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Evaluating a flood-risk education program in the Netherlands

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ABSTRACT

Despite the importance that is attached to flood-risk awareness and preparedness in the Netherlands, Dutch students show low flood-risk perceptions and preparedness intentions. This study focused on evaluating the effectiveness of a flood-risk education program that aimed for the enhancement of 15-year-old students' flood risk perception as well as their preparedness intentions. The experiment consisted of a pretest/posttest-design with an intervention group and a control group in a particular area in a flood-prone area in the Netherlands. 271 students participated in this study. As expected, the results showed that the intervention caused increases in risk perception while perceptions of fear and trust remained the same. However, preparedness intentions did not change. Strategies to improve flood-risk education are discussed.

1. Introduction

In 2014 the OECD concluded in a study about water governance in the Netherlands that Dutch citizens show an 'awareness gap' with respect to water management and water safety. This awareness gap is also applicable to Dutch students (Bosschaart, Kuiper, van der Schee, & Schoonenboom, 2013; Bosschaart, Kuiper, & van der Schee, 2015). Despite the low elevations and the eventful flood history, it is hard for Dutch students to give serious thought to flooding in their own surroundings. Students' flood-risk perceptions are low, their trust in water safety is high and the topic is not salient at all (Bosschaart et al., 2013). In the last decades, geography education in the Netherlands has always paid attention to flooding in the Netherlands. But the contents of the text books are restricted to the causes of high water and the enormous efforts that have been made to prevent the country from flooding. In this way geography education has contributed to the "myth of dry feet" (Heems & Kothuis, 2012), a conception which is deeply embedded in Dutch society.

This study covers the role that formal lower-secondary education, i.e. geography education, could play in achieving or facilitating the goals of flood-risk communication in the Netherlands. Therefore this study aims at evaluating the effectiveness of a flood-risk education program that contributes to raising students' flood-risk awareness as well as changing their preparedness intentions. The main task of this program will be to deconstruct "the myth of dry feet" (Heems & Kothuis, 2012). Lindell and Perry (2004) put this into more tangible words:

> "The purpose of hazard communications is to prompt people to redefine the situation from one in which the environment is primarily positive to one in which the environment is threatening. The process of redefining the situation leads to the identification of possible actions that could be taken and concludes with decisions about appropriate responses to the threat."

In their review study concerning flood-risk perception and flood-risk communication Kellens, Terpstra, and de Maeyer (2012, p. 46) stated that "... research on flood-risk perception and communication is still in its infancy". With respect to risk perception research, they suggested that future studies should be better supported theoretically. Furthermore, they concluded that until now most studies concerning flood-risk perception are cross-sectional in nature. Experimental studies concerning flood-

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risk communication are largely lacking. This study tries to heed both aspects.

2. The myth of dry feet

Heems and Kothuis (2012) studied the water safety policy since 1953. In this year the last disastrous flood hit the southwestern part of the Netherlands and caused more than 1800 casualties. They made clear that the discourse about water safety has evolved. While in the first two decades after 1953 everybody was convinced of the need to fight against the water, during the 70's and 80's many people got the impression that the battle against the water had been decisively fought. Since 1995 the authorities gradually have become convinced that the threat of flooding is still existent. According to Heems and Kothuis this switch in thinking only concerned the authorities. The people themselves are hardly aware of a flood threat and they still tacitly expect a water safety guarantee from the (water-) authorities. Correljé, Broekhans, and Roos (2010) have stated that Dutch people no longer perceive flooding triggered by dike breaches as caused by a natural phenomenon. In case of a flood, people have the impression the authorities are to blame for it. Terpstra (2009) showed that Dutch citizens are hardly worried about the risk of flooding, compared to other risks. Heems and Kothuis concluded that despite the communication efforts, there still exists a chasm between the general public and the authorities in the way they experience flood risk. They call this "the myth of dry feet" which means that people have the conviction that dry feet can be guaranteed by the government.

3. Theoretical background

3.1. Hazard perception, preparedness and risk communication

In their integrative model of risk perception Renn and Rohrmann (2000) state that people's judgment of risks is based on their individual mental models and psychological mechanisms. These individual judgments are strongly influenced by a wide variety of communication processes that lead to social and cultural learning (Breakwell, 2001; Joffe, 2003). In the shaping of risk perception, the awareness of the possibility to get exposed to a threat plays an important role. Lindell and Perry (2004) call this 'threat belief'. The extent to which threat belief is personalized, influences risk perception (Mileti & Peek, 2000).

Various studies have shown the effect of previous experience with flood hazards on risk perception (Grothmann & Reusswig, 2006; Siegrist & Gutscher, 2006; Terpstra, Lindell, & Gutteling, 2009). When people do not have experience with a hazard and the hazards' probability is low, cues from the environment are mostly reassuring. Then, risk communication or risk education is the only way to influence people's risk perceptions by focusing on vicarious experiences through experimental manipulation.

The Protective Action Decision Model (PADM; Lindell & Perry, 2004) describes the way people decide about protective actions as a stepwise process which starts with the reception of, attention to and comprehension of information. These processes determine subsequently people's threat appraisal, their assessment of the personal relevance and the assessment of potential coping behavior. Taking into account all these subsequent steps is a pre-requisite for successful risk communication (Lindell & Perry, 2004). According to the Protection Motivation Theory (PMT; Rogers, 1983) the arousal of fear could stimulate cognitive evaluation of the threat and the response. But fear appeal could also have inhibiting effects on protection motivation (Ruiter, Abraham, & Kok, 2001). When the level of fear or distress is too high the cognitive response could lead to ignoring or denial of the threat. This response is called 'emotion-focused coping'. The strategy to reduce the physical threat or vulnerability, 'problem-focused coping', is the adaptive response. Ronan and Johnston (2005) concluded that with respect to (natural) hazards the question whether emotional arousal is related to preparedness is not answered adequately. But they also concluded that some degree of hazard concern is a prerequisite for preparedness intentions. People's preparedness intentions are not only influenced by their threat belief or risk perception (Bubeck, Botzen, & Aerts, 2012). Intentions are also influenced by people's coping appraisal which can be described as the way people perceive the efficacy and costs of flood-preparedness measures as well as their self-efficacy.

3.2. Risk perception among adolescents and hazard risk education

Research with respect to risk perception and natural hazards has focused to a large extent on adults. Few studies have been undertaken among children and students. Moreover, these studies focus particularly on students' knowledge of hazard responses (Ronan, Crellin, & Johnston, 2010; Ronan and Johnston, 2001; Ronan, Johnston, Daly, & Fairley, 2001). This may be an adequate approach in the situation of New Zealand. Here a variety of natural hazards like earthquakes, volcanoes and flooding are possible and students have 'reasonably accurate risk perceptions' (Ronan et al., 2001, p. 2). But in the Dutch situation, where students, just like adults (Terpstra, 2011), are supposed to have weak risk perceptions and where there is no explicit hazard education program, we intend to focus on both risk perceptions and preparedness intentions.

The importance of the role that school education can play in raising students' awareness of hazard-related risks and in indirectly increasing the awareness of students' families has been emphasized by several authors (Ronan & Johnston, 2001, 2003, 2005; Shaw & Kobayashi, 2001; Slovic, Fischhoff, & Lichtenstein, 1981). There are various reasons why school education should be involved in this process. Firstly, because formal education can pay attention to a topic like flood risk more thoroughly. Renn (2008, p. 258) states about this: "... being involved in educational programs has the advantage that basic knowledge in applied sciences and basic understanding of probabilistic reasoning can be made the main target of the communication effort." In addition, Stoltman, Lidstone, and DeChano (2004, p. 6) describe students as "one of the best diffusion agents for information about natural hazards, their occurrence, planned responses, and the means to mitigate effects."

3.3. Flood-risk education

Basing ourselves on risk communication research, we assume that students' thinking about flood risk should be modeled as a stepwise process that consists of developing knowledge and understanding, awareness and perception, and preparedness intentions. In order to overcome various obstacles in this stepwise process, learning theory and understandings about information processing prove to be complementary.

In his model of 'the three dimensions of learning', Illeris (2007) distinguished the cognitive, emotional and social dimensions of learning that contribute to either assimilative or accommodative learning. In this way he combined various existing learning theories. In social and cognitive psychology various dual process models of information processing are used that make a distinction between experiential and analytical information processing (Smith and DeCoster, 2000). Smith and DeCoster (2000) made clear that in order to accomplish an attitude change through communication, both modes of information processing are necessary. With respect

to risk perception, Finucane, Peters, and Slovic (2003) described this as the "dance of affect and reason". Therefore we assume that in the design of flood-risk education learning processes should be modeled in such a way that accommodative learning could take place. This can be achieved by modeling a variety of learning activities in such a way that experiential and analytical information processing could take place.

Until now, risk communication as well as geography education with respect to flood risk has been focused on the Netherlands in general. There are however various reasons to tune a flood-risk education program to the regional situation. First of all, the flood-prone areas in the Netherlands differ enormously with respect to elevation, flood mechanism, flood protection and vulnerability and hence in necessary protective action. Besides, previous studies have shown that students in the Netherlands are well aware of flood risk in the Netherlands in general. But the optimistic bias is applicable to flood risk perception concerning their own surroundings (Bosschaart et al., 2013).

4. Flood-risk education program

4.1. Flood-risk education program

The flood-risk education program that will be evaluated in this study, should contribute to improving 15-year-old students' personal flood-risk perceptions and flood-preparedness intentions. The flood-risk education program was based on an educational design research approach. The theoretical underpinning as well as the design research approach was reported in a separate study. Besides, the design process also yielded the design principles *affect*, *availability* and *blended learning*. These design principles, assumptions that represent the essential functions and characteristics of the program, evolved during the development of the program (Bosschaart, van der Schee, & Kuiper, 2016).

Because of the location of the participating schools, the flood-risk education program of this study applies to West-Friesland, a region in the province of North-Holland (Fig. 1). The program was designed with the characteristics of this region in mind and making use of information of the regional water board.

The flood-risk education program consists of seven lessons (Fig. 2). The program is characterized by a variety of learning activities which are both teacher- and student-directed. Students are confronted with intrusive flood-risk information about the local situation that should arouse moderate levels of fear. In this way, students are prompted to process flood-risk information analytically, without causing panic and emotion-focused coping.

Fig. 1. The area of the participating schools in the province of North-Holland, the Netherlands.

By incorporating 3D-serious games, 2D-flood simulations, fieldwork and discourse, students

should experience different aspects of flood risk in the surroundings. This approach enables students to tag elements in the surroundings with flood risk information and affect-laden imagery. By emphasizing both the threat of flooding and coping measures, students could get a balanced picture of flood risk. The threat of flooding has been elaborated as a chain of successive events that take place prior to and during a flood (Fig. 2: lesson 1,2,3):

high water levels > dike breaches > flooding water > effects for inhabitants

The second part of the program (Fig. 2: lessons 4,5,6,7) deals with water management and prevention measures by the water

Flood-risk education program with respect to West-Friesland				**Student directed parts**	**Teacher / student direction**
Contents per lesson	1	Dikes and dike breaches in the province of North-Holland and West-Friesland	Causes (high water+ dike failure mechanisms)	3D-game	Teacher+ student
	2	The effects of flooding in the province in West-Friesland	Effects (inundation area and depth + casualties + costs)	2D-simulation	Student
	3			Societal discourse	Teacher+ student
	4	Water management in the province of North-Holland	Authorities (prevention, mitigation, disaster preparedness)	Fieldwork-assignment	Teacher+ Student
	5 6 7	Flood preparedness and mitigation measures in the surroundings	Self (prevention, mitigation, disaster preparedness)	Group project	Student
Duration	7 lessons of 50 minutes				

Fig. 2. Overview of the flood-risk education program.

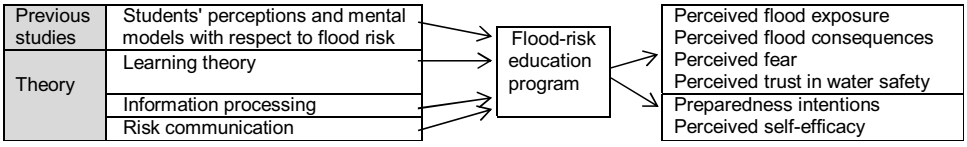

Fig. 3. Theoretical basis of the flood-risk education program.

board and the individual coping strategies. The latter focus on preparedness measures prior to and during a flood.

4.2. Aims and hypotheses

In this study we evaluate the effectiveness of the flood-risk education program. In order to deconstruct 'the myth of dry feet', students should be brought in the position to redefine the environment from one in which it is primarily positive into one in which the environment is threatening. This should lead to a change in risk perception and preparedness intentions.

The main research question is: *To what extent does the flood-risk education program affect students' perceptions of flood risk exposure, flood risk consequences, trust in water safety and fear, as well as students' preparedness intentions and self-efficacy?*

Fig. 3 shows both the underpinning of the flood-risk education program and the variables that could be influenced by the program. These variables go back to a previous study about students' 15-year-old flood-risk perceptions in the Netherlands (Bosschaart et al., 2013). Because the flood-risk education program deliberately focuses on the chain of events with respect to flooding, by making use of intrusive information, we expect that:

1 The flood-risk education program has a positive effect on the perception of flood exposure and flood consequences.

Because the flood-risk education program enables students to appraise both the threat of flooding and the prevention measures and coping strategies, we expect that:

- The flood-risk education program has no effect on perceptions of fear and trust.
- The flood-risk education program has a positive effect on students' preparedness intentions and self-efficacy.

5. Method

5.1. Research design and research group

As the learning goals of the program were entirely focused on perceptions and intentions, we applied a quantitative approach in order to determine the effectiveness of the flood-risk education program. This study is characterized by a pretest-posttest design with an intervention group and a control group. In 2013, 271 15-year-old students at pre-university education level (VWO) and senior general secondary level (HAVO) participated in this study. Those students came from three secondary schools in West-Friesland in the province of North-Holland (Fig. 1). 184 students from two schools in Hoorn and Enkhuizen experienced the intervention with the flood-risk education program. Additionally,

Table 1
Factor pattern coefficients for exploratory factor analysis with oblique rotation of flood-risk perception scales (N = 229).

Items	PFE	PFC	PT	PF
Perceived flood exposure (PFE)				
1. I think the surroundings of my school could be hit by flooding.	**0.74**	0.07	−0.08	0.08
2. I think the surroundings of my school could be hit by flooding in the coming year.	**0.65**	−0.15	−0.25	0.07
Perceived lood consequences (PFC)				
3. If the school surroundings would be hit by flooding, I think the roads would be damaged heavily.	0.15	**0.61**	−0.01	−0.05
4. If the school surroundings would be hit by flooding, I think houses would be damaged.	**0.52**	**0.17**	**0.41**	−0.05
5. If the school surroundings would be hit by flooding, I think my family and I would end up in a life-threatening situation.	**0.46**	**0.52**	0.18	−0.02
6. If the school surroundings would be hit by flooding, I think daily life would be disturbed for a long time.	0.19	**0.74**	0.03	0.13
7. If the school surroundings would be hit by flooding, I think there will be many deadly victims.	−0.03	**0.81**	−0.20	0.02
Perceived trust in flood safety (PT)				
8. I think that the surroundings of the school are protected well against flooding.	−0.13	−0.08	**0.66**	0.04
9. I think that the dikes in the surroundings of the school are maintained well by the water managers.	−0.05	−0.08	**0.83**	−0.01
10. I think that water managers in the surroundings of the school are able to predict water levels well.	0.03	0.01	**0.80**	−0.01
Perceived fear (PF)				
11. Thoughts about flooding in my own surroundings panic me.	0.07	0.01	−0.01	**0.87**
12. Thoughts about flooding in my own surroundings make me feel anxious.	0.08	−0.05	0.02	**0.92**
13. Thoughts about flooding in my surroundings make me feel worried.	−0.06	0.08	0.04	**0.86**
Eigenvalues	1.08	2.97	2.15	1.85
Cronbach's α		0.68	0.69	0.86
Pearson correlation	0.35**			

Note: Pattern coefficients over 0.40 appear in bold.
** $p < 0.01$.

87 students from a school in Grootebroek acted as a control group. The whole group of 271 participants consisted of 15-year-old students who were at the end of their third and last year of junior secondary education. Of the 271 pre- and posttests, 42 turned out to be incomplete. 15 students forgot to fill in their name and 27 students overlooked the back side of the pretest or posttest. So the final number of participants whose pre- and posttest could be analyzed, is 229.

At the same time of the intervention, the control group participated in geography lessons about flooding and flood prevention in the Netherlands. These lessons were related to a conventional program as described in a commonly-known geography textbook in the Netherlands (van den Berg, 2008). Both content and pedagogy differed from the flood-risk education program. In the control group, attention was mainly paid to knowledge and understanding of the causes of high water levels as well as the huge adaptations that are necessary to prevent the country from flooding. Dike breaches, flooding and their effects as well mitigation measures and preparedness did not play a role. Besides these topics, there are two important differences. In the control group, flood-risk was related to the Netherlands in general. This is in contrast with the flood-risk education program of the intervention group. Furthermore, the pedagogy of the conventional program was mainly focused on teacher-directed classroom learning combined with student-directed exercises in workbooks to process the information analytically.

In the intervention group that consisted of nine classes in two schools, seven teachers were involved in the experiment. Three of these teachers played a role in the design process of the flood-risk education program. The other four teachers were trained by the first author and one of the teachers, during two sessions prior to the experiment.

The gender distribution between the intervention group and the control group did not differ significantly ($\chi^2(1) = 1.06$, $p = 0.30$). With respect to school type (pre-university education level and senior general secondary level) there was a significant difference in distribution between both groups ($\chi^2(1) = 7.36$, $p = 0.01$). The control group consisted of 71% students at pre-university level while the intervention group consisted of 61% students also at pre-university level.

5.2. Measurements

All participating students completed the questionnaire prior to the intervention (T_0) as well as one or two weeks after the last lessons (T_1). The pre-test and post-test were six or seven weeks apart. With respect to students' beliefs about flood-risk, students were asked to judge a series of thirteen statements on a 5-point scale (1 = disagree completely, 2 = disagree partly, 3 = partly agree/partly disagree, 4 = partly agree, and 5 = agree completely). Perceived flood exposure was measured with two items and perceived flood consequences with five items. Both perceived trust in flood safety and perceived fear were measured with three items each. By using a principal component analysis (PCA) we determined to what extent the items loaded on the intended constructs. As the resulting factors might be correlated, the PCA was run with oblique rotation. Furthermore, the internal consistency for each construct was determined by using Cronbach's α (three items or more) and Pearson correlation (two items). Table 1 shows items and factor loadings. The results confirm largely the intended factor structure. Despite the cross-loadings on two items concerning the construct perceived consequences (Table 1, items 4 and 5), we decided not to delete the two items because of the contribution to the internal consistency of this construct. Moreover, the validity of this construct based on these five items was already demonstrated in another study with a larger research group (Bosschaart et al., 2013). For each variable, the mean was calculated as the average of the items within the scales.

In addition, students' preparedness intentions ("I think it is important to think about measures one can take to prevent damage from flooding.", one item) and students' self-efficacy ('In case of flooding, I know what to do to put myself in safety'; one item) were measured.

5.3. Analysis

As the flood-risk education program aims at changing perceptions, the effectiveness of the flood-risk education program depends on the extent to which perceptions evolve. To investigate the research question and to test the hypotheses, various techniques were used. In order to determine whether there are differences between the intervention group and the control group at the baseline, previous to the intervention, we performed a MANOVA on the means at T_0.

To determine the effects of the intervention a MANCOVA was performed with the means of the variables at T_1 as dependent variables and the means of the variables at T_0 as covariates. This method was chosen because of the differences between the intervention group and the control group, with respect to two of six risk perception variables. According to Stevens (2009), incorporating the variables at T_0 as the covariates, contributes to adjusting the posttest means as if both groups had started out equally. This method was preferred to the use of the analysis of gain scores because of the low reliability of this method (Stevens, 2009). Furthermore, school type (pre-university education level (VWO) and senior general secondary level (HAVO)) was also used as

Table 2
Means, standard deviations of the variables (5-point scale) in the Intervention group and the Control group at T_0 and T_1 and the MANCOVA with effect size.

		Intervention group (N = 154)		Control group (N = 75)		MANCOVA ($F_{6,211} = 3.86$, $p = 0.001$)		Effect size
		Mean	SD	Mean	SD	F	p	η_p^2
Perceived flood exposure (2 items)	T_0	2.49	0.89	2.29	0.93	12.86	0.000	0.06
	T_1	3.03	0.88	2.42	0.90			
Perceived flood consequences (5 items)	T_0	3.21	0.80	3.15	0.71	4.96	0.027	0.02
	T_1	3.22	0.76	2.95	0.75			
Perceived fear (3 items)	T_0	2.16	0.97	1.95	0.88	2.66	0.105	
	T_1	2.17	1.02	1.84	0.92			
Perceived trust in flood protection (3 items)	T_0	3.84	0.81	4.20	0.65	2.39	0.124	
	T_1	3.80	0.70	4.10	0.85			
Preparedness intentions (1 item)	T_0	3.13	1.25	3.55	1.19	0.27	0.606	
	T_1	3.38	1.19	3.49	1.26			
Perceived self-efficacy (1 item)	T_0	3.05	1.17	3.01	1.12	4.80	0.029	0.02
	T_1	3.63	1.06	3.30	1.22			

covariates, because of the differences in group composition. Gender was taken up because previous studies (Bosschaart et al., 2013) showed differences in risk perception between boys and girls.

Effect size was determined using partial eta squared. The effect sizes were interpreted as small, medium and large, respectively (Cohen, 1988).

6. Results

6.1. Differences between the intervention group and control group at T_0

Table 2 and Fig. 4 show that the means of the items on the construct prior to the intervention, differ between the intervention group and the control group. A MANOVA was performed on the pretest scores. The MANOVA was controlled for gender. The MANOVA was significant ($F_{6,250} = 4.07$, $p < 0.001$) and showed significant differences with respect to perceived trust and the preparedness intentions. This means that the control group and the intervention group differed at the baseline with respect to two of the six variables. This is remarkable because all students in both groups were comparable with respect to potential threat of flooding, characteristics of the area, distance to the dike, age, educational level and the contents of preceding geography education.

6.2. Effects of the intervention

In order to determine the effects of the intervention a MANCOVA was performed. Because the means of some variables at T_0 differed between the intervention group and the control group, the pretest means were included as covariates as well as gender and school type. The MANCOVA (Table 2) was significant and showed that for three variables the changes in the intervention group were significantly different, compared with the control group. In addition to Table 2, Fig. 4 shows the changes between T_0 en T_1 for each variable graphically.

With respect to perceived flood exposure the means increased for both groups. The intervention group showed a stronger increase. Concerning flood consequences the means hardly changed. The MANCOVA showed that the intervention had a medium-sized positive influence on perceived flood exposure ($F = 12.86$, $p = 0.000$, $\eta_p^2 = 0{,}6$) and a small positive influence on perceived flood consequences ($F = 4.96$, $p = 0.03$, $\eta_p^2 = 0{,}2$). This supports the first hypothesis.

With respect to perceived fear and perceived trust in flood protection the means for the intervention group did not change while the means for the control group decreased slightly. The MANCOVA showed that perceived fear ($F = 2.66$, $p = 0.11$) and perceived trust in flood protection ($F = 2.39$, $p = 0.12$) did not change significantly in both the intervention group and the control group. This is in support of the second hypothesis.

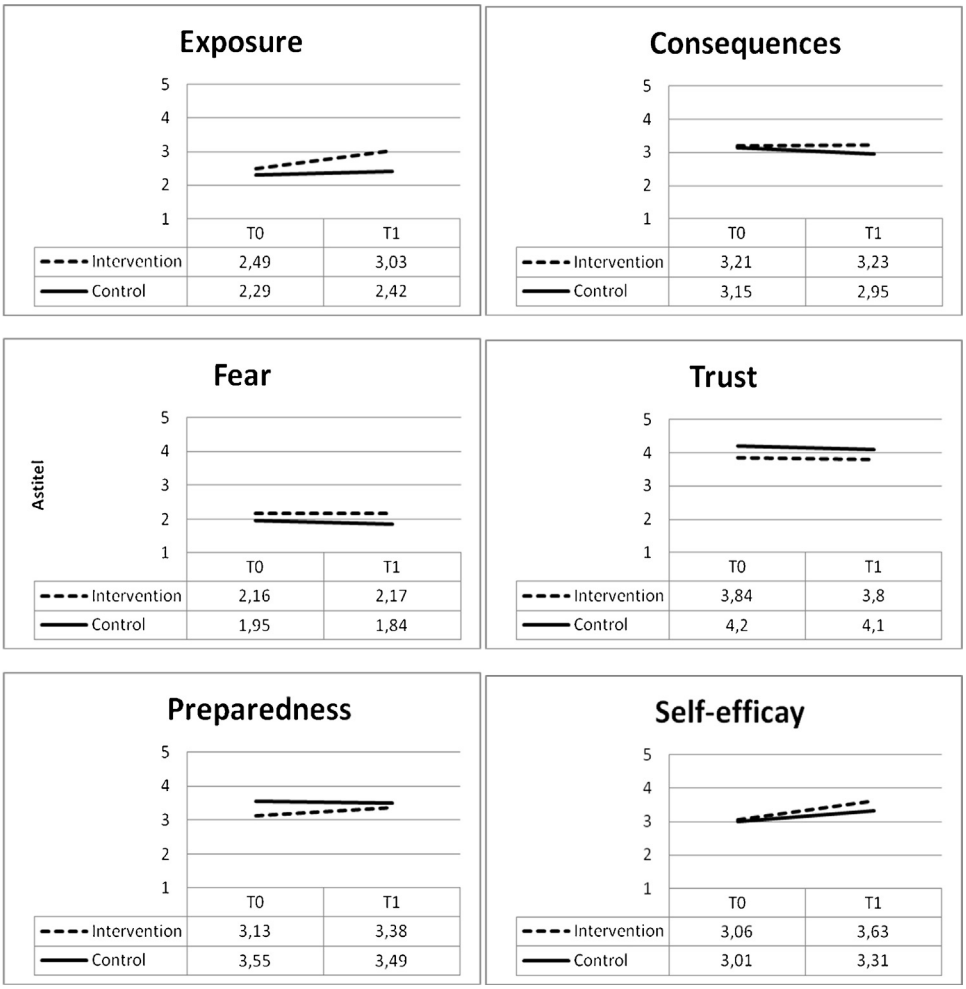

Fig. 4. The effects of the intervention compared to the control group, for each of the six variables.

The means for preparedness intentions increased with respect to the intervention group and slightly decreased for the control group. However, the MANCOVA did not show a significant difference between the intervention group and the control group with respect to preparedness intentions ($F = 0.27$, $p = 0.61$). On the other hand, the means concerning perceived self-efficacy increased in both groups. The intervention group showed the strongest increase. The MANCOVA made clear that the intervention showed a small positive influence on the perceived knowledge about self-protection ($F = 4.80$, $p = 0.03$, $\eta_p^2 = 0{,}2$). Therefore the results support the third hypothesis only partly.

7. Conclusions and discussion

In this study we have determined the effects of a flood-risk education program among 15-year-old students in a particular region in the lower Netherlands. The flood-risk education program is aimed at deconstructing 'the myth of dry feet' by giving students the opportunity to redefine the environment into one that could be threatening.

7.1. Results

In order to determine the effects of the flood-risk education program, we have compared the intervention group with a control group that experienced a conventional program about flooding in the Netherlands in general. The intervention program and the conventional program differ substantially with respect to contents and pedagogy. While educational programs, just like the conventional program, mostly focus on knowledge and understanding, with belief and attitude change more or less as a by-product, the intervention program pretends to affect explicitly beliefs and attitudes towards flood risk.

Students who were subjected to the intervention about flood risk in their surroundings show a significant increase with respect to the perception of flood exposure, compared with the control group. This is in accordance with what was expected. With respect to perceived flood consequences there was just a slight increase compared with the control group. In support of the hypotheses, the perception of fear and trust did not change. As opposed to the expectations, the preparedness intentions did not change significantly while the perceived self-efficacy increased as expected. In the control group, despite the conventional program about flooding in the Netherlands, almost all perceptions did not change significantly, compared with the intervention group.

The results show that the flood-risk education program influences students' threat belief or risk perception without changing their perception of fear and their trust in flood-protection. Therefore we may conclude that the intrusiveness of the information was the case to such an extent that students' appraisal of the threat of flooding changed without causing feelings of anxiety or panic. This is important because authorities often think that presenting simulations and worst case scenarios cause panic and decrease trust. Admittedly, the perception of flood consequences changed just slightly. Taking into account the substantial attention to flood consequences by means of simulations, a stronger increase should have been obvious. On the other hand, compared with the perception of flood exposure, the perception of flood consequences was already higher prior to the intervention. This could explain the slight increase of this variable. The absence of changes in perceived fear corresponds to the findings of Terpstra et al. (2009) and Zaalberg, Midden, Meijnders, and McCalley (2009). Although fear, measured as self-reported fear, did not change, we assume that both cognitive and affective evaluations have influenced the threat belief.

Although the perception of trust in water safety did not change, we assume that the nature of this trust changed. Initially, trust could be characterized as blind faith which is deeply embedded in Dutch society (Heems & Kothuis, 2012). As the intervention did not only emphasize the threats, but also focused on the efforts that are made by the water boards, we assume that the idea that water safety is self-evident changed. Therefore, we expect that blind faith changed in trust which is more or less based on cognitive evaluations. Further study is needed to determine whether this assumption is true.

As the risk-education program had a composite character and we just measured the beliefs and intentions, it is only possible to judge the overall effect. We did not measure changes in the knowledge structures or mental models. Given the expected changes in threat belief and perceived knowledge, we conclude that the information processing and learning processes took place in the intended direction. This means that affective reactions evoked both experiential and analytical processing of information. These reactions were prompted by the use of a 3D-game which confronts the students with a virtual dike burst as well as 2D simulations of flooding at different spots along the dike in the surroundings. Afterwards, enabling students to tag field experiences with flood related information and affect laden imagery and the opportunity to discuss flood risk with relatives, caused cognitive and affective evaluations that may have produced feelings of inconvenience to such an extent that accommodative learning could take place. Under these circumstances, belief change took place but change of intentions failed to occur.

An online version of the flood-risk education program (www.overstromingsrisicoatlas.nl), which is sponsored by the regional water boards as well as the Dutch Ministry of Infrastructure and Environment, is one of the main outcomes of this study.

7.2. Limitations

We have to take into account some limitations of this study. First of all, two different schools participated in the intervention. In each school various teachers gave their lessons to different classes. Although the teachers were recommended to give the lessons in accordance with the instructions, there will have been differences in teaching style. And despite the instructions, it was the first time the teachers used the material. Therefore the teaching and learning conditions were suboptimal and it seems plausible to assume that the results would improve when the teachers are more experienced with the program.

In the determination of the effects of the intervention, we used a MANCOVA. Although the covariates were used to eliminate the differences between the intervention group and the control group with respect to the pretest, gender and school type, according to Stevens (2009), we have to take into account that both groups could differ on other unknown variables. This problem will always exist when intact groups like classes are used.

The lack of change with respect to preparedness intentions could be explained in different ways. Firstly, it is possible that students thought that preparedness is not their responsibility but the responsibility of their parents. From a methodological point of view, it has to be mentioned that preparedness was measured with only one item, which is less reliable. This might mean that change of intention took place, but we didn't measure it. Moreover, because the flood-risk education program was carried out during the regular school schedule, students were occupied with the topic for about 50 min, twice a week. Each lesson was preceded and followed by lessons in other school subjects. Therefore, it seems plausible to wonder whether these short periods of time were long enough to get fully involved in the topic. Furthermore, the question is whether the presentation modes used to show the 3D-game and

the 2D-flood-simulation caused immersive subjective experiences by which students were fully involved. The 3D-game was played on smart phones and 15-in. computer screens. The flood-simulation was carried out on 15-inch computer screens. According to Zaalberg and Midden (2013) the presentation mode affects people's coping appraisals with respect to flooding. They compared the effects of an interactive 3D flood simulation on 72-in. screen with multimodal sensory stimulation with non-interactive 2D simulations on 15-inch screens. The multimodal 3D presentation mode had a stronger effect on preparedness motivation. Therefore it seems plausible to assume that the 3D-game and the 2D-simulation in our program did not cause enough involvement so that the attitude towards preparedness could be influenced. In fact, it is questionable whether attitude change could be achieved without altering perceptions of fear. This is in accordance with Ronan and Johnston (2005) who stated that some hazard concern or distress is needed in order to achieve problem-focused coping.

The experimental design of this study enables us to draw conclusions on the effects of the intervention. But because the posttest was taken only a few weeks after the intervention, we cannot make a solid statement about the long term effects.

Both Heems and Kothuis (2012) and Harries (2008) made clear that risk perceptions and attitudes towards preparedness are deeply embedded in more fundamental beliefs that live in society. Perceptions and attitudes are influenced by representations about the relation man-nature, the controllability of the environment and the responsibility distribution within society. In order to change these fundamental representations it seems that a flood-risk education program of 6 or 7 lessons might be too short.

7.3. Recommendations

This study shows that the use of flood simulations (3D-game and 2D-simulation) used by the water authorities, are useful in raising flood risk perception without adverse effects. So, there is no reason for water boards in other parts of the Netherlands to be restrained in providing this material for the use of risk communication or risk education.

As the intervention of this study did not succeed in enhancing students' preparedness intentions, further study is needed to determine whether it is possible to change intentions by increasing their involvement. This could be done by creating more immersive conditions and could be achieved by creating virtual environments that are perceived as 'real'. Within this framework, Zaalberg and Midden (2013) suggest to experiment with the presentation mode. By using more immersive simulation techniques in a virtual environment, feelings concerning really losing something of value should be evoked which would lead to negative emotions. In an educational setting this kind of experimental research is hardly feasible because of ethical complications. Nevertheless, flood-risk education could benefit from this type of research. Moreover, Heems and Kothuis' suggestion to prompt a legitimate fear that leads to vigilance seems to be appropriate in relation to attitude change.

The flood-risk education program is related to 15-year-old students. We assume that the effectiveness with respect to change of beliefs and attitudes could be enhanced if the risk education program would be embedded in a succession of activities in the course of primary and lower secondary education. Such a comprehensive flood-risk education program should be designed carefully while taking into account the regional and local flood-risk situation and the developmental stage of each age. Moreover, a comprehensive flood-risk education program should be part of a geography curriculum that explicitly contributes to shaping realistic beliefs about the relation man-nature and the controllability of the environment (Komac, Natek, & Zorn, 2008; Komac et al., 2010).

Dutch people who are rather free from fear with respect to flooding and do not accept vulnerability with respect to flooding, still believe in the 'myth of dry feet'. A country that is physically and culturally interwoven with water cannot afford such an indifferent approach and geography education ought to play a crucial role in raising flood-risk awareness as well as preparedness intentions.

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