focus on their formal exams. Some classes, which participated in this research, also had an exam the same day the pretest or posttest was taken which might have influenced the test scores.

The weak positive correlation and the strong positive correlation between the scores of the pretest and posttest of respectively the control group and experimental group were predictable because students from the control group didn’t gain any additional knowledge and insight between the pretest and posttest, in contrast to the experimental group that gained more knowledge and insight during the outdoor program. During the outdoor program, students had the opportunity to experience the new ecological concepts in reality, ask critical questions and have group discussions to clear their misunderstandings and gain more insight in their theoretical knowledge. This may be the cause why means scores of the control group didn’t improve significantly. This means that the outdoor education program contributed to improvement in knowledge and technical skills and the 4 MAT teaching model was a good approach for teaching new ecological concepts.

Implications

The 4MAT model is indeed a good model to use as an instructional strategy and can not only be used to determine the learning styles. Revising application of the 4MAT model in the outdoor program survey could be more focused on training students both inside classrooms and outdoors to use their common sense (Quadrant 3) and abstract conceptualization (Quadrant 2). Students can train their abstract conceptualization by e.g. role playing activities. Giving their opinion about general events (e.g. subjects in the newspapers) may improve using their common sense and using all senses in the environment to gain a better understanding of ecosystems.

Programs such as the one at Peperpot can have a big impact on how children perceive the environment and how they might react to various environmental problems and issues in the future. Additional research on
these types of programs may provide additional insight into the long term impacts. Such programs might have an impact on an individual’s perception of the environment and related problems and issues.

References


........................................................................................................................................

34
Figure 2: Students arrive at Peperpot

Figure 3: Students got excited by observing Capuchin monkeys
Appendix 1. Application of the eight steps lesson plan according to Bernice McCarthy (1987)

CONNECT
What are you trying to achieve in this program? / Why are the students learning this?
According to the 4 MAT learning cycle, I wanted students to understand ecological patterns and processes of (new) ecological concepts, because these concepts are central to ecological literacy in order to encourage attitude and behavior changes towards biodiversity (Coyle, 2005, p. 97).
The concepts that were explained are:
- Concept: Impacts of biotic and a-biotic factors on ecosystems
  Key terms: biotic factors, a-biotic factors, ecosystems, biodiversity, adaptation, tolerance
- Concept: Relationships between organisms at several levels in ecosystems
  Key terms: ecological relationships, species, habitat, community, population, ecosystems, interactions, concurrence (competition), cooperation, food relationships, food chain, food web, predation, symbioses, mutualism, commensalism, parasitism, reproduction relationships
- Concept: Ecological cycles and equilibriums within them
  Key terms: equilibriums within populations, population density, natural enemies, over-harvesting, ecological cycle, photosynthesis, producers, consumers, waste consumers, reducers, organic matter, inorganic matter, autotrophic, heterotrophic

What do you want them to know or understand when the lesson is complete?
After this training students who participated in the outdoor program should be able to:
- Recognize ecosystems and the environmental influences on them.
- Explain which adaptations organisms go through to adapt to a certain environment and explain which organisms have a low or high tolerance level (in this case for sunlight) according to their distribution
- Recognize on which ecological level interactions take place between individuals and their environment within an ecosystem
- Recognize the ecological relationships between individuals of one species and between individuals of different species
- Recognize environmental influences on the balance of a population
- Explain the role of producers, consumers and reducers in a nutrient cycle within an ecosystem

What are the lifelong lessons or the enduring (long lasting) understanding(s) you want them to leave with?
I wanted students to understand these important ecosystem concepts to gain more insight into what influence their behavior can have on ecosystem functioning and what role they play in their daily life’s as being part of an ecosystem.

What would you like them to internalize and apply to other situations?
With the 4MAT teaching model, I wanted to increase their ecological understanding. This will result in higher levels of motivation and performance (Durrant, Harp & Terry, 1993).
How do I get them interested in the journey?
Students participating in the outdoor program received charts with an animals’ or plants’ name written on it to construct food chains by holding each others’ hand.
Goal of the activity: acquaintance & gain interest, attention, create a happy, funny and relaxed atmosphere. Approach: simulation; strategy: cooperative learning
This activity fitted in quadrant 1 & 4 of the 4 MAT cycle

Introduce the subject with goals and objectives and connect the subject to student’s previous experience.
Students were asked about their pre-knowledge and own experiences with the questions e.g.:
What do you already know about food chains and food webs?
Is it important to maintain food chains and webs within ecosystems? Why?
What do you already do to maintain food chains and webs?

ANALYZE
Discuss the experience /what was the purpose of this activity?
After the game, I ask the group about their experiences e.g.
Have they learned something from their fellow students? If yes, what?
Why did I open the outdoor program with this activity?
What have you learned from this activity?
Do you feel any connection between yourself and other living creatures in ecosystems? Why or why not?
What can you do (or what do you already do) to maintain these food chains and webs?
The goal of activity 2 was to get students aware that they are a daily part of several food chains or webs within ecosystems and they are part of processes in ecosystems.
Approach: experiential; strategy: reflection
This activity fitted in quadrant 1 & 4 of the 4 MAT cycle

INTEGRATE
Integrate the game and discussion by introducing the concept
In this case it was difficult to carry out a game in the classroom with about 50 students per class. Therefore, an introduction of the concepts was done first for all students of the control group and the experimental group. A game was carried out only with the experimental group during the introduction of the outdoor program. Students were asked about their pre-knowledge about these concepts and key terms as mentioned above and visual material was used to introduce the concepts.
Approach: teacher centered; strategy: self assessment, peer assessment, reflective
The goal of this activity was introduction of new knowledge
Introducing new concepts fitted in quadrant 1 & 2 of the 4 MAT cycle

INFORM
Teach the Concept
Expert knowledge (based on the biology book “Biology en natuur voor jou”) was collected and possessed in a handout, which each student received. Through visual material and examples, the 3 concepts were clarified.
Goal of the activity: provide knowledge of the ecological concepts
Approach: Teacher centered; strategy: self assessment, peer assessment, reflective
Providing expert knowledge fitted in quadrants 1, 2, 3, 4 of the 4 MAT cycle

PRACTICE
*What will they do to understand what is being taught?*
In the hand-out, several exercises were given of each topic. Some of them were carried out in the classroom by students, while some were left for students to carry out at home, while reading the hand-out. Goal of the exercises was to help students to develop flexible knowledge
Approach: Problem based, discovery; strategy: practice
Practicing fitted in quadrant 3& 4 of the 4 MAT cycle

EXTEND
*Engage the entire group into discussions*
In this case, it was difficult to engage the whole group into discussions, but the outdoor education program was based on working in groups, so students had to discuss with each other to carry out the learning activities. All learning activities were based on higher level thinking questions (What if, discuss, imagine).
Goal of the activity: Stimulate higher level thinking
Approach: discussion, problem based; strategy: review, team work, reflection
Discussions fitted in quadrant 1 & 4 of the 4 MAT cycle

SUMMERIZE
*Re-iterate the learned material with a summary*
After the classroom courses a brief summary was given of all three ecological concepts. Students were also able to ask some questions after the course, whereas parts of the learned material were also re-iterated.
After the outdoor program, students came together in a camp, were several questions were asked e.g.: How have you experienced this outdoor program? Have you learned something from your fellow students? If yes, what?
The goal of summarizing and providing comprehensive information (answers) to students’ questions was re-iteration
Approach: reflection; strategy: review
Summarizing fitted in quadrant 1 of the 4 MAT cycle

APPLY
*Creatively integrate new material into real life situations*
An outdoor education program at the Peperpot nature park was composed for the students of the experimental group. After the outdoor learning activities have been carried out, students got the opportunity to ask questions about observations which made them more curious to explore on their own. The goal of this activity was to gain insight and technical skills in the new ecological concepts.
Approach: Experiential, direct, discussion, problem- based, case-based, discovery, learner- centered
Strategy: collaborative, hands-on learning, cooperative, guided practice, demonstration
The outdoor program fitted in quadrants 1, 2, 3, 4 of the 4 MAT cycle.
Figure 4A: The “ice breaker” ……………constructing food chains!


Appendix 2. Questionnaire of strategies and approaches that are used to teach and examine ecological concepts

<table>
<thead>
<tr>
<th>Welke lesmethode wordt overwegend gebruikt?</th>
<th>School 1</th>
<th>School 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klassikaal/theorie</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Groepswerken</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proeven uitvoeren</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verslagen maken (zelfonderzoek)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anders</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hoe vaak wordt aanschouwelijk materiaal gebruikt?</th>
<th>School 1</th>
<th>School 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welke?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geen</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Niet vaak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wat er in de omgeving van de school te vinden is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Studenten brengen zelf aanschouwelijk materiaal mee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tekeningen o/h bord</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hoe vaak gaan de studenten naar het veld in het derde leerjaar?</th>
<th>School 1</th>
<th>School 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waar? Waar zijn ze reeds geweest?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nergens</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Soms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voor elk nieuw concept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peperpot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Op of rondom het schoolerf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anders</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Welke vragen worden overwegend op een repetitie gesteld?</th>
<th>School 1</th>
<th>School 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uitsluitend gebaseerd op de theorie dat in het stencil voorkomt</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Doordenkvragen, niet uitsluitend reproductievragen</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Vragen gebaseerd op proefjes in de klas of veldtrips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welke concepten/ begrippen uit dit onderzoek zijn reeds behandeld?</td>
<td>Openbaar Mulo Meertzorg</td>
<td>Sewrajsing school</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>(A)biotische factoren</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Biodiversiteit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptatie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tolerantie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Niveaus in de ecologie</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Soort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbiose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evenwichten in ecosystemen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definitie ecosysteem</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Habitat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voedselketens/ voedselweb</td>
<td>*, Basis school</td>
<td>*, Basis school</td>
</tr>
<tr>
<td>Fotosynthese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tolerantie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concurrentie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voedingsstoffen kringloop</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Welke concepten worden in het derde leerjaar behandeld?</th>
<th>Tropische ziekten</th>
<th>Tropische ziekten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wormen/wormziekten</td>
<td>Wormen/wormziekten</td>
<td>Ecologie</td>
</tr>
</tbody>
</table>

Figure 4B: Students from both schools joined together and “figured it out!”
Appendix 3. The outdoor program

_Dit biodiversity outdoor education programma is ontworpen in het kader van een afstudeerthesis van de MSc.opleiding Education Biology aan de Institute for Graduate Studies & Research in Suriname en is bestemd voor de derde klas van het Mulo onderwijs._

Deze test wordt uitgevoerd in het Peperpot Natuurpark en bestaat uit praktijk oefeningen en doordenk-vragen, waarbij de vragen multiple choice zijn. _Meerdere antwoorden kunnen per vraag juist zijn._ Er wordt in groepsverband gewerkt. Observeer en beredeneer uitvoerig met je groepsleden om tot de juiste antwoorden te komen. Je hebt een half uur (30 minuten) per vraag om deze te beantwoorden. Dit outdoor educatie program bestaat uit 7 opdrachten en duurt 4 klokuren. Pauze: 09.00-09.20u.

**Als je doodskopaapjes ziet in de bomen, observeer ze op een afstand en blijf heel stil en rustig staan.**

*Introductie*
Rollenspel: De hele groep studenten zal participeren in het maken van voedselketens, waarbij ze zelf als schakels in de ketens zullen functioneren (20 minuten).

*Demonstratie*
Alvorens de groepen beginnen met de test zal de begeleider een demonstratie geven hoe en waar veldgegevens verzameld moeten worden (10 minuten).

**Benodigdheden per groep**
- Theoriestencils
- 2 zip-lock zakken
- 1 schaar
- Pen

**Datum:**................

**Groepsleden:**
1..................................school:......................
2..................................school:......................
3..................................school:......................
4..................................school:......................
5..................................school:......................

_Achtergrond informatie over het Peperpot Natuurpark_
De overheid heeft een natuurbos te plantage Peperpot, met een grootte van 700 hectare, uitgeroepen tot natuurpark. Dit natuurgebied heeft een bijzonder karakter. Door de jaren heen is er een bos ontstaan die tezamen met de oeroude koffie- en cacaooaanplant op de plantage een enorme biodiversiteit heeft opgeleverd. Het park draagt bij aan duurzame ontwikkeling en ecotoerisme op de plantage. Peperpot ligt op slechts tien minuten rijden van Paramaribo en is in tegenstelling tot andere natuurreservaten en natuurparken in het binnenland gemakkelijker te bereiken. De natuurlijke vegetatie en het cultuurerfgoed zijn samengevloed tot een geheel: de hele geschiedenis van de cacao- en koffieplantages, de huizen, fabrieken en de bomen. Het merkwaardige karakter van het natuurpark heeft een enorm aantal vogels aangetrokken die ook in het binnenland voorkomen. Ook beschermd diersoorten zoals de reuzen miereneter en de tigrikati komen voor in het gebied (WWF Guianas, 2009).

_Regels:_
- _Deponeer je afval in de vuilniszak(ken) die in het kamp geplaatst wordt. Deze vuilniszakken laten we niet achter in het park!_
- _Degenen die zich schuldig maken aan vervuiling en vernieling van het park zullen onmiddellijk geschorst worden voor deelname aan de test_
- _Je mag de dieren in het park niet plagen_
• Gesloten schoeisel is verplicht
• Lawaai is absoluut niet toegestaan

Thema 1 Basisstof 1: Milieufactoren
Milieufactoren zijn omgevingsfactoren die van invloed zijn op een organism. Abiotische factoren zijn invloeden uit de niet-levende natuur op een organism. Biotische factoren zijn invloeden uit de levende natuur op een organism. Door de biotische- en abiotische factoren op organismen onstaan ecologische relaties in een ecosysteem. Een ecosysteem is een geheel van planten en dieren in een gebied en hoe ze samenleven met elkaar en hun omgeving (Goerdayal et al, 2002).

Loop langs de Mopentibo trail. Langs de Mopentibo trail zijn aan weerszijden van de kreek rode palulu planten. Deze planten zijn van een roze lint voorzien en een nummer. Zoek per groep 1 op en neem de tijd om het te observeren. Let vooral op de vorm van de bloemen en beantwoord vervolgens deze vragen aan de hand van bovenstaande gegevens. Noteer welk nummer jouw plant heeft.

Vul in: Plant#..................

1A. De a-biotische factoren die invloed hebben op de rode palulu plant zijn:
   a. Water langs de kreek, regenwater, zonlicht en temperatuur, lucht, kleiachtige bodem
   b. Water langs de kreek, zonlicht en temperatuur, lucht, bodemdier
   c. Mieren, vogels, muskieten

1B. De biotische factoren die invloed hebben op de rode palulu plant zijn:
   a. Bodemdier, insecten, vogels, slingerplanten rondom de palulu plant
   b. Regenwater, muskietenlarven, vogels
   c. Er zijn geen biotische factoren die de palulu plant beinvloeden

Thema 1 Basisstof 2 Niveaus van de ecologie; Thema 1 Basisstof 3 Relaties; Thema 2 Basisstof 4 Voedselrelaties

2A. Welke vorm van symbiose bestaat er tussen de mieren en de rode palulu plant:
   a. Parasitisme: de palulu plant wordt vernield door mieren
   b. Commensalisme: mieren drinken nectar en water uit de bloemen en de palulu ondervindt geen schade
   c. Mutualisme: mieren drinken nectar en water uit de bloemen en de palulu plant heeft de mieren nodig voor bestuiving en verdere groei

2B. Een ecosysteem in of rondom de rode palulu plant kan zijn:
a. Het water in de kreek is een habitat voor waterplantjes. Deze plantjes voorzien het water van zuurstof waardoor muskietenlarven en vissen kunnen leven. De muskietenlarven vormen tevens voedsel voor vissen.
b. Het water in de kreek is een habitat voor plankton (algien die voedsel zijn voor kleine visjes). De kleine visjes vormen weer voedsel voor vogeltjes z.a. de kingfisher
c. De palulu bloem vangt regenwater op, die tevens een broedplaats vormt voor muskieten maar ook een drinkplaats voor vogeltjes

3A. Vleermuizen, kujake’s, monki-monki aapjes en awari’s leven allemaal van vruchten. Vleermuizen en awari’s zijn nachtdieren, terwijl kujake’s en monki monki aapjes dagdieren zijn. Ze komen ook voor in hetzelfde gebied in Peperpot natuurpark. Tussen welke 2 diersoorten bestaat de voedselrelatie “concurrentie?”
   a. Vleermuizen en kujake’s
   b. Monki-monki aapjes en awari’s
   c. Vleermuizen en awari’s

3B. Om zeker te zijn van het antwoord van vraag 3B, zou je als jonge onderzoeker dit ook zelf kunnen nagaan. Met welk onderzoek zou je het beste kunnen nagaan tussen welke dieren er concurrentie heerst in de vruchtbomen?
   a. Een camera plaatsen die dag en nacht opname maakt van welke dieren van de vruchten komen eten
   b. Zelf in de bomen klimmen en dag en nacht observeren welke dieren van de vruchten komen eten
   c. De half opgevreten vruchten bekijken en herkennen welke dieren eraan hebben gegeten

Thema 1 basisstof 5 Kringlopen

Een volledige kringloop van voedingsstoffen is het proces vanaf de vorming van organische voedingsstoffen (uit anorganische) totdat ze weer worden afgebroken. Hiervoor zijn producenten, consumenten en reducenten nodig. Uit anorganische stoffen worden organische geproduceerd door planten. Deze organische stoffen worden weer afgebroken tot anorganische stoffen door reducenten (Goerdayal et al, 2002).

Loop vervolgens naar het eerste naturleerpad (trail 1). Deze trail is voorzien van een roze lint. Ga tot het einde waar je een boomstam zult tegenkomen waarop paddestoelen groeien. Deze zullen voorzien zijn van roze lintjes. Observeer goed en ga met je groepsleden na welke antwoorden juist zijn van de onderstaande vragen.

4A. De paddestoelen en de boomstam behoren in de kringloop van voedingsstoffen tot:
   a. Paddelstoel = producent ; boomstam = producent
   b. Paddelstoel= consument ; boomstam= producent
   c. Paddelstoel=reducent ; boomstam = dood organisch materiaal

4B. De kringloop van voedingsstoffen die het beste past in het Peperpot natuurpark is:
   a. Gesloten, omdat er niet gejaagd mag worden, er vindt geen ontbossing plaats en organisch afval van planten en dieren verteert binnen het parkterrein
   b. Open, omdat de grasmachines de wandelpaden elke week platmaaien en omdat het park niet volledig is omrasterd; de dieren hebben alle vrijheid om in en uit het park te gaan
   c. Noch open, noch gesloten

Thema 1 Basisstof 8 Evenwicht

Een evenwicht binnen een populatie treedt op als de grootte van de populatie ongeveer evengroot blijft voor een lange periode. Als populaties binnen een ecosysteem in evenwicht zijn spreekt men van een ecologisch evenwicht in dat ecosysteem. Zo een evenwicht kan worden beïnvloed door beschikbaarheid aan voedsel, habitats voor soorten, predatie, invloeden van de mens of voortplantingsnelheid. Als evenwichten binnen een ecosysteem
zodanig verstoord raken kunnen soorten binnen dat ecosysteem met uitsterven worden bedreigd (Goerdayal et al., 2002).

Elke groep zoekt een schaduwrijk plekje op om zich comfortabel te voelen, terwijl jullie discussies voeren om vraag 5 te beantwoorden.

5A. Het Peperpot natuurpark is ook een habitat voor aka’s (roofvogels). Deze roofvogels eten ook wel doodskop-aapjes die zich in de boomkronen bevinden, daarom is het een natuurlijke vijand van de aapjes in het park. De aka’s staan aan top van een voedselketen omdat ze geen natuurlijke vijanden hebben. Voor het natuurpark is de voedselrelatie tussen de aka vogel en de doodskopaapjes wel / niet goed omdat:
   a. Wel goed, de roofvogel populatie is nodig om de populatie apen in evenwicht te houden
   b. Niet goed, roofvogels mogen geen aapjes eten, anders sterven de aapjes uit
   c. Het maakt niet uit, want als de aapjes niet meer in het park voorkomen, vinden de aka’s wel iets anders om te eten

5B. Peperpot is tot een natuurpark verklaard omdat:
   a. De mensen van Peperpot worden beschermd
   b. De geschiedenis, plant-en diersoorten van Peperpot beschermd en behouden moet worden
   c. Uitsluitend beschermde plant-en diersoorten op Peperpot voorkomen

Thema 2 Basisstof 1 Temperatuur, licht en lucht

In een ecosysteem kiest iedere soort zijn eigen habitat (leefplek), waar de milieufactoren gunstig zijn. Alle organismen passen zich aan hun omgeving aan om te kunnen overleven (adaptatie). Sommige soorten organismen hebben een beter adaptatievermogen dan andere soorten, waardoor ze meer weerstand kunnen bieden tegen extreme milieufactoren. Deze soorten hebben dan ook een grotere overheidskans en ze kunnen zich makkelijker verspreiden over verschillende soorten ecosystemen. Soorten met een groot adaptatievermogen kunnen de extreme milieu invloeden ook beter verdragen, waardoor ze in meerdere soorten ecosystemen kunnen voorkomen. We zeggen dat deze soorten hoge tolerantie (=verdragen) hebben (Goerdayal et al., 2002).

Loop langs de Mopentibo trail en op het natuurleerpad (trail 1). Observeer waar je overwegend varenplanten tegenkomt.

6A. Varens tref je overwegend aan op....X.....plaatsen, dus je kan concluderen dat varenplanten behoren tot de .....Y.......  
   a. X=schaduwrijke plaatsen; Y=schaduwplanten  
   b. X=schaduwrijke & vochtige plaatsen; Y= schaduwplanten  
   c. X= zonrijke plaatsen; Y= niet-schaduwplanten

Langs de Mopentibo trail en op het natuurleerpad zijn er vakjes (plots) met roze lintjes afgebakend waarbinnen vegetatie groeit. Elke groep krijgt 2 zakken waarbij op de ene zak staat “Mopentibo trail vegetatie/ plot A” en op de andere zak staat “ Natuurleerpad vegetatie/ plot B”. Volg de onderstaande stappen in volgorde:
   1. Let goed op de a-biotische factoren die invloed hebben op de vegetatie. Vergelijk de Mopentibo trail met het Natuurleerpad en vul in:

<table>
<thead>
<tr>
<th>Temperatuur</th>
<th>Mopentibo trail (plot A)</th>
<th>Natuurleerpad (plot B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>koeler/koeler</td>
<td>Warmer/koeler</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>zonlicht</th>
<th>Meer/minder</th>
<th>Meer/minder</th>
</tr>
</thead>
</table>

2. Elke groep verzamelt plantjes uit 1 plot van de Mopentibo trail en 1 plot van het Natuurleerpad; dus elke groep verzamelt vegetatie uit 2 plots. Je gebruikt een schaar om de plantjes af te knippen.
3. Het is al vodoende om 1 à 2 exemplaren per plantensoort te verzamelen (je moet niet alle plantjes uit de plot afknippen).
4. Haal de plantjes uit de zakken maar houd de plantjes van beide zakjes wel gescheiden.
5. Observeer de planten per plot en kijk naar hun aanpassingen (adaptatie). Let daarbij vooral op:
   a. Beharing op bladeren en/of stengels (groot/glad)
   b. Bladgrootte (grote/kleine)
   c. Dikte van bladeren (dik/dun)

6. Vergelijk de aanpassingen van planten uit beide plots en vul onderstaande tabel in:

<table>
<thead>
<tr>
<th>Beharing op bladeren en/of stengels (groot/glad)</th>
<th>Mopentibo trail (plot A)</th>
<th>Natuurleerpad (plot B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wel / geen beharing</td>
<td>Wel / geen beharing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bladgrootte (grote/kleine)</th>
<th>Grote / kleine bladeren</th>
<th>Grote / kleine bladeren</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dikte van bladeren (dik/dun)</th>
<th>Dikke / dunne bladeren</th>
<th>Dikke / dunne bladeren</th>
</tr>
</thead>
</table>

6B. Tot welke conclusie kom je als je let op de a-biotische factoren en de aanpassingen van planten uit plot A en plot B?
   a. Planten van de Mopentibo trail hebben veel beharing, kleinere en dikkere bladeren waardoor ze zich beter kunnen aanpassen aan de felle zon; door deze aanpassingen verliezen ze minder vocht.
   b. Planten van Natuurleerpad hebben veel beharing, kleinere en dikkere bladeren waardoor ze zich beter kunnen aanpassen aan de felle zon; door deze aanpassingen verliezen ze minder vocht om extreme verdamping tegen te gaan.
   c. Planten van de Mopentibo trail hebben veel beharing, kleinere en dikkere bladeren waardoor ze zich slechter kunnen aanpassen aan de felle zon; door deze aanpassingen verliezen ze meer vocht waardoor ze snel zullen uitdrogen in de zon.

6C. Planten kunnen ook aanpassingen hebben aan hun bloemen om bestuiving makkelijker te laten plaatsvinden. Langs de Mopentibo trail zal je koningsbloemen tegenkomen, met een opvallend geel-rode kleur. (De plantjes zijn van een roze lint voorzien). Elke groep zoekt een plantje op en observeer de bloemen heel goed. Beredeneer in groepsverband als koningsbloemen behoren tot.....X.....omdat ze als aanpassing hebben....Y...
   a. X=Insectenbloemen Y= de opvallende, felle kleuren als een lokmiddel voor insecten
   b. X=Windbloemen Y= lange meeldraden, stuifmeel wordt meegenomen door de wind
   c. X= Insectenbloemen Y= een sterke geur of kleverige stuifmeelkorrels of nectar

Evaluatie

7A. Na dit outdoor educatie program :
   a. Heb je meer interesse voor ecologische concepten gekregen
   b. Heb je weinig interesse voor ecologische concepten gekregen
   c. Heb je helemaal geen interesse voor ecologische concepten gekregen

7B. Door mee te doen aan dit educatieprogram te Peperpot hebben jullie wel kennis en vaardigheden gekregen in de biologie concepten:
   a. Invloeden van biotische and a-biotische factoren op ecosystemen
   b. Relaties tussen organismen op verschillende niveaus van ecosystemen
   c. Ecologische cyclussen en evenwichten in de ecologie

.................................................................................................................................

Dank je wel voor de medewerking!
Figure 5: Observations during learning activities
Appendix 4. Scores learning activities of outdoor program

<table>
<thead>
<tr>
<th>Question</th>
<th>group1</th>
<th>group2</th>
<th>group3</th>
<th>group4</th>
<th>group5</th>
<th>group6</th>
<th>group7</th>
<th>group8</th>
<th>group9</th>
<th>group10</th>
<th>groups with right answer</th>
<th>groups with wrong answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>1B</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
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<td>0.5</td>
<td>0.5</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>2A</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>2B</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
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<td>0.5</td>
<td>0.5</td>
<td>10</td>
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</tr>
<tr>
<td>3A</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>3B</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
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</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>5A</td>
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<td>0</td>
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<td>0</td>
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<td>1</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>5B</td>
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<td>0.5</td>
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<td>0</td>
<td>0.5</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>6A</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
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<td>8</td>
<td>2</td>
</tr>
<tr>
<td>6C</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>

7A Evaluation
7B Evaluation

Scales

scale 0–4 (least) 5–7 (moderate) 8–10 (good)
Figure 6: Data collection
Appendix 5. Pre - test

Naam student:
School:
Klas:
Datum:

Richtlijnen
Deze multiple choice test is gerelateerd aan het derde leerjaar van het Mulo Biologie onderwijs. Het bestaat uit 20 vragen, waarbij steeds 1 antwoord juist is. Op het formulier met potlood omcirkelen welk antwoord juist is. Bij vraag 4 moet je de juiste letter zelf invullen. Het gebruik van literatuur is niet toegestaan. Je hebt 60 minuten om deze test te maken (Let op: max. 3 minuten per vraag).

Success! 😊

1. Bacterien en schimmels zijn belangrijk in ecosystems omdat ze:
   a) aan de top van de voedselketens staan
   b) anorganische stoffen in organische stoffen omzetten die opgenomen kunnen worden door planten
   c) organische stoffen omzetten in anorganische stoffen die opgenomen kunnen worden door planten
   d) zonne energie omzetten in glucose door fotosynthese

2. In een voedselketen behoort een rups tot een:
   a) Producent
   b) Consument
   c) Afvaleter
   d) Reducent

3. Welke twee abiotische factoren hebben invloed op ecosystems:
   a) temperatuur en dieren
   b) planten en dieren
   c) water en bacteriën
   d) zonlicht en water

4. Vul in:
   Hout om huizen te bouwen is een..................
   Het aantal kwi-kwi’s in een zwemp wordt uitgedrukt in..............
   a) bron van vervuiling
   b) populatie dichtheid
   c) natuurlijke hulpbron
   d) bedreigde soort
   e) biodiversiteit

5. De studie van de interactie tussen organismen met hun omgeving wordt genoemd:
   a) ecosystems
   b) abiotische factor
   c) ecologie
d) voedselketens

6. Een ecosysteem bestaat uit:
   a) alleen levende organismen
   b) alleen levenloze organismen
   c) levende organismen en de invloeden uit de niet levende natuur op die organismen
   d) levende organismen en dood organisch materiaal

7. Welke van de voedselketens zijn correct?
   a) zaden -> boskonijn -> jaguar
   b) kikkereitjes -> kikkervisje -> volwassen kikker
   c) plankton -> roofvissen -> kikkervisje
   d) waterslang -> kikker -> kikkervisje -> insecten

8. De koereiger (sabaku) pikt teken (kupari’s) uit de vacht van de koe. Van welke vorm van synbiose is er sprake?
   a) mutualisme
   b) commensalisme
   c) parasitisme
   d) voedselrelatie

9. Biodiversiteit is:
   a) alle met het blote oog zichtbare soorten in een ecosysteem
   b) de natuurlijke hulpbronnen van de mens
   c) varieté aan soorten in een ecosysteem
   d) een hernieuwbare energiebron

10. Op welk ecologisch niveau zit een konijn die samenleeft met andere konijnen in een weiland?
   a) individu
   b) populatie
   c) levensgemeenschap
   d) ecosysteem

11. Vleermuizen, kujake’s, monki-monki aapjes en awari’s leven allemaal van vruchten. Ze komen ook voor in hetzelfde gebied in het Peperpot natuurpark. Er is sprake van de voedselrelatie concurrentie tussen:
   a) Vleermuizen, kujake’s, monki-monki aapjes en awari’s
   b) Vleermuizen en kujake’s
   c) Monki-monki aapjes en awari’s
   d) Vleermuizen en awari’s

12. Een populatie van Babun apen in het Brownsberg natuurpark is in evenwicht het aantal babun apen op de Brownsberg:
   a) zich overwegend reproduceert
b) het aantal zaaddragende bomen afneemt op de Brownsberg
c) stopt met toenemen en ongeveer evengroot blijft
d) niet in staat is te overleven in dat gebied

13. Para gras vormt een pest op slecht onderhouden percelen en sloten omdat:
a) para gras geen natuurlijke vijanden heeft
b) de bodem veel te vruchtbaar is
c) de herbicides niet efficient werken
d) de tolerantie van para gras groot is

14. Een vogel is een heterotrofe organisme in een voedselkringloop omdat:
a) Zijn uitwerpselen voedingsstoffen vormen voor de planten
b) Het zelf op zoek kan gaan naar voedsel
c) Niet op zonne-energie hoeft te vliegen
d) Geen zonne-energie en koolzuurgas kan omzetten in voedingsstoffen in zijn lichaam

15. Vegetatie die als eerst groeit op een pas gevormde kale modderbank wordt genoemd:
a) Primair bos
b) Climax vegetatie
c) Primaire successie
d) Onkruid

16. Peperpot is tot een natuurpark verklaard omdat:
a) De mensen van Peperpot worden beschermd
b) De geschiedenis, plant-en diersoorten van Peperpot beschermd en behouden moet worden
c) Uitsluitend beschermde plant-en diersoorten op Peperpot voorkomen
d) Er een behoefte was aan een trimbaan in Commewijne

17. Wat is niet juist over waterplanten
a) Landplanten hebben een beter ontwikkeld wortelstelsel dan van waterplanten
b) Bij drijvende waterplanten zijn de huidmondjes zijn aan de bovenkant van hun bladeren
c) Halen hun voedingsstoffen uitsluitend uit het water
d) De bladeren zijn niet bedekt met een cuticula om verdamping tegen te gaan

18. Zaden die door de wind worden verspreid hebben de volgende aanpassingen:
a) Stevige houten zaadhuid om het zaad
b) Doorzichtige zaadhuid om het zaad
c) Lichte zaad aangehecht aan een pluis of propellervormige bloem
d) Zijn eenzaadlobbig

19. Voedingsstoffen die bomen, in het Surinaams tropisch regenwoud, verbruiken zijn afkomstig van:
a) Dichtsbij zijnde kreken en kunstmes
b) Uitsluitend uitwerpselen van dieren
c) Uitsluitend zonlicht en koolzuurgas
d) Continue verterende humuslaag onder de bomen

20. In een gezond ecosysteem zoals het tropisch regenwoud van Suriname:
   d. Is de jaguar populatie nodig om de bosvarken populatie in evenwicht te houden
   e. Mogen jaguars geen bosvarkens doden, anders sterven de bosvarkens uit
   f. Mogen jagers helemaal geen dieren afschieten
   g. Is de populatie bosvarkens uitsluitend afhankelijk van natuurlijke vijanden

...............................................................................................................................

Dank je! 😊

Figure 7: Data analysis
Appendix 6. Post - test

Naam student:
School:
Klas:
Datum:

Richtlijnen
Deze multiple choice test is gerelateerd aan het derde leerjaar van het Mulo Biologie onderwijs. Het bestaat uit 19 vragen, waarbij steeds 1 antwoord juist is. Op het formulier met pen invullen welk antwoord juist is. Het gebruik van literatuur is niet toegestaan. Je hebt 60 minuten om deze test te maken (Let op: max. 3 minuten per vraag)

Success!

1. Paddestoelen zijn schimmels. Je ziet ze vaak op dode bomen of op planken en houtblokken. Paddestoelen zijn belangrijk in ecosystemen omdat ze:
   e) aan de top van de voedselketens staan
   f) anorganische stoffen in organische stoffen omzetten die opgenomen kunnen worden door planten
   g) organische stoffen omzetten in anorganische stoffen die opgenomen kunnen worden door planten
   h) zonne energie omzetten in glucose door fotosynthese

2. In een voedselketen behoort een Kankantrie boom tot een:
   e) Producent
   f) Consument
   g) Afvaaleter
   h) Reducent

3. Twee biotische factoren die een effect op ecosystemen kunnen hebben zijn:
   e) temperatuur en dieren
   f) planten en dieren
   g) water en bacterien
   h) zonlicht en water

4. Vul in:
   Water uit de bovenloop van de Surinaamse kreken en rivieren is een................
   Het aantal Babun apen op de Brownsberg wordt uitgedrukt in............... 
   f) bron van vervuiling
   g) populatie dichtheid
   h) natuurlijke hulpbbron
   i) bedreigde soort
   j) biodiversiteit

5. Geef aan wat juist is:
   e) In gezonde ecosystemen komen gesloten voedselketens voor
   f) In gezonde ecosystems komen zeer korte voedselketens voor
   g) Binnen een voedselketen kan er sprake zijn van alle vormen van symbiose
h) In gezonde ecosystemen zijn er enorm veel voedselketens aanwezig

6. Welk begrip hoort bij de omschrijving “Levende organismen en de invloeden uit de niet levende natuur op die organismen”
   e) Soort
   f) Ecosysteem
   g) Populatie
   h) Levensgemeenschap

7. Welke van de voedselketens zijn niet correct?
   e) zaden -> boskonijn -> jaguar
   f) kikkereitjes -> kikkervisje -> volwassen kikker
   g) plankton -> garnalen -> roofvissen
   h) insecten -> kikker -> waterslang

8. De makka slang woont samen met de kapasi (gordeldier) in een hol in de grond. De kapasi graaft de hol waarin de makkaslang ook mag wonen, terwijl de makkaslang het hol bewaakt tegen allerlei gevaren. Welke vorm van symbiose is er sprake?
   e) mutualisme
   f) commensalisme
   g) parasitisme
   h) voedselrelatie

9. Met “de varieteit aan soorten in een ecosysteem” wordt bedoeld:
   e) zichtbare soorten
   f) natuurlijke hulpbronnen
   g) biodiversiteit
   h) hernieuwbare energiebron

10. Op welk ecologisch niveau zit een agouti (boskonijn) die voor zijn voedsel afhankelijk is van awara vruchten in een weiland
   e) individu
   f) populatie
   g) levensgemeenschap
   h) ecosysteem

11. Monki-monki aapjes en agouti’s (boskonijnen) leven allemaal van vruchten en zaden. Ze komen ook voor in hetzelfde gebied in het Peperpot natuurpark. Er is sprake van de voedselrelatie “commensalisme” omdat:
   e) De aapjes delen van vruchten op de grond laten vallen tijdens het eten, waardoor de agouti’s ook van deze vruchten kunnen eten
   f) Er is geen sprake van commensalisme, maar mutualisme
   g) De aapjes en agouti’s elkaars natuurlijke vijanden zijn
   h) De aapjes en agouti’s graag samen naar voedsel zoeken
12. Als een populatie vissen in een zwamp stopt met toenemen en ongeveer evengroot blijft is er sprake van:
   e) vissterfte
   f) evenwicht
   g) waterverontreiniging
   h) een overschot aan vissen

13. De rode tilapia vissen vormen een pest in zwampen in de jonge kustvlakte omdat:
   e) Rode tilapia’s geen natuurlijke vijanden heeft
   f) Het water in de zwamp veel te vruchtbaar is
   g) de pesticides niet efficient werken
   h) de tolerantie van Rode tilapia’s groot is

14. Een hagedis is een heterotrofe organisme in een voedselkringloop omdat:
   e) Zijn uitwerpselen voedingsstoffen vormen voor de planten
   f) Het zelf op zoek kan gaan naar voedsel
   g) Niet op zonne-energie hoeft voort te bewegen
   h) Geen zonne-energie en koolzuurgas kan omzetten in voedingsstoffen in zijn lichaam

15. Aan Peperpot is een hoge biologische en geografische waarde toegekend door de Surinaamse overheid omdat:
   e) De mensen van Peperpot worden beschermd
   f) De geschiedenis, plant- en diersoorten van Peperpot beschermd en behouden moet worden
   g) Uitsluitend beschermd de plant- en diersoorten op Peperpot voorkomen
   h) Er een behoefte was aan een trimbaan in Commewijne

16. Wat is juist over planten die op land groeien
   e) Landplanten hebben een slechter ontwikkeld wortelstelsel dan van waterplanten
   f) Bij landplanten zijn de huidmondjes zijn aan de bovenkant van hun bladeren
   g) Halen hun voedingsstoffen uitsluitend uit de bodem
   h) Niet alle landplanten zijn even goed aangepast om verdamping tegen te gaan

18. Zaden die door vogels worden verspreid hebben de volgende aanpassingen:
   e) Stevige zaadhuid om het zaad
   f) Doorzichtige zaadhuid om het zaad
   g) Lichte zaad aangehecht aan een pluis of propellervormige bloem
   h) Zijn eenzaadlobbig

19. Voedingsstoffen die waterplanten verbruiken zijn afkomstig van:
   e) Uitsluitend uitwerpselen van waterdieren
   f) Uitsluitend zonlicht en koolzuurgas die in het water is opgelost
   g) Alleen de humuslaag op de bodem van de zwamp
   h) De humuslaag op de bodem van de zwamp en de opgeloste voedingsstoffen in het water
20. In een ecosysteem die zichzelf kan herstellen:
   h. Is de jaguar populatie nodig om de herten populatie in evenwicht te houden
   i. Mogen jaguars geen bosvarkens doden, anders sterven de bosvarkens uit
   j. Mogen jagers helemaal geen dieren afschieten
   k. Is de grootte van de populatie agouti’s (boskonijnen) uitsluitend afhankelijk van natuurlijke vijanden

.............................................................................................................................

Dank je!

Figure 8: Wrap up...students reunite with their teachers again