REPORT 5.A: Increase flood awareness through a school program

DENDERLEEUW PILOT

Increase flood awareness through a school program

The Centre for Mobility and Spatial Planning (AMRP) of Ghent University has set up a school program in the context of the Interreg FRAMES program. Its purposes was to explore if it might be possible to increase the actual level of flood awareness of children from the age of 10 to 18 years in Flanders. In addition the idea was to investigate to which degree the subject is addressed in the Flemish education system and how it might be improved. The program consists of three workshops for different age categories. The school program was tested in two schools of Denderleeuw, located in the Dender basin. This report presents the various steps in the design of the program and details of the workshops performed in the schools.

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Table of content

Abstract (Nederlands)

De Afdeling voor Mobiliteit en Ruimtelijke Planning van de Universiteit Gent heeft in het kader van het Interreg FRAMES project een scholenprogramma ontwikkeld. Het FRAMES project is gesubsidieerd door de *European Regional Development Fund* en heeft als doel de veerkracht tegen overstromingen van burgers en actoren van zowel de publieke als de privé sector in het Noordzeegebied te verhogen. Het scholenprogramma richt zich op het inzicht van de leerlingen en leerkrachten rond overstromingen en klimaatverandering en gaat na in hoeverre deze onderwerpen aan bod komen in het Vlaams onderwijssysteem.

Het scholenprogramma bestaat uit drie workshops voor verschillende leeftijdsgroepen met elk een didactisch spel. “Spelen met water” is het eerste spel en is oorspronkelijk bedoeld voor leerlingen van 9 tot 12 jaar. Het spel is gefocust op modelleerbare landschappen. Het doel is om het inzicht van leerlingen te verhogen dat landschappelijke karakteristieken een invloed hebben op het voorkomen van overstromingen. “Spelen met maatregelen” is het tweede spel en richt zich op leerlingen van 12 tot 15 jaar en maakt gebruik van een computerspel “Deltaviewer”, ontwikkeld door de Nederlandse Deltacommissie. Het spel spits zich toe op de uitdaging van een evenwichtig waterbeleid door gebruik te maken van verschillende maatregelen die op elkaar een invloed hebben. “Spelen met rollen” richt zich op leerlingen van 15 tot 18 jaar en is sterk geïnspireerd door het bordspel “Hoog Water zonder Kater” van de Commissie Integraal Waterbeleid (CIW). Het spel werd verder ontwikkeld en aangepast voor een jonger publiek in samenwerking met de CIW.

Het scholenprogramma werd getest in een basisschool, ’t Landuiterke, en een middelbare school, het Koninklijk Atheneum Denderleeuw (KADenderleeuw), beide gelegen in Denderleeuw. De workshop “Spelen met water” werd getest met twee klassen van het zesde leerjaar. In het KADenderleeuw kon enkel de workshop “Spelen met rollen” getest worden als gevolg van het lessenrooster van de school. De workshop werd uiteindelijk getest met twee klassen van het vierde middelbaar. Een ex-ante en ex-post analyse aangevuld met interviews met de leerkrachten hebben de mogelijkheid gegeven om het scholenprogramma te evalueren en de nodige informatie bijeen te brengen voor wetenschappelijk onderzoek en verdere bemerkingen.

Algemeen werden zowel positieve als negatieve reacties op het spel gegeven. Vooral de moeilijkheidsgraad van beide workshops werd als kanttekening genoemd. Een oplossing zou zijn om in de toekomst de drie leeftijdsgroepen op te schuiven naar het middelbaar onderwijs. Dit zou het bijkomende voordeel hebben om één enkele middelbare school te moeten contacteren voor het uitvoeren van het scholenprogramma. Voorst werden verschillende conclusies werden getrokken ten aanzien van de basis- en middelbare school. In het algemeen vertoonden leerlingen en leerkrachten in

de basisschool een geringe kennis en inzicht in klimaatverandering en overstromingen. Omtrent het thema klimaatverandering komt enkel het broeikaseffect en de CO_2-uitstoot aan bod in het curriculum van de leerkrachten uit het basisonderwijs. Het thema overstromingen wordt nauwelijks behandeld. De leerkrachten van de basisschool achtten het daarbij niet nodig om hun curriculum aan te passen omdat het thema klimaatverandering in de huidige omstandigheden 1 tot 2 uur per jaar behandeld wordt. Wat volgens hen genoeg is om het thema te behandelen. In het middelbaar komt de relatie van klimaatverandering en overstromingen wel aan bod maar enkel in algemene zin. Dit versterkt volgens de leerkrachten een “ver van bed gevoel” bij de jongeren. De bijkomende kennis die de leerkrachten en leerlingen rond deze thema’s kunnen verwerven komt hoofdzakelijk van de actualiteit en hangt dus enkel af van hun eigen initiatief. De kennis en het inzicht van de leerlingen en de leerkrachten van de middelbare school bleek niettemin groter te zijn rond deze thema’s al werd een aantal gebreken en foute beweringen opgemerkt. In tegenstelling tot de basisschool, vonden de leerkrachten het wel belangrijk om de thema’s klimaatverandering en overstromingen meer aan bod te krijgen in hun curriculum.

De beperkte aanpak van de thema’s overstromingen en klimaatverandering in de curricula van de leerkrachten versterkt de noodzaak om dergelijke spellen op te nemen. Dit temeer aangezien één van de doelstellingen van het Vlaams onderwijsbeleid zich toespitst op het voorbereiden van jongeren op de toekomstige uitdagingen en complexe situaties aan te pakken. Volgens de leerkrachten promoot de Vlaamse onderwijshervorming, die sinds 1 september 2019 van kracht is, een nauwere samenwerking tussen leerkrachten met verschillende expertise en trans-disciplinaire aanpak. Dit kan gezien worden als een opportuniteit voor een samenwerking tussen scholen en hogere kennisinstituten om een overdracht van correcte informatie rond deze thema’s te garanderen. Op lang termijn is het niettemin van belang om leerkrachten de juiste informatie door te geven tijdens hun opleiding en vervolgens deze thema’s te incorporeren in hun curriculum.


HERE WE FIND A THRIVING CITY: BRAND NEW BUILDINGS, A BUSTLING ECONOMY.
A SCENIC THOROUGHFARE WINDS THROUGH THIS HAPPY MUNICIPALITY. HERE, A FARMER DRIVES HIS LIVESTOCK TO MARKET.
TRAGICALLY, THIS SERENE METROPOLIS LIES DIRECTLY BENEATH THE HOOVER DAM...
WATTERSON

1. Introduction

One of the main objectives of the FRAMES project is to increase the flood resilience of communities by making people and stakeholders better prepared. This objective can be placed in the preparedness layer of the Multi-Layered Water Safety (MLWS) concept. The MLWS concept focuses on the principle that public authorities do not have the capacity to solely deal with floods anymore and that there is a need to share the responsibilities with other private and civic stakeholders. The preparedness layer implies measures that tend to cope with floods when they happen, for instance emergency relief, well-trained rescue operations or the distribution of sandbags. These measures focus strongly on the population's reaction to floods (VMM, 2014). Previous studies (Mees, 2017; Tempels, 2016) in the Flemish Region have already indicated the low awareness of the population in relation to floods, which hampers the development of a strategy, implying community participation for flood resilience. Another objective of FRAMES is to present policy recommendations in order to increase the applicability of MLWS. As MLWS includes a preparedness layer, further implying the participation of communities, there is a need to enhance the awareness of these communities. The previous mentioned studies also argued that this enhancement could not be achieved without increasing the communication efforts concerning the Flemish flood risk management. Notwithstanding, until now professionals and academics predominantly focus on the adult group of the population. This leaves the question if there is not a need to enhance the awareness of the younger non-adult generations since they are the next generation to deal with floods. Next to this, the public education system is an important societal tool of influence in the development of the population's perception of climate change (Alexander, 2010; Anderson, 2012).

In addition numerous activities are being organised by secondary school students. For instance the *Youth for Climate* movement, has organised several marches during the school year 2018-2019 (Gurría, 2019). These movements indicate that a substantial portion of the younger generation feels concerned about the problem of climate change. However, it remains unclear to which degree the overall younger population is aware of the specific climate challenges, its consequences and what could be done about it. Moreover it remains unclear if and how these subjects are being taught in the Flemish schools.

Therefore the Belgian FRAMES partners designed a school program with the objective of increasing the awareness of the younger generations to the specifics of floods in the face of climate change. This school program tends to find answers to the following questions:

- What is level of awareness of the younger generations concerning climate change and the increasing risk of floods in Flanders?
- To which level does the Flemish education system raises awareness?

- Can a school program with didactic games increase the awareness, preparedness and the recognition of a shared responsibility?

This report first describes the different steps for designing the program. It further explains how the schools were contacted and how the school program was adapted to each school's working structure. This is followed by an evaluation during and after the main workshops of the program questionnaires filled in by the students and interviews with the teachers. Finally, we will discuss how the school program can be enhanced and how we could make more effectively use of the Flemish education system as a societal tool to enhance the awareness of the population.

2. Program development

2.1. Literature study: lessons learnt from previous programs

The need for the development of environmental and flood education programs in schools is stressed by an increasing range of academic scholars (Galván-Pérez et al., 2018; Johnson et al, 2014; Nyberg et al., 2014; Pande, 2001; Tsai et al., 2014). Each study grounds its findings on specific school programs with different didactic methodologies. They offer interesting lessons and inspiration for the development of a school program.

Pande (2001) for instance developed an environmental education program in rural central Himalayan schools, which is facing major environmental problems such as deforestation and soil erosion causing shortages of water, firewood and fodder. The education program starts with the idea of a village as a laboratory. After a first (theoretical) introduction, students and teachers will visit the village and, in collaboration with villagers, make quantitative assessments of village resources. Afterwards this study offers several insights: environmental education should be holistic and focused on a long range of the future; evaluation methods are essential to assess attitudinal changes; environmental education must be participatory and experiential; and local-specific approaches are more effective than general approaches (Pande, 2001). Likewise, the DESD (Decade of Education for Sustainable Development), which was in action between 2005 and 2014 under the leadership of UNESCO, identified 4 important aspects in disaster risk reduction education: interdisciplinary and holistic learning, value based learning, participatory decision-making, and locally relevant information (Nyberg et al., 2014).

Other school programs also focus on game-based education in the form of role games (Rusca et al., 2012), board games (Tsai et al., 2015) or computer games (Galván-Pérez et al., 2018). The principle of a game is to encourage the players' active learning by exploration. Role games are used generally to enhance the skills in negotiating, consensus building and working teams. These skills are considered essential for all professionals especially in water management programs, which are multi-disciplinary

and involve different actors from different backgrounds (Rusca et al., 2012). Board games can be highly efficient in behavioural change through continuous engagement and solving problems by inducing spontaneous behaviour. In order to achieve such aims, a board game needs to imply a challenge and trigger the players' curiosity by adding a variety of elements in the game (Tsai et al., 2015). Finally, Galván-Pérez et al. (2018) made an assessment on computer games and identified four dimensions that a computer game needs in order to be efficient. First, the game needs a narrative dimension with a global storyline, a well explained context and characters to which the players can identify themselves. The second dimension is the scientific content dimension: the terminology needs to be correct, false concepts and misconceptions need to be presented as such and the use of information sources has to be explicit. In terms of gameplay dimension, the game has to have a degree of interactivity, a reward system and a feedback system. The instruction need to be available as well. Didactically speaking, the game must answer some criteria. It must reach the competences and abilities of the students. Moreover, the game has to be problem solving oriented, interdisciplinary and must offer the possibility of group work. As it is rare to find computer games that answer all the criteria, it is the maximum combination of these criteria that enhances a games' quality (Galván-Pérez et al., 2018).

An important aspect in the development of education programs is the evaluation to identify its assets and deficiencies (Pande, 2001). Johnson et al. (2014) made a methodological review of the evaluations of disaster education programs for children from different regions around the globe. His review identified 35 studies of education programs. An important finding was that the evaluation of most disaster education programs was based on measuring the children's knowledge of risks and did not include teachers or parents as research participants. Another one was the poor quality responses of especially very young children. This problem could be resolved by adapting the questionnaires to the age of the children. It was also noted that evaluation during the program was more effective in getting higher response rates than voluntary take home surveys. Conclusively, the review identified several effective evaluation tools to measure the children's self-efficacy, adaptive capacities, subject comprehension and knowledge transfer. A possible tool is the use of Likert-type scale[1] questionnaires, who focus on their personal self-confidence in achieving specific preparedness and response tasks to disaster events. The observation of the children's application of existing knowledge and their problem-solving attitudes during the program is also quite effective, although it requires the necessary workforce to make these observations. Measuring the young children's subject comprehension

[1] The Likert scale is type of response structure commonly used in questionnaire. Statement concerning a topic are presented and the participant needs to indicate whether he/she strongly disagrees, disagrees, neither agrees or disagrees, agrees or strongly agrees.

through a Narrative Story Stem Technique[2], which examines children's oral narrative structures to characterize their knowledge and perceptions, is an effective solution to the poor quality responses of very young children (Johnson et al., 2014).

2.2. Design of the didactic games

2.2.1. Introduction

The literature study therewith gives interesting lessons that were compiled in 11 didactic focus points. They were included as much as possible in the development of the FRAMES school program. Pande (2001) argues that (1) key concepts of the theme need to be **introduced** to prepare the pupils, (2) an approach including a **long range in the future** is required when addressing environmental problems, (3) an **evaluation method** has to be prepared prior to the program to assess the pupils change of perspective and learning, (4) the didactic games have to be **participatory and experiential** and that (5) addressing the problem statement from a **local specific approach** makes it relevant for the pupils. Rusca *et al.* (2012) and Tsai *et al.* (2015) emphasize (6) the use of **active learning by exploration** and to (7) be challenge and **problem solving oriented**. Furthermore, Galván-Pérez *et al.* (2018) underline the importance of didactic games that have (8) **a narrative dimension**, (9) are **scientifically correct**, (10) have a form of **interactivity** and that (11) include a conclusive session implying a **reward system and feedback**.

The fundamental purpose of the school program is to address different age groups. Age groups were defined for operational reasons regarding the Flemish school system. A distinction needs to be made between primary and secondary schools. The school program is consequently firstly divided into two workshops for each school structure. Additionally, secondary schools in Flanders comprise 6 grades with the age of pupils ranging from 12 to 18 years old. A total of three age groups were thus defined: (1) from the 4th to the 6th grade primary, (2) from the 1st to the 3rd grade secondary and (3) from the 4th to the 6th grade secondary. Specific themes of the flood problematic with a didactic workshops were set in function of the age limits of each target. A workshop was developed for each age group with its own learning objective, didactic game and content. Each workshop tends to fulfil as much as didactic components possible identified from the literature study. Subsequently, we have developed didactic games for each of these age-groups. Each game followed a certain path of design for which the didactic focus points served as a beacon. However, depending on the games' rules and methodologies, some didactic focus points could not be fulfilled.

[2] The Narrative Story Stem Technique is a method to assess a child's perception and knowledge through the use of toy figures representing family members. The child is invited to continue a story, hence presenting his perception and knowledge in relation to a certain situation.

2.2.2. Play with water (for 4th-6th grade primary)

- *First ideas and try outs*

At first, we tried out several environmental games that were freely available on the internet. The first idea of the play with water game was to focus on the landscape context of floods. In this respect, large parts of the population lost the insight of the importance of landscape features for floods (Mahaut, 2009). The MLWS concept does not solely imply traditional measures such as dikes, sewers and effective docks to control the flow of water on the principal waterways. The concept entails measures across the whole area of a river basin implicating the responsibility of every stakeholder influencing a landscape (Hoss *et al.*, 2011). However, the traditional approach (implying dikes, etc…) remains dominant amongst different stakeholders in Flanders. The willingness to contribute to other measures is low due to the low awareness of the problematic (Mees *et al.*, 2016; Tempels, 2016). An effective application of the MLWS relies thus on the understanding of the beneficial input that stakeholders can bring to deal with floods wherever they are located in a landscape. This challenge was the starting reflexion for the first game. The aim of the game was thus to increase the understanding of the pupils about the interaction between the landscape features and the hydrological processes causing floods. The students should be able to identify the direction of the water flow on a specific landscape and which landscape elements reduce the risk of flood and the damages caused by floods. Moreover, they should be able to determine whether a landscape is at risk or not.

In order to answer these pedagogical objectives, we developed a model that could eventually be adapted to influence the flood risks. We came up with an upslope surface where water could be poured on, a slope on which the water could flow and a downslope surface where the water could cause a "flood". Following this, calculations were made to define the dimensions of such a model depending on the water volume that could be poured down by children from 9 to 12 years old. As the limit of water volume was set at 5L, we came up with an up- and downslope surface of 40 cm wide to 20 cm long and a slope of 40 cm wide to 40 cm long. The slope gradient was set at 18° to make the model relatively realistic but strong enough to have an sufficient runoff velocity.

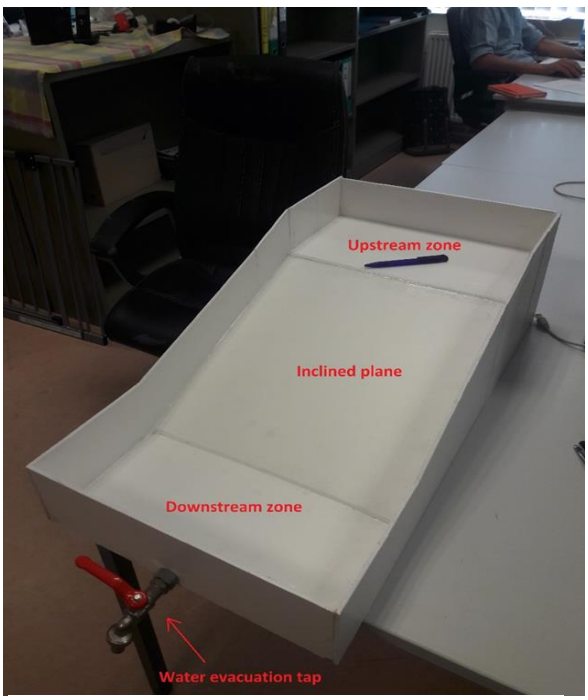

Figure 1: Picture of the landscape model's prototype (made out of PVC sheets and silicone to make the joints impermeable).

PVC-plates were used to construct the model and silicone for the joints. A prototype (figure 1) was built in the beginning of August 2018 and tested in the course of the month, followed by a brainstorming to explore the possible didactic material that could be used to shape the landscape model. The most practically relevant ideas that emerged from the brainstorm were the use of small model lego-houses to embellish the landscape, the use of clay for building structures for water flow control and sponges to imitate the effect of vegetation and pervious surface.

- *Final version*

Five models were subsequently built to be able to serve a class of up to 25 pupils in groups of five students. The limit of students per group was set to five to enhance the chances of participation of each student during the game. Each model has the same structure, as mentioned (figure 1): (1) an upstream zone: the zone where it "rains" using a watering can, (2) an inclined plane: the zone on which the water runs off and (3.) a downstream zone: the zone where the flood takes place. Moreover, several movable elements are handed over for each landscape model. These small elements represent different landscape features that have an influence on the hydrological processes. These include thin sponges with grass strips on top of it and malleable clay. The grass strips reduce the runoff rate of the water while the sponges can act as infiltration zones. The clay can be used to create dikes or channels. Two small houses constructed with Lego pieces are located on the upstream and downstream zone (figure 2). A flood gauge is drawn on the walls of the downstream zones of each model in order to measure the level of floods. The purpose of each group was to find the best combination of landscape

Figure 2: Picture on the left: a landscape model with an upstream zone, a slope and a downstream zone. On both zones are small Lego houses. Picture on the right: the sponges and the clay as movable elements.

features possible to keep the Lego houses down-stream dry. Once achieved, the level of water during flooding needs to get as low as possible by using the flood gauge. The facilitator of the game or teacher can support the students during the game and give hints of possible solutions to trigger their creativity.

2.2.3. Play with measures (1st-3rd grade secondary)

- *Finding the game*

As mentioned earlier, an effective application of the MLWS concept implies an overall understanding of the processes related to the water cycle (Hoss *et al.*, 2011). Since applying a measure on a specific location of a water basin will inextricably have an implacable influence on another location, it is important to grasp the integral impact of measures and to know their influence individually and combined with other measures. Therewith the MLWS concept widens the frame of possible measures against floods but is nevertheless dependent on the available resources and budget. The first idea of this second workshop was to focus on the diversity of measures but with a limited availability of resources. The aim was thus to enhance the pupils' understanding that a thoughtful combination of measures is needed when being dependent of limited resources. In terms of didactics, the intention was to use a computer game to firstly diversify the didactic material and secondly because of their potential efficiency as educational tools (Galván-Pérez *et al.*, 2018; Tsai *et al.*, 2015).

Two computer games came out of these first deliberations: FloodSim and Deltaviewer. FloodSim is a simulation game based on political decision-making in flood management in the United Kingdom. It was developed by the by PlayGen Ltd and commissioned by Norwich Union (Rebolledo-Mendez *et al.*, 2009). Deltaviewer is an interactive computer game developed in 2012 by the Dutch *Deltacommissie* in the frame of the Delta program. It can be used online: https://www.deltacommissaris.nl/deltaprogramma/deltaviewer. For language reasons, Deltaviewer was chosen for the school program. The whole game and its didactic material are in Dutch and is consequently more comprehensible for students from 12 to 15 years old.

- *Deltaviewer description*

In the game, students are responsible of the water management in a Dutch delta region in the years 2050 and 2100. The students must fulfil three purposes: water supply, protection against flooding and damage control. The students have to implement various measures at different locations to achieve these goals. The measures are flood control basins, locks, pumps, dikes, evacuation plans and sand adding on the coast.

Figure 3: Printscreens of the Deltaviewer game

Overall, Deltaviewer is user friendly and allows to master the game step by step. It projects the pupils in a long range of progress, includes an evaluation moment, lets the pupils explore different measures, confronts them with a problem, has a narrative dimension, is scientifically correct and is interactive. It fulfils thus several didactic components listed from the literature study. On the other hand, the measures are adapted to a Dutch delta landscape, which does not concur with the landscape of the Dender basin. Moreover no feedback is given at the end. To counter these deficiencies, the chosen measures, their applicability and efficiency in the Dender basin should be discussed in the last session.

From this discussion, we concluded that the game can be conducted in four steps:

1. Introduction: the game and the measures need to be presented to the specific context?.
2. 2050: the student has a certain budget at his disposal to apply some measures. The student needs to find the right balance in the cost of the measures versus their effect on the water management. Moreover, the measures influence each other reciprocally.
3. 2100: the situation has worsened and the student needs to take extra measures. His choices in 2050 will be evaluated in regard to the situation in 2100.
4. Translation: the outcomes will be discussed with regard to the specificities of the Dender bassin.

The objective of the game for the year 2050 is to find a good balance between flood protective measures and the availability of drinking water. Most protective measures reduce the availability of drinking water, which consequently require additional infrastructures to satisfy the drinking water supply. The next step in 2100 adds an additional objective: reduce the damage in case of flooding. During that phase of the game, climate change has increased the scale of floods and the drinking water challenge. An extra evacuation program is added to the list of measures.

2.2.4. Play with roles (4th to 6th grade secondary)

- *Original game of CIW*

The MLWS concept emphasizes the involvement of different actors from the public, civic and private sectors in Flood Risk Management and a shared multi-actor responsibility. However, according to the study conducted by Tempels (2016), a large part of the inhabitants of the Dender Basin living in flood zones consider the Government as the main responsible for reducing floods. Hence, there seems to be little awareness about the diversity of actors that can play a role in sustainable water management. Therewith, the aim of this game is to give the students insight in the diversity of actors that can have a positive influence on water management. Another focus is to present different measures, including the impact they might have in terms of prevention, protection or preparedness. Finally, one of the workshop's ambitions is to give insight to keep the reduction of flood impact and the available budget in balance.

CASE 1 – Nieuwe sociale woningen

Mogelijke maatregelen:	Prijs:	Effect:	Info:
1. Bouwen op palen	€240.000	Schade bij overstroming beperkt tot 10%.	Het biedt een oplossing om de huizen te beschermen. Burgervereniging 1 is er echter tegen. De bouwondernemer is er wel voor.
2. Grondenruil (duurt 3 jaar)	€100.000	Meteen te betalen (ten laatste in jaar 2), huizen worden ingetekend buiten T100 na 3 jaar. Huizen worden wel gebouwd in de landbouwzone 1.	Het is een volledig veilige oplossing met 0% kans op overstromingsschade. De nieuwe wijk moet daarentegen op het grond van landbouwer 1 gebouwd worden. Al krijgt hij daarvoor een compensatie is hij er tegen. Dit is de oplossing die de burgervereniging 2 het leukste vindt.
3. Dijk aanleggen	€140.000	Huizen intekenen en beschermd	Een dijk biedt hoge bescherming tot een zeker niveau. De hoogte van de nodige dijk blijft beperkt in deze case tot 1m, waardoor het landschappelijk aanvaardbaar is. Burgervereniging 1 is er tegen.
4. Gewoon bouwen	€0	Huizen intekenen	Snelle, goedkope actie. Er is wel een grote kans op juridische problemen indien er een overstroming voorkomt. Burgervereniging 1 en de VZW Broekmonde welzijn zijn er tegen.
5. Wachtbekken opwaarts	€250.000	Huizen worden gebouwd en een wachtbekken wordt aangelegd. De dijk voor het bekken biedt een parallelle fietsroute van de nieuwe wijk naar de school.	Dit is, op vlak van milieu, de beste oplossing. De schepen van ruimtelijke planning en milieu en de waterbeheerder hebben deze oplossing zelf voorgesteld en kreeg steun van de schooldirecteur. Burgervereniging 2 heeft een gemengd gevoel voor. De fietsroute vinden sommigen leuk maar de wijk zal er wel komen.
6. Paraatheid	€50.000 + €2.000/j	Schade bij overstroming wordt beperkt tot 80%. Deze maatregel kost €50.0000 tijdens het jaar van opstarten, de volgende jaren is er een onderhoudskost van €2.000/jaar.	De brandweer en de hulpdiensten hebben dit als maatregel voorgesteld.

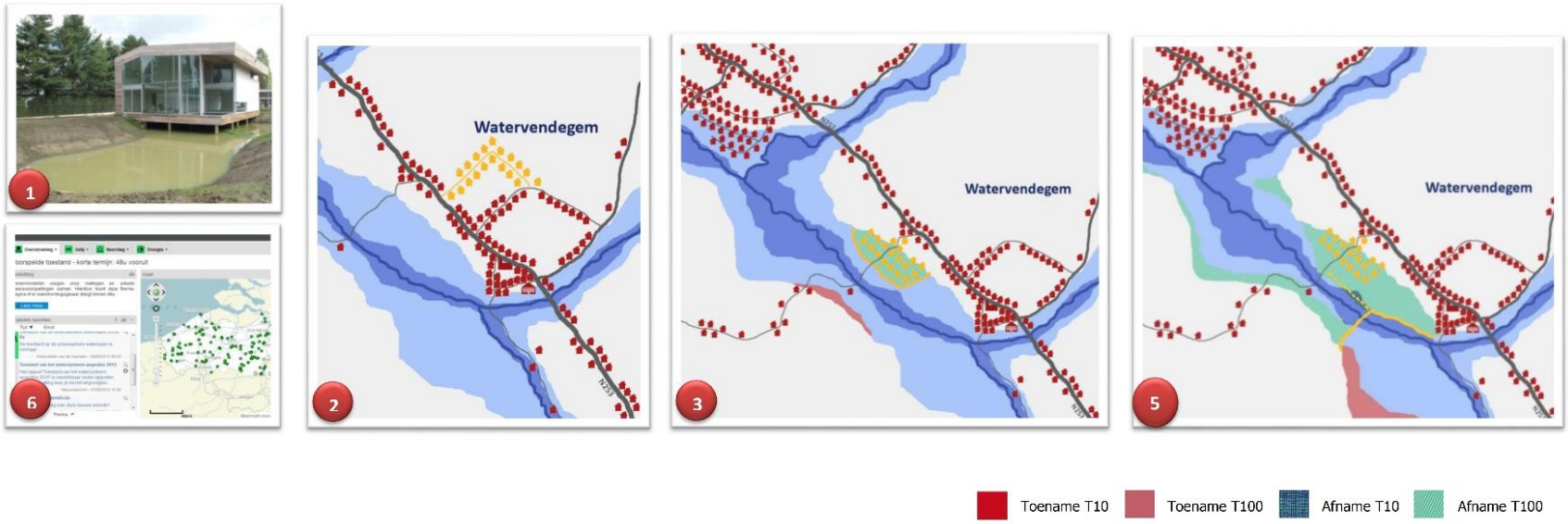

Figure 4: Example of neighbourhood a case description used in the final version of the game. The first column in the box features the different measures, the second column the price for each measure, the third column shows their resulting effect and the fourth column gives description of the different roles' opinion for each measure. The lower images give a graphic view of the each measure's influence.

The Flemish Commission for Integral Water Management (CIW) has developed a game that is focussed on the increase of knowledge of water professionals concerning the MLWS concept and the various respective measures to that effect. The game is a participatory board game with the original aim to enhance discussion between the players about which strategy is the most efficient with the available budget. The players take up the role of local authority officials who have to deal with regularly occurring floods in different neighbourhood cases. The game has ten rounds. At each round, the players receive a certain budget that they can use or safe for later to apply measures. However, each year also floods might occur. The objective is to maintain as much of the houses dry. The game uses a lot of didactic material such as maps featuring two flood zones, videos with fictitious weather broadcasts and political statements and made-up urban planning projects with lists of measures per case.

The CIW game, while in development, did not fulfil all objectives for the school program. Through an agreement with the CIW, it was used as basis and inspiration for the design of this third game. A CIW associate was present as an observer during the workshops, which served as tests for the further development towards the final version.

- *Changes made by Ghent University*

The game in this school program focused specifically on the difficulty of finding a common ground between local actors when applying flood resilient measures. Different roles were thus designed: the Mayor, the Alderman, a local NGO, three neighbourhood committees, the local emergency services, four different farmers, the water manager, a build entrepreneur and a school director. The players as a group got the primary objective of limiting the number of flooded houses at the end of the game to 30. If 30 houses got flooded, everybody would lose. Next to this, each role had its own secondary objective and interests that will define whether they win or lose at the end of the game once the limit of the 30 houses has not been reached. Roles can be taken by more than one students, depending on the number of students. Some roles are related to a specific neighbourhood case that needs to be flood resilient and others have a preference for specific measures (figure 4). The Mayor is the central figure that tends to get as much as roles satisfied. The purpose of the Mayor is to be re-elected at the end of the game.

Some cases and flood resilient measures were adapted to answer the diversity of actors and enhance discrepancies in their preferences and the available budget. Due to the limited time during class and the time required for feedback and effectively handling a group of 20 youngsters, the number of rounds was reduced from 10 to 6. The full game with rules, description of roles, description of neighbourhood cases with measures, didactic material and instructions for the game facilitator is available in the annex “Play with roles GAME material.zip”.

2.3. The final school program

We developed the final program with each game being independent from each other (Table 1). Nevertheless, there could ideally be a follow up over several years to make it a multiyear program. The workshops, apart from being independent, increase in complexity in terms of learning objectives, rules and content, congruent with the age of the pupils.

Furthermore and in order to include didactic components in the school program, each game is structured with 3 sessions:

- The first session takes 30 to 60 minutes during which key concepts were presented to the students in order to trigger their curiosity, and to prepare for the main session. It was set to bring first insights about floods, their causes and the future challenges. During that first session, the rules of the game of session 2 can be presented if needed. Ex-ante evaluations are also executed during these introductory sessions to assess the initial knowledge and compare these with the final leanings after session 3.. When possible, a colleague is present during the workshops to take notes while the lecturer is asking input from the students to explore their experience, knowledge and comprehension of the workshop topic. The objectives and rules of the games are subsequently explained.
- The second session was organised as a didactic game itself (see above) and took about 1 to 2 hour time depending on the workshop and the school conditions.
- It ends with a conclusive third session of 30 to 60 minutes during which a common synthesis was drafted of the findings and learning of the students. Feedback is given and an ex-post evaluation is consequently done during this session. Subsequently, the information gathered during the three sessions is used to evaluate the program.

Each session allowed a flexibility in duration, in order to be adapted to the school organisation, the length of the courses and the group size. The full school program presentation and instructions can be found in the annex “School program presentation NL.pdf”.

After these three operational sessions and post-interview session were organised with the teachers about the pros and cons of the workshops, the knowledge and learning moments of the students, the comparability with the existing teachers curriculum and the willingness of the teachers to address these subjects in the future (see paragraph “2.3. Interview with teacher”). The complete instructions for the program coordinator, with ex-ante evaluation questions during the introductory session and ex-post evaluation questions for the conclusive session, can be found in the annex (“School program instructions.zip”).

	Session 1: Introduction (30 min to 1h)	Session 2: The game (1h to 2h)	Session 3: Conclusion (30min to 1h)
Play with water 4-5-6 primary school	Oral evaluation of the students' perception, experience, knowledge and solutions about floods. Presentation of climate change and the processes causing floods adapted to the students' age.	Game using a landscape model. Evaluation of the students during the game.	Listing the findings and measures made on the landscape model with the students.
Play with measures 1-2-3 secondary school		Computer game from the Netherlands	Questionnaire per group of students.
Play with roles 4-5-6 secondary school		Role play with a specific budget for flood management	List of main challenges encountered during the game.

Table 1: Schematic overview of the 3 workshops and the three sessions.

3. Operationalisation-results

3.1. Selecting the schools

Selecting schools interested in the program has taken more than three months. A first meeting was held the 18th of April 2018 with representatives of the Flemish *Milieuzorg op school* (MOS) program[3]. This meeting provided a list of possible schools located in Ninove and Denderleeuw

The school group IKORN of Ninove was contacted first. Unfortunately, after several mails and reminders, the school group was not further interested in the program. Consequently, based on that experience, the search shifted to Denderleeuw. Moreover, school principals were directly contacted to avoid long transfers of information between school administrations. This approach was successful with two schools of Denderleeuw expressing much interest in the program.

The first one who agreed to join the school program was the primary school *'t Landuiterke*. The school wanted already to increase the permeability and the vegetation of the their playground. A meeting took place with the board of the school the 4th of July. They responded very enthusiastic and the

[3] The MOS-program is a regional public initiative focusing on raising awareness and helping school concerning environmental issues.

logistical aspects of the workshops were immediately scheduled. It was agreed that 2 workshops would be carried out the 16th and 18th of October 2018 in the afternoon to the two classes of the 6th grade pupils. A list of the pupils' address was handed over by the school prior to the workshop to be able to locate pupils' home in relation to known flood zones in order to check first answers by the pupils.

The *Koninklijk Atheneum van Denderleeuw* (KADenderleeuw) also wanted to join. A first meeting was held the 26th of June 2018 with the geography teachers responsible for the so-called 'ecology module'; a special module that focus all year on a specific subject, which is not explicitly addressed in the general program. The teachers expressed a great interest in the project during the first meeting and proposed to execute the program for two classes. But due to a change in the teacher program, the dates for the first class was only set half a year later on the 23rd and 30st of April 2019 and for the second class on the 9th and 16th of May 2019.

3.2. Results 't Landuiterke: Play with water

3.2.1. Class A

The first class, whose workshop took place 16th of October 2019, counted 23 pupils. According to the list of addresses, 13 pupils lived further than 100m of an effective flood zone and 10 from a distance minor than 100m. No children of class A lived in an effective flood zone. According to the director's information, class A was composed of pupils with less good marks and being less attentive and inclined to follow the school rules.

3.2.2. Class B

The second class of the 18th of October's workshop counted 20 pupils. The list of addresses indicated that 13 pupils lived further than 100m of an effective flood zone and 7 at the distance minor than 100m of whom 1 pupil lived in an effective flood zone. This class's children had, according to the director, better marks and usually needed to receive less attention from the teachers.

3.2.3. Operationalisation

Out of these 42 pupils present, nevertheless 3 pupils from class A and 2 pupils from class B had experienced flooding in their homes. As to the questions whether the pupils thought their house or school could ever be flooded, no clear distinctive answer was given except for the pupils having a flood experience who stated rightly that chances would be slim. Only one pupil from class B mentioned the link between urbanisation and floods and not one of the pupils seemed aware of the future increase in flood risks due to climate change.

The use of natural clay at the first workshop with class A seemed to be problematic. The clay tended to solute in the water reducing the amount of clay available and making the workshop very dirty.

Artificial clay was consequently used for the second workshop with class B following the suggestions from the teachers.

Concerning the measures created by the pupils, a range of measures can be noted (see figure 5). A group from class A came up with the idea of moving the downslope house to the upslope side after having dissolved all the clay in the water (figure 5 A1). Another group from class A came up with building dikes with U-structures retaining the water combined with a dike around the downslope house (figure 5 A3). The groups from class B came up with more various combinations of landscape features to handle the overflow such as increasing runoff length of the water (figure 5 B1), build retention ponds upstream (figure 5 B2), U-structures to retain water (figure 5 B3) on the slope as well as dikes around the houses (figure 5 B1, B2 and B4).

In the concluding session, the awareness of possible floods improved significantly in class B. The number of students expecting their house could be exposed went up from 2 to 10. No clear observable change was noted in class A however. Overall and in both classes, the students made the correct assumption that the school was not located in a downstream area. No clear answer was given if the school could help to diminish flood risks in the neighbourhood.

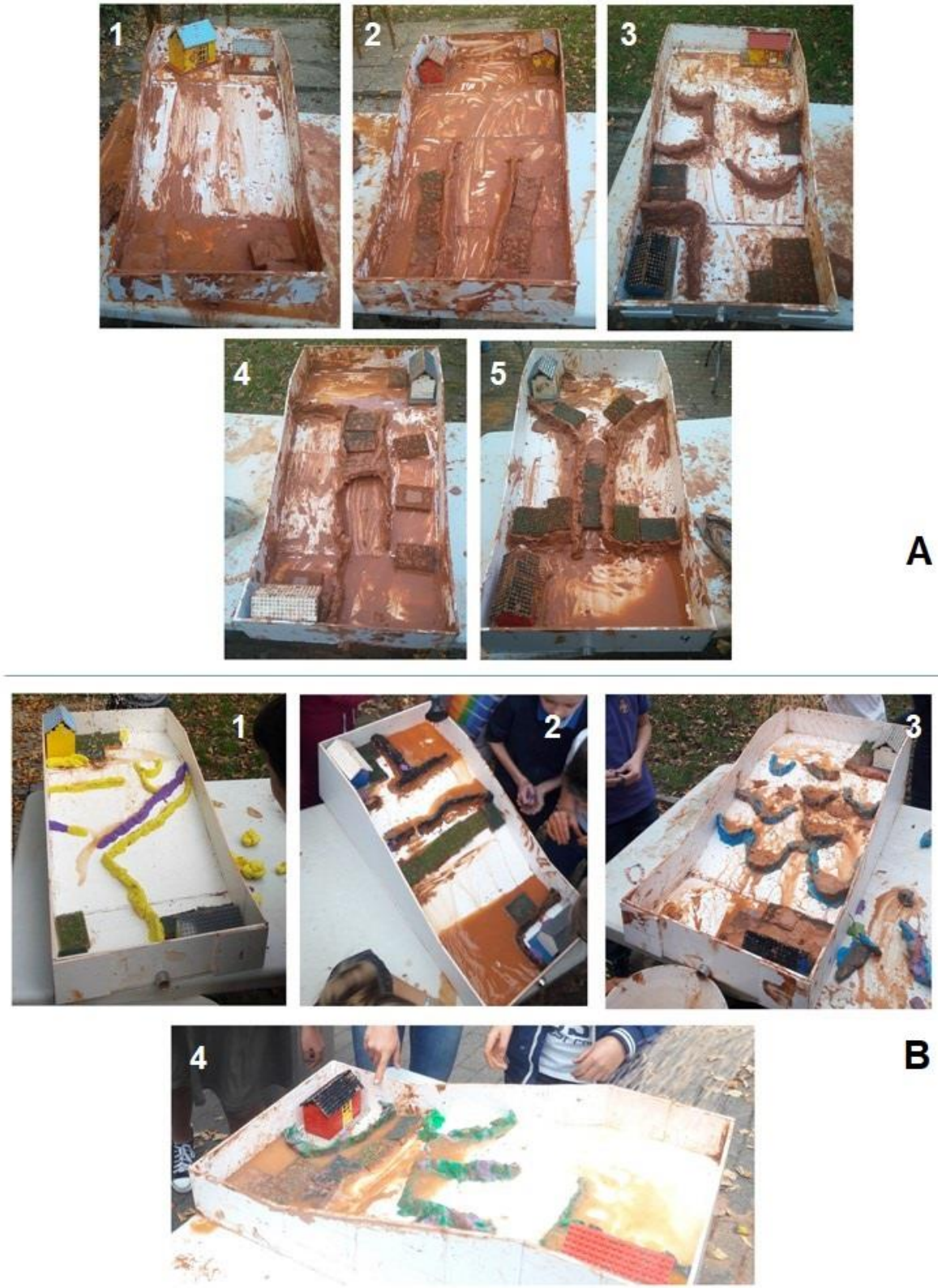

Figure 5: Pictures from the resulting landscape models from the different groups of class A (above) and class B (below).

3.2.4. Interviews with teachers[4]

The teachers of the primary school who attended the workshop “play with water” were overall enthusiast concerning the workshop itself. They argued that the explanations and presentation during introductory session were clear and useful, underlining the importance of giving a simplified introduction and relating the subject to their **real life situation**. As for the downsides, some logistic details were mentioned such as the **dirt caused by the use of cla**y and water or **the difficulty of keep the sponges** stuck on the surface. The **level of difficulty** of the workshop was also put forward and its duration was experienced as **too long**. Some suggestions were presented to improve the workshop; for instance the **use of maps** to enhance the spatial perception of the students. Furthermore, organising **small lectures** for the groups with the best landscape models at the concluding session was also cited as being effective. It should give space for the students to explain their own perspectives including discussions with other students.

However, the teachers argued that the pupils probably did not learn very much from the workshop referring to the level of acquired information or scientific knowledge. The only thing that the pupils did learn from the workshops, according to the teachers, were the principles of infiltration and the relation to their real life situation, e.g. the location of the school or their house in the hydrological landscape. The pupils’ knowledge and awareness about floods and climate change would remain close to their own experience and events broadcasted on the news.

Floods is clearly not a main subject in the teachers’ curriculum. Only major flood event in the news would make it a subject for the education program. The relation of floods with landscape features, urbanisation or climate change has also never been mentioned in their curriculum. Yet, the importance of climate change as a primary school subject is increasingly mentioned since the year 2000. Nowadays, the causes, consequences and solutions to climate change are pronounced to become mandatory course subjects. The accuracy of the courses’ content was although not evaluated, making it impossible to assess the possible errors present in the curriculums of the Flemish teaching institutions.

[4] see annex: “Interview with primary teachers NL.pdf”.

3.3. Results KADenderleeuw: Play with roles

3.3.1. Class A

Students of the first class of KADenderleeuw of the 23rd and 30st of April's workshops were of the fourth grade following the general education program, with specialised courses of Latin and economics. The class counted 10 girls and 10 boys of whom 15 were 16 years old, 4 were 17 years old and 1 student was 18 years old. The teacher explained prior to the workshop that the class was a relatively calm one "*based on nowadays' norms*" with some students being attentive, others having troubles with attention and one particular student being noisy.

3.3.2. Class B

The second class of the 9th and 16th of May's workshops came from the study orientation 4 *handel* ("trade" in English). It is part of the technical education program, with specialised courses in commerce next to the general courses of that program. The class counted 9 girls and 4 boys of whom 6 were 16 years old, 5 were 17 years old and 3 18 years old. This corresponds with the general statistics of the different education programs in Flanders (Duquet *et al.*, 2005). The teacher explained before the workshops that the class was not noisy, but that the students were very passive, not putting much attention to the courses.

3.3.3. Observations and results from the questionnaires

- *Introductory session*

For both classes, the game was constituted of two sessions of 100 minutes corresponding to 2 full courses each: an introductory and a main session. During the first session, some basic exploratory questions were given to link climate change to specific themes such as population, water, energy, nature and mobility. This didactic activity gave some main information about the existing knowledge of the students concerning climate change. In addition, the students were presented with the flood problematic and asked about their experience.

In general, both classes tend to know the problematic of climate change through the relation of CO_2-emmission and the mobility and energy consumption portfolio's. Nonetheless, the students did need some pedagogical support through guided questions to place the subject in the frame of causes, consequences and countermeasures. Both classes could, in the end and with some minor difficulties, place CO_2-emmissions as a cause and put forward some countermeasures such as shifting to sustainable energy production or reducing CO_2-emmissions by using public transport or by travelling less. When relating climate change to water, both classes also mentioned droughts and floods as consequences. On the other hand, students put forward general concepts such as "being ecologically responsible", high population density or plastic pollution in relation to climate change, without being

able to explain correctly their relation to it. On this matters, a lot of debate came up in depicting these as a cause, a consequence or a countermeasure. In both classes, plastic pollution in the oceans was wrongly put forward as a cause for climate change.

Their experience with floods was very limited with only one student having experienced floods at home. All the other students remembered the 2010 floods because some streets were blocked off in the neighbourhood causing major mobility problems. They did not have deliberated yet if it could happen again. Some even stated that it was an exception and that it happened a long time ago.

- *The game*

The first game with class A resulted in some observations and lessons learnt that were subsequently integrated in the second game. The most important lesson learnt was that dikes in the game were too cheap and affected only a few roles. This incited the students to choose for this measure in many cases of the game reducing the difficulty of the consideration, the intensity of the debate between roles and the diversity of measures. The price of the dikes was adapted afterwards and more diverse measures were consequently used in the second workshop.

A major observation is the importance of the continuous active participation of the supervisor or moderator. Many students were very passive rarely interacting with others. Other students seemed to have difficulties in building up a constructive argumentation or were either too shy to speak in front of the class. Some students were very active in the game but interrupted other students regularly. Hence, the supervisor needs to keep the lead to manage the debate, to ensure the participation of a role in case of a too passive stance or to reduce the input of another too active role. It was also noticed that there is a need for 10 to 15 minutes time of preparation for the students to get acquainted with the game (roles, cases and rules). Therewith the first three turns of the game were passive and without a lot of reactions or debate. On the other hand the small films between each turn were very effective to gain a more lively game. It gave the opportunity to reset the attention of the students and start the new turns in a calm atmosphere.

The mayors in both workshops managed to achieve the groups' objective to have less than 30 houses flooded at the end of the game. Furthermore, mayors in both groups found a way of reaching consensus and answer positively to a majority of the demands from the other roles. However and interestingly, both mayors were not re-elected at the end of the game, with 14 against 6 not in favour in the first class and with 9 against 5 not in favour in the second class.

- *Aftermath*

In the last 15 minutes of both workshops, students received a questionnaire with multiple questions described in the annex "Play with roles Questionnaire students NL.pdf". The first general questions

focused on their living location, gender, age and family status. It was followed by questions about their perception of the importance of the different roles' in real life and what they thought about the most difficult and easiest aspects in the game. It finishes with questions about which measures they can take themselves and to whether they think the game is realistic or not and why.

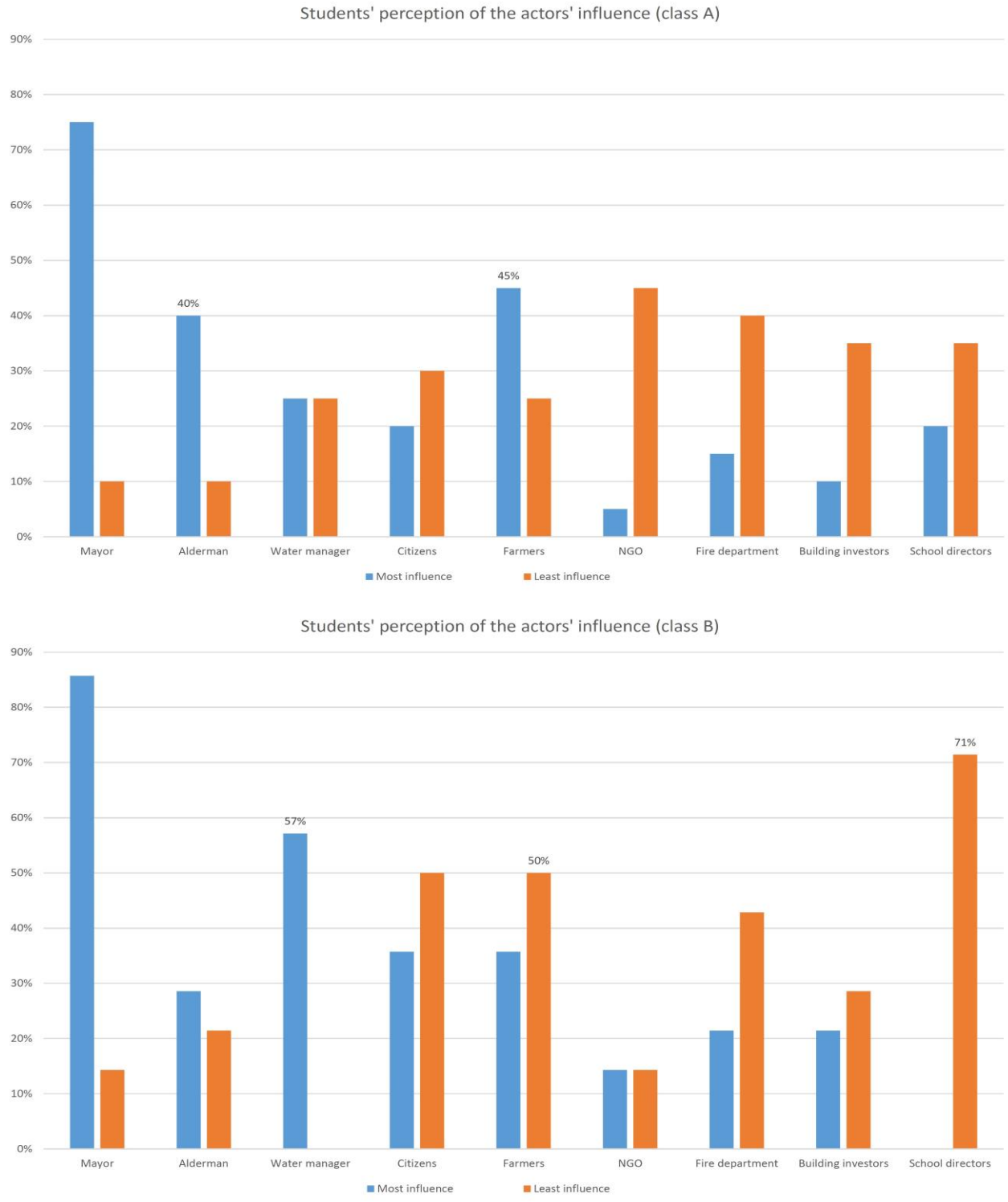

Figure 6: Percentages of response per class to the questions "Which 3 roles do you think have the most and the least influence in reality to deal with floods?"

5 students out of the 20 from class A and 7 students out of 14 from class B did not give enough information to locate them in function of flood zones. Of the others, 1 student in class B lived less than 100 meters from a flood zone. Next to this, 13 students from class A and 5 students from class B lived between 100 and 500m of a flood zone. In terms of family status, the same proportion came up with around 15% in both classes living in single parent families. More interestingly, similarities and differences can be observed between the two classes when asked about their perception of the actor's importance in resolving the flood problematic in reality and their ease or challenges during the game (see figures 6 and 7 respectively).

In both classes, the mayor scores very high, which is not surprising because of the central position that is held by the mayor in the game. Roles as NGO, the fire department, building investor and school director did not score high in influence and scored in at least one class high as having the least influence. The perception of the alderman and the water manager was somewhat varying in the two classes. The alderman was considered to have quite some influence in class A (40%), while its influence in class B was disputed. On the other hand, the water manager scored high in having the most influence in class B (57%), while there is no clear opinion in class A. The role of citizens and farmers is subject to discussion in both classes. There is no significant opinion whether citizens seem to have the most or least influence with debating scores in both classes. A slight higher percentage for being the least influential is however noticeable. There is no shared perception of the farmers influence is in both classes. Farmers score higher in class A as being the most influential (45%) and in class B as being the least influential (50%). The opposite perception concerning farmers is notwithstanding notable in both classes.

Different factors can influence the students' perception of the actors' influence. Firstly, students started the game with their own ex-ante perception, which inextricably has influenced the final results. Secondly, the students' behaviour and motivation during the game can also exert different outcomes and consequently, the overall perception of influence that their role can have in decision-making processes in real life. Thirdly, the game rules and structure themselves will contribute to the students' perception. For instance, the perception of the mayor's influence is most probably due to his say on the final decision and rules of the game. Moreover, student endorsing the role of the water manager was very active in class B, which could explain its high score in being the most influential compared to the score in class A. Contrarily, the student playing the school director of class B had a very passive attitude, which should also and most probably have an influence on the results. The perception of the citizens' and farmers' influence is on the other hand subject to debate in both classes and it is yet difficult to hypothetically relate it to one specific assumption listed above.

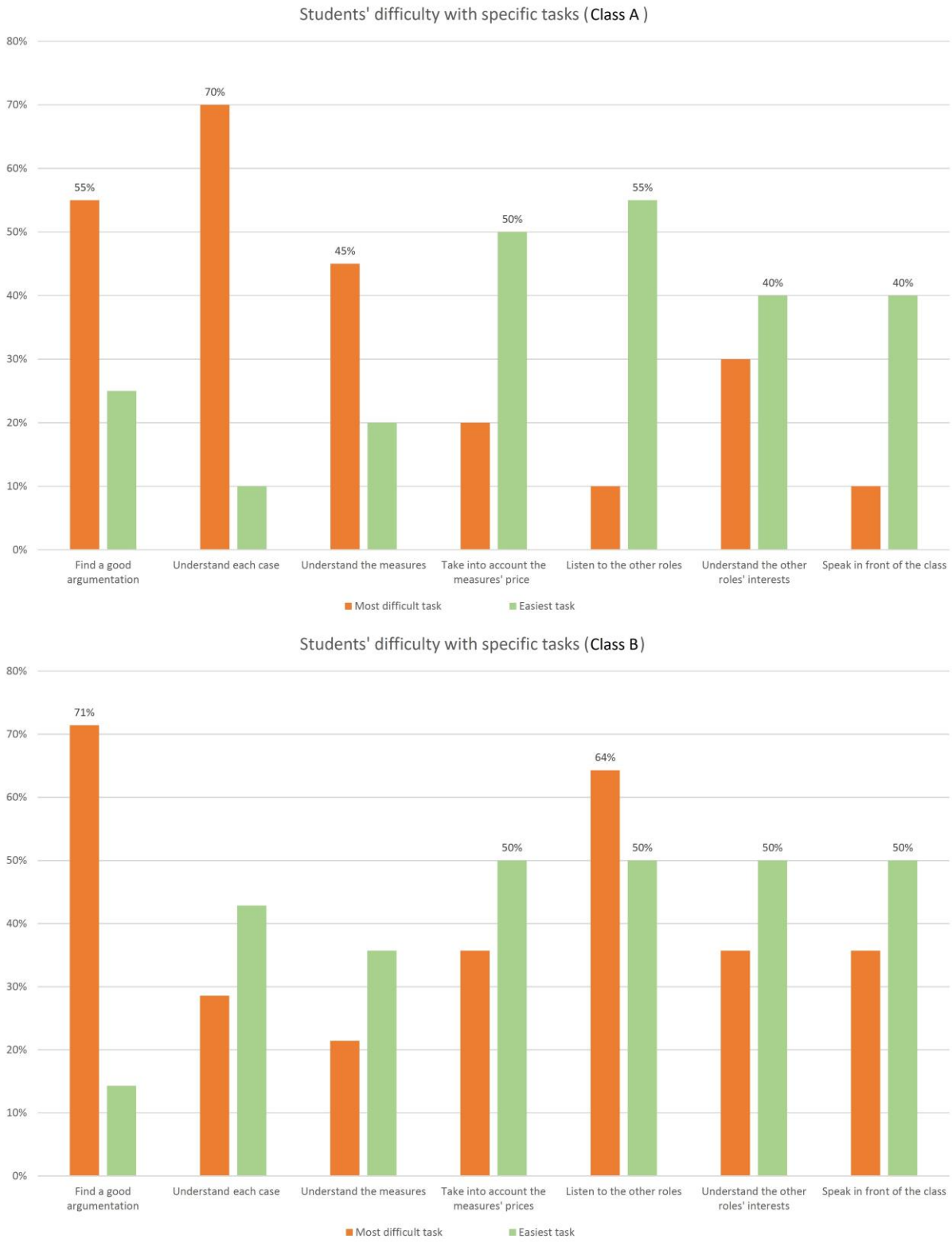

Figure 7: Percentages of response per class to the questions "Which 3 aspects were the most difficult and the easiest in the game?".

Concerning the easiest and most challenging tasks of the game, a majority of students in both classes (55% in class A and 71% in class B) argued that "finding a good argumentation" was one of the most difficult task in the game. In both classes, around half of the students selected "take into account the measures' price", "listen to the other roles", "understand the other roles' interest" and speak in front of the class" as being the easiest tasks. In terms of differences between the two classes, "understand each cases" and "understand the measures" were also considered difficult in class A, while more students in class B selected these tasks as being the easiest rather than the most difficult. In contrary to class A, many students (65%) of class B had difficulties in listening to other roles, which was also pointed out by the teacher during the interview afterwards.

As mentioned above, the questionnaire ends with open questions concerning the students' opinion about what the authorities could do, what they could do themselves and whether they think the game was realistic. A clear difference can be noticed between the two classes. In class A, the most mentioned measures that the authorities could do is building dikes (75%). This is likely due to the fact that dikes were too cheap in the first workshop, reducing the diversity of measures chosen by the students. The other measures presented by the students of class A were that the authorities could install a retention basins (25%), develop emergency services (25%), enhance house-level measures (20%), not build in flood zones (20%) or just "invest" (20%). House-level measures (43%), dikes (29%) and retention basins (21%) are the most mentioned in class B. To the question about what they could do themselves, a clear difference is also noticeable between the two classes. 35% of the students in class A cited sandbags[5], building dikes or install retention basins (30%); whilst the students of class B could not put forward a lot of measures they could take themselves[6].

Finally, a majority of the students, 70% in class A and 71% in class B, considered the game to be not realistic. Interestingly, 50% of these students in class A and 29% in class B stated that it was because the chances of floods are too low in their municipality or neighbourhood. Other students were more questioning the existence of debates amongst public authorities with private and civic stakeholders about such issues. One student argued that decision-makers probably spend more time and resources to solve floods in reality. Finally, one student stated that floods were a problem that the municipality would solve rather in collaboration with other municipalities or higher entities.

[5] which is surprising because it was pointed only once during the introductory session
[6] with 36% stating they would not know what to do or leave the question blank

3.3.4. Interviews with teachers

The interview with the secondary teachers took place the 29th of May, 13 days after the last workshop. Their answers and the discussion points were noted and sent afterwards for approval (see annex: "Interview with secondary teachers NL.pdf").

When talking about the up- and downsides of the workshops, the teachers mentioned the real importance of the introductory session for preparing the students to the subject. They were very satisfied by its content with visual material and videos. The students were introduced with the right vocabulary and it was complementary to the game. On the downside, the introductory session was too long according to the teachers. The students' attention came down after a while. There was a lot of absence in the second class. This was due to the specific position of the special ecology module in the school courses organisation. Students do not get marks in the course reducing their interest and attendance. However, the teachers were very positive about the added value of such workshops.

A major difficulty came up during the second workshop. Some students did not listen to the argumentations of others and did not adapt their speech to the others' role. One teacher put forward the importance of developing and implementing pedagogic methods in classes to enhance the students' skills in that matter. In addition, the flood, drought and climate change problems have still a strong "away from my turf" feeling. Referring to the young age of the students, this lead to a lack of interest and motivation from the students. Consequently, the teachers advised to organise such workshop to older students from the last grade of secondary school.

Concerning the experience of the students to climate change and floods, the teachers pointed out that climate change is a very contemporary subject due to the recent youth climate movements (Gurría, 2019). Floods, on the contrary, is not a very known subject by the students. Their only experience with floods were those of 2010. The subject of climate change is part of the teachers' curriculum. It is addressed especially during extra-muros activities and a special "Day of the student". On these days the students have to address a specific subject themselves by organising activities and give presentations.

A major problem, according to teachers, is the lack of interest of the general population which influences also the students awareness, notwithstanding its importance. The teachers pointed to the results of a recent pole, wherein purchase power was elected as the most prominent concern of the future, pension second, migration third and climate change only as fourth and last. Similarly, the students do not feel concerned whilst they are not really confronted with the problem.

Finally the teachers suggested a couple of opportunities to include these subjects in their program to a larger scale. In the current situation, these subjects can only be addressed more profoundly through

additional project programs that are organised by schools individually. These programs are not part of the teachers' curricula set by the Flemish education systems and it is thus only up to the schools to address these issues. The future education reform of 2020 will restructure the main course structures and Flemish primary and secondary education program. According to the first broadcasted and initial objectives of the reform, more emphasis will be put on combined and transdisciplinary teaching through project programs, extra-murros activities as well as co-teaching.

4. Conclusion

The conclusion is divided in two parts. The first part focuses on the strengths and weaknesses of the program and how it could be improved. The second part reflects on the general awareness of students and teachers concerning climate change and floods.

4.1. Lessons learnt for the school program

The first step of the school program is to contact and find schools willing to carry out the workshops. The author(s) first contacted an umbrella organisation that did not respond immediately to the question. It was only after two months of subsequent mails and phone calls that it became clear that the first applied school group was not interested. Afterwards one could conclude that it could be less time demanding and more effective to contact the school administrations immediately. Only two of the three workshops could be carried out: play with water in a primary school "*'t Landuiterke*" and play with roles in a secondary school "KADenderleeuw". Each workshop was carried out in two classes allowing a test session, followed by some adaptations for the game in the second class. All the teachers indicated the high difficulty level of the workshops. One could thus argue to shift the age group of each game with two years measure to change the age focus of "Play with water" for students from 12 to 14 years old, "Play with measures" for students from 14 to 16 years old and "Play with roles" for students from 16 to 18 years old. This shift would offer the advantage to present the whole school program in a single secondary school.

The play with water workshop was well received by the teachers, stating that the game was interesting and didactic. They gave some suggestions to improve the workshop; for instance the use of maps, which would allow the students to have a projection of the model to a concrete known and existing landscape. Another suggestion was to give the pupils the opportunity to explain the landscape they shaped to the rest of the class in the form of a small lecture. This could train their aptitude to speak in public. On the other hand, the teachers pointed out that the children would probably have learned more in a traditional class, instead of this gaming setting. However, studies (Imbrecht *et al.*, 2008; Struyven & Janssens, 2007) have indicated that the classical setting is predominantly useful in teaching

knowledge and –to a lesser degree- insight. Hence and contrarily to active learning methods, the traditional setting does not enhance other behavioural skills (e.g. collaborate with others to build structures to control water flow), cognitive competences (e.g. test ideas and learn from it) or social attitudes (e.g. developing open mindedness to others' proposals) (Struyven & Janssens, 2007).

A difference was noticed between the two classes regarding the diversity of modelled measures. Class A came up with two measures (dikes and U-shaped structures) with an additional third measure of last resort when all of their resources were depleted (their clay completely solved in water): moving the house upslope. Class B came up with four different measures: dikes, U-shaped structures, upslope retention ponds and increase runoff length. Some explanations in the introductory session were adapted based on observations from the first session with class A. This could have influenced the results. Nevertheless in reference to the self-adaptability of the pupils, the workshop can be seen overall as a success, although the impact of the workshop on the children's awareness could not be measured clearly. Only in class B a definite raise of awareness could be noticed before and after the game. Nonetheless a positive point in both classes were the students' ability to envision the landscape models with regard to a real life landscape circumstances.

The secondary teachers were relatively more positive concerning the workshops of play with roles. While the primary school's teachers were enthusiast about the workshop at the beginning of the interview, they subsequently argued that the pupils would probably have learned more with a traditional course setting and questioned the importance of tackling such issues at school. The secondary teachers, however seemed to endorse the use of such game for pedagogic purposes. They considered it as important to address the subjects of climate change and floods at school. Nevertheless, they had some critique or advice about the game settings. For instance, the introductory session was too long. Yet, it was necessary to introduce the game. Another important remark of the teachers was that the game was too difficult for the age group, since most of the students struggled with listening to other students' argumentation, and interpreting their ideas. Installing a specific procedure to share the speech time could be helpful. Another possibility would be to apply the workshop for an older age group who is generally more disciplined and feels more concerned by the climate change problematic. This could in addition solve the issue concerning the high level of the workshop.

The students' perception of the actors' influence gave interesting results. Some high scores for the level of the actors' influence on floods can be attributed to either the game settings or the attitudes of players. For instance, the mayor received a high score in being the most influential because of its importance set by the rules of the game. In class B, the high score of the water manager and that of the school director in being the least influential was biased by the very active and passive attitudes of

their respective players. Interestingly, the glance on the citizens' and farmers' importance is somewhat subject to debate in both classes. The diversity in the students' perception of the actors' influence, except for the mayor's, indicates that it is not solely set by the rule of the games but also that the ex-ante impressions of the students and their individual attitudes could gain influence on solving the matter. This indicates that the students are aware at the end of the game that different actors can play a role on flood risk management. However, when asked whether it reflected reality, the majority of students responded that the game was not realistic. More than half of these students (58%) stated that it was not such an important issue in their living areas. This means that out of the total number of students who attended the workshop, about 40% have the opinion that floods are not an important issue. It shows that the impact of the workshops was limited.

4.2. General awareness and the Flemish education system

Overall, the ex-ante analysis showed a general low awareness from children of the primary school, the students from KADenderleeuw and the teachers as well. In the primary school, only children with flood experience gave right answers but only one made the connection between the occurrence of floods and the specifics of urbanisation. This concords with the findings made by Tempels (2016) who pointed out that the most significant factor for flood awareness and countermeasures is personal experience. The majority of the groups in the play with water workshop intuitively started with building dikes around the houses, which shows that little is known of any other structural flood management measures. This was later confirmed by the primary teachers who stated that the relation between floods and climate change was not part of their curriculum. Nevertheless, they did not deem it important to change the curriculum, as climate change and floods are not major problems; indicating also a low awareness from the teachers side.

A higher awareness and knowledge about floods were noticeable from the students of the secondary school and the teachers as well. However, incorrect ideas were presented during the introductory session. For instance, both classes made a direct link between plastic pollution and climate change without correct explanation. Both classes could not give clear explanations concerning the relation of CO_2 production and climate change. Moreover no clear explanations could be given with regard to the future occurrence of floods due to climate change and the possibilities to adapt to it. It indicates that this issue is still quite misunderstood and false conceptions are still very much present, even in an official educational setting. Most importantly, the students still regarded the game as not being realistic because most of these students regarded the future chances of floods low. The teachers pointed out during the subsequent interview that climate change receives a lot of attention because of the current events, but that the mentioned consequences such as droughts or floods are mostly presented through examples that occur in other continents, ultimately feeding the existent 'far from

my turf feeling'. Contrary to the primary teachers, the secondary teachers deemed it important to have the issues of climate change and floods addressed more profoundly and with correct information.

This low awareness of the majority of the students and their teachers as well needs attention. In addition noticed misunderstood information concerning climate change and floods, can be considered highly problematic in the face of the upcoming climate change forecasts (IPCC, 2019). As the Flemish education system aims in general to prepare the younger generations to deal with future complex situations (Vlaams Onderwijs, 2019), the transmission of correct information as well as increasing the awareness to these future challenges needs to be further stressed. Therewith the upcoming Flemish education system reform, starting in the school year 2019-2020, could be regarded an opportunity to enhance the transdisciplinary educative approach through project programs and co-teaching. Such opportunity should be a window for further and more regular collaboration between the Flemish education systems and the academic sector. Such a more regular collaboration could enhance and update education in primary and secondary in schools with the most recent academic findings. However, this opportunity still remains dependent solely on the school's individual initiative. From a long-term perspective, it seems substantial to ensure that teachers receive correct information concerning these issues and consequently implement these topics in the teacher's curricula.

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