Learning about flood risk: comparing the Web-based and physical flood-walk learning environments

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Contents

Abstract

Numerous of sustainable development related challenges are emerging today, e.g. flooding problems. Our group has developed 'the flood walk' project since 2010 to convey flood risk knowledge in an authentic context. Considering the limitation of time and space to educate people the flood risk knowledge, we tried to transform the physical flood walk field trip into a Web-based virtual trip. In this study, we aim to examine whether the Web-based flood-walk environment can help participants to achieve the same learning outcome as its authentic counterpart. A total of 65 upper secondary school pupils participated in this study. The results illustrate that a physical experience is irreplaceable, and the importance of providing *physical experiences* for learners in both formal and informal education needs to be emphasised.

Keywords: Risk knowledge, Flood, Web-based, Learning environment, Attitude.

Introduction

The importance of developing the knowledge of risk has been perceived globally today in different research domains (e.g. Levinson, Kent, Pratt, Kapadia, & Yogui,2011, Renn, 2008), especially after the emergence of socio-scientific issues (i.e. global warming as well as the use of nuclear power as energy resource) and the notion of sustainable development (UN DESD, 2011). For example, in the case of the tsunami disaster that happened in Thailand during 2003, there was a little girl who just learned the knowledge of tsunami in school one week before their trip to Thailand, and when she saw the 'sign' of tsunami, she told her parents and then they shouted at the beach and saved a lot of tourists' lives at that time (Eshach, 2006). In a more recent case of nuclear power problem caused by the tsunami and earthquake in Japan during March 2011, again, it has shown the importance of having risk knowledge and having the ability of relating it to the location of constructing nuclear power plant as well as how to solve the problems in case of a failure. Rauch and Steiner (2013) point out that making a contribution to education for sustainable development needs to have efforts among stakeholders in global learning, citizenship education, health education, peace education and so on. Here, we also want to address that the development of risk knowledge needs not only educators, but also the involvement of different stakeholders from policy, science and society (Bründl, Romang, Bischof, & Rheinberger, 2009).

In Sweden, there is seldom any earthquake problem, but we face risks of floods, for example in the city of Karlstad. Since both River Klarälven and Lake Vänern surround the city and Karlstad is built in a delta area that is constantly changing, floods have always been problematic in Karlstad. Accordingly, the development of risk perception concerning flood is essential. At Karlstad University, a project called 'the flood walk' has been developed by the Center for Climate and Safety (CCS) since spring 2010, and the project aims to increase people's awareness of the risk of flood in general as well as locally in Karlstad. Although the benefits from 'the flood walk' activity have been demonstrated from our group's 'walk' experiences during the past years, we are facing difficulties of running 'the flood walk' with more than 30 participants and such authentic experience cannot be transferred to people who do not visit Karlstad, or in other countries. To present an optimistic approach for sustainable development, global society as a whole ought to participate in creating a vision of tomorrow (Rauch & Steiner, 2013). Therefore, to convey the knowledge of flood risks to students and different populations without the boundaries of time and space, developing a Web-based learning environment is an important step to move on. The study presented here is a pilot study and aims to develop a Web-based flood-walk learning environment and to compare the participants' risk knowledge development (cognitive domain) and attitudes (affective domain) between the two learning environments.

Education for sustainable development and the flood walk project

Coping with natural hazards and risk management can be seen as important elements of sustainable development, or in other words, we could say that coping with natural hazards in sustainable ways needs education that is in vein of this direction. In 2002, the United Nations General Assembly puts in place a United Nations Decade of Education for Sustainable Development (DESD), spanning from year 2005 to 2014, and designated UNESCO to lead the Decade (UNESCO, 2009). The DESD breaks down the traditional educational scheme and promotes:

- interdisciplinary and holistic learning rather than subject-based learning
- value-based learning
- critical thinking rather than memorizing
- multi-method approaches
- participatory decision-making
- locally relevant information, rather than national.

In this study, both of the 'Web-based' and 'physical' flood walks are in line with the above-mentioned DESD notion via focusing on the elements of locally relevant information (flooding is considered as one of the major social risks in the municipality of Karlstad), multi-method approach and critical thinking as well as interdisciplinary and holistic learning rather than subject-based learning.

The Flood Walk project is to a large extent based on information from the Flood Program in Karlstad municipality. During the walk, participants are allowed to join a city tour with 14 stops either by walk (focusing on few stops) or by car/bike. The city tour stays in the center of the city, while the car tour goes to the surroundings and at locations in western and eastern parts of Karlstad. There is also a written instruction guide, a compendium. The purpose of developing the written guide is to make it available freely and to use in a flexible way for guiding a group or let people walk on their own. It is also possible to choose what sites participants want to visit and how long participants want to stop, which depends highly on how much time is allowed and the interests of the participating groups.

For each location of the 14 stops during the walk, we have picked out some suitable images. There are historical photos, illustrations, tables with interesting facts of previous flood events and more. The images are laminated and could work as a 'mobile power point presentation' during the walk. In the guide material, there are also, for each stop or subject, one or more questions that can be used to guide a discussion among participants and instructor(s). The discussion will probably continue during the walk between the stops. There is also s mall-group discussion ("chat groups") setting to make participants share experiences and knowledge with each other. At the next stop, new formations of groups might be re-arranged to create a fruitful exchange among participants, guides and researchers/ experts.

Based upon the flood hazards and the importance of risk knowledge as well as the *flood walk* experiences that our research group has developed, we developed a Web-based flood-walk to convey flood risks and the related risk knowledge to citizens and students nationally and internationally. The major objective was to increase people's awareness of flood risk and knowledge to cope with this type of nature disasters without the boundaries of time and space.

Dynamic assessment

Comparing traditional methods of assessing people's achievement, dynamic assessment focuses on assessing people's learning process and learning potential. We view dynamic assessment as an alternative supplementing approach to traditional methods to assess students' learning. The term of dynamic assessment was developed by R. Feuerstein in 1979. Basically, we could say that dynamic assessment is a philosophy of conducting assessments. Although there are variations on several dimensions embedded, the most important and consistent characteristics include (Feuerstein, 1979; Haywood & Lidz, 2006):

- The assessor actively intervenes during the course of the assessment with the learner with the goal of intentionally inducing changes in the learner's current level of independent functioning.
- The assessment focuses on the learner's processes of problem solving.
- The most unique information from the assessment is information about the learner's responsiveness to intervention.
- The assessment is most often administered in a 'pre-test, intervention and re-test' format.

Connecting dynamic assessment to our flood walk project, it is not hard to see the benefit from designing different test items linking to the different teaching-learning context of 14 stops of the flood walk activity. In-between the stops, we could also add questions to evaluate learners' learning process and cognitive development, which fits the idea of dynamic assessment well. In this study, mainly, we conducted one round of dynamic assessment (with the five chosen stops), and we could consider designing more rounds (with more stops) of dynamic assessment in other future studies. Digital assessment has become a helpful approach today (Eyal, 2012), and it fits well to our development of Web-based flood-walk environment. Accordingly, dynamic assessment was conducted as our assessment approach embedding in both of the Web-based and physical flood walks.

Research purpose and questions

The overall aim of the study was to compare students' knowledge (about nature and society related issues and flood management) development in the Web-based and the physical flood-walk environments. Through this study, the participating pupils were expected to be informed about how our nature and environments are managed and to develop interdisciplinary knowledge with a focus on flood risk issues.

The specific research questions are:

1. Is there any difference concerning the pupils' declarative knowledge (knowledge that is conscious and could be verbalized) development related to flood problems between the physical and Web-based flood-walk environments?
2. Is there any difference regarding the pupils' attitudes in flood related issue between the physical and Web-based flood-walk environments?

Method

Based on the physical flood-walk activity, a video-taped walk was produced in autumn 2011 to create a Web-based flood-walk environment. To compare the two kinds of learning environments, the content of the Web-based flood-walk environment was made comparable to the physical flood-walk environment. It is a mixed-method study with a questionnaire (including multiple-choice and open-ended questions) developed via this study to disclose the participants' learning and responses from the two different learning environments.

The development of the questionnaire

In order to develop the learning environment (for both of the Web-based and physical environments), the teaching goals, the respective questions and the manuscript for the teaching content were discussed and developed by the authors during a number of project meetings. An overview of the flood-walk topics and the related learning objectives is shown below (Table 1).

Table 1. Learning objectives for different flood walk topics.

Flood-walk topics (connected to a specific stop along the walk)	Learning objective
1. Physical geography (hydrology, sedimentation, etc.) (Stop 1)	Learning about the natural system of rivers and causes of floods
2. Historical events (Stop 2)	Floods are a naturally re-occurring phenomenon but the impact is changing. Karlstad already faced several floods.
3. Hindrances for the water (Stop 2)	Learning about hydraulic mechanisms in a

	river, urbanised river, and in a delta
4. Vulnerability/critical infrastructure (Stop 3)	Learning about different vulnerabilities and direct and indirect effects of floods
5. (Urban) planning (including legislation)/ flood adapted architecture (Stop 4)	Learning about how urban planning works with regard to flood risk management and legislative regulations
6. Protection measures (Stop 5)	Learning about different measures and strategies for flood risk management

The most important flood-walk topics were identified and the learning objectives were formulated accordingly. Based on the learning objectives (Table 1), a questionnaire was developed and covers the topics to let the participants easily fill in during physical and Web-based flood walks respectively. The format of the questionnaire is a mixture of multiple-choice and open questions. The questionnaire was developed in Swedish first and translated into English to be presented in this article. The questionnaire is composed of five parts (please see Appendix I):

Part 1. Background information of the participant: age, education, place of living (city/countryside)

Part 2. Three pre-questions about *awareness*, *experience* and *willingness* about floods. The answer was made on a 7-point Likert scale from "disagree strongly" to "agree strongly".

Part 3. Three open questions answered both *before and after* the walk. The questions were about the causes and consequences of flood, and the possibilities to reduce flood risks. The pupils' answers were assessed by the second and the third authors of this article individually and a consensus was achieved after discussions. The pupils' answers were given by the assessors with a 5-point scale, from 1 (low knowledge) to 5 (high knowledge).

Part 4. Multiple-choice questions answered after stop 2 and 5. The questions were about more detailed knowledge taught during the walk and used to assess and compare pupils' learning outcomes.

Part 5. Ten post-questions about different aspects of the learning environment. The answer was made on a 7-point Likert scale, from 1 (disagree strongly) to 7 (agree strongly).

The design of the research and the participants

Originally, there were 14 stops developed in the physical flood-walk environment. However, in this project, according to our experiences, we identified the five most popular stops to develop a Web-based flood-walk environment and to compare with the same 5-stop in the physical flood environment (Figure 1). The five stops represented basic thematic parts of the risk management process, as described in Table 1. Besides learning objectives 2 and 3 were connected to stop no. 2, all the other objectives were connected to one stop each (Table 1).

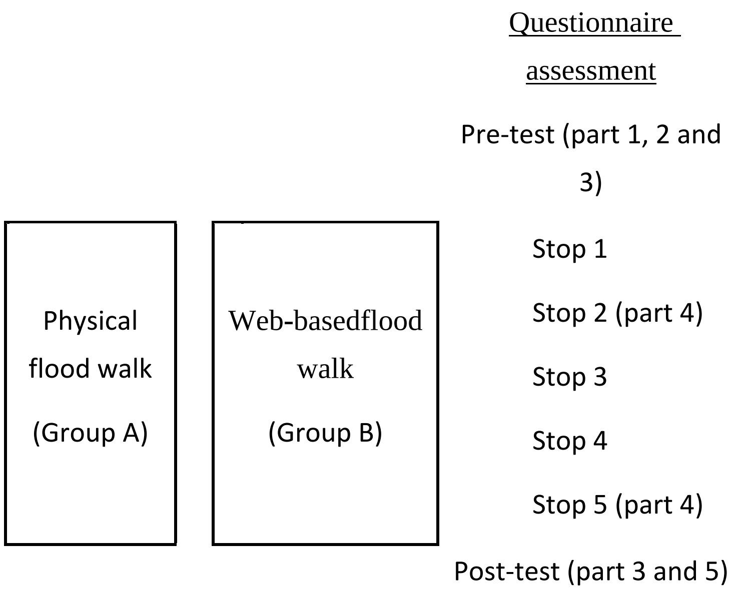

Figure 1. The research design of the study (for the questionnaire; see Appendix 1).

A total of 40 upper secondary school pupils (with an average age around 17 years-old) participated in the physical flood walk (Group A). The pupils were from either the science or the technology program. One class of 25 pupils (average age was around 16 years-old) from a science program joined in the Web-based flood-walk environment (Group B). Both groups of pupils needed to fill in the above-mentioned questionnaire *before, during* and *after* joining the physical or the Web-based flood walk.

Regarding the technical environment, we checked possible Web-platforms to integrate the e-module including the tests. We found that it was best to develop the Web-based flood-walk environment as an e-learning module. The platform called ***It's learning*** platform (www.itslearning.com) that is a regularly used education platform at Karlstad University. Thus, this module can be easily imported and integrated into other learning environments.

Data collection and analysis

The questionnaire filled-in by the participants was the basis for both quantitative and qualitative analyses to compare the learning outcome. The qualitative part was analyzed through coding the learning process. Regarding quantitative data, learners' responses were collected before and during the different flood walk activities, and analyzed through the descriptive analyses and Independent t-test statistical method (SPSS 12.0 version).

Results

In general, including tests time, the physical flood walk took about 1.5 hours, and it was around 50 minutes for the Web-based flood walk. Therefore, it saved about half of the time in conducting a Web-based flood walk to convey risk knowledge. How about the learning outcome? In the following section, the results are presented.

Awareness, experience of and willingness to learn about flood problems

Concerning the pre-assessment of awareness, experience of and willingness to learn about flood problems (Table 2), it was shown that, to a high degree (over 4 out of a 7-point scale), the pupils from groups A and B were aware of flood problems and had recognized flood problems are important to learn, even though they might not have experiences of flood problems in life. However, it was disclosed that the physical walk group of pupils showed significant difference concerning the awareness and experience of flood problems. The correlation of pupils' awareness and experiences was not investigated in depth in this study, but it has been considered in our following projects.

Table 2. Pre-assessment of awareness, experience and willingness to learn (* with significant difference, *p*<0.05).

The scale is from 1 (disagree strongly) to 7 (agree strongly).	Physical walk	Web-based walk	P value (*p*<0.05)
I am aware of flood problems	5.2	4.1	0.004*
I have experience of flood problems	3.5	1.8	0.000*
I find it important to learn about flood problems	5.6	5.8	0.697
Mean score	**4.8**	**3.9**	

The flood knowledge

In terms of the open questions about the flood knowledge (Table 3), a clear improvement was seen from pre- to post-test for both groups of flood walk activities. Even though, the Web-based flood walk group had higher score on flood causes knowledge with a significant difference (*p*<0.05), understandings have improved for both groups of pupils.

Concerning the understanding of flood consequences after the flood walk, the group of the Web-based flood walk showed a better improvement with a significant difference (p<0.05) than the physical flood walk group.

Table 3. Open questions about deeper flood knowledge (* with significant difference, *p*<0.05).

The scale is from 1 (low knowledge) to 5 (high knowledge).	**Before walk**			**After walk**		
	Physical walk	Web-basedwalk	P value (*p*<0.05)	Physical walk	Web-basedwalk	P value (*p*<0.05)
Flood causes	1.9	2.4	0.021*	2.9	3.3	0.125
Flood consequences	2.1	2.0	0.150	2.2	2.6	0.009*
Possibilities to prevent flood problems	1.9	1.1	0.606	2.8	2.6	0.309
Mean score	**1.9**	**1.8**		**2.6**	**2.8**	

In addition to the open-ended questions, during the flood walk activities, we had embedded six multiple-choice questions to evaluate the pupils' understanding of flood related knowledge after stop 2 and 5. These stops are corresponded toobjectives 1-3 and 4-6 respectively (see Table 1). In the results, it was shown that there was no significant difference with regard to knowledge development (Table 4).

Table 4. The knowledge test results from flood walk activities.

Average scores from three questions in each stop (Full score = 3)	Physical walk	Web-basedwalk	P value (p<0.05)
Stop 2	1.53	1.20	0.209
Stop 5	1.98	2.08	0.623

Pupils' attitude towards the learning of flood related issues

Regarding the impact of learning environment on pupils' learning attitude of flood issue, the results from 10 post-questions revealed that the Web-based flood walk and physical flood walk environments generally had no different impact on pupils' learning attitude (Table 5). However, with significant differences, the physical flood walk environment did enhance pupils' understanding of flood issues happening in other places (4.9, $p<0.05$), promote pupils' learning interests (5.1, $p<0.05$) and their motivation to explore more knowledge related to flood issues in the future (3.9,$p<0.05$). One thing that needs to be addressed is that pupils from the Web-based flood walk only showed a score of 2.3 concerning the exploration of flood related knowledge in the future.

Table 5. Results from questions about the learning environment (* with significant difference, $p<0.05$).

The scale is from 1 (disagree strongly) to 7 (agree strongly).	Physical walk	Web-based walk	P value (p<0.05)
This learning environment helped me to understand the complexity of flood issues	5.8	5.4	0.186
This learning environment added knowledge of preventing flooding for me	5.8	5.4	0.202
This learning environment improved my ability to communicate with other people on floods	5.3	5.0	0.390
This learning environment improved my awareness of flooding	5.8	5.3	0.121
This learning environment helped me to understand the flood issue happening in other	4.9	3.9	0.022*

places (i.e. Bangkok in 2011)			
This learning environment made me understand the connection of different sectors (i.e. transportation, hospitals, electricity supply, etc) in society	5.2	4.9	0.562
Sharing the experiences of other sectors (i.e. transportation and hospitals) was the most interesting part of this learning environment	5.3	4.8	0.180
This learning environment promoted my learning interests and motivation to learn about flooding	5.1	4.3	0.035*
I would like to participate the same activity in the future	4.4	3.8	0.168
I will like to explore flood-related knowledge by myself in the future after this learning activity	3.9	2.3	0.000*

Conclusion and discussion

In our modern society with numerous issues related to sustainable development (Levinson, Kent, Pratt, Kapadia, & Yogui, 2011; UN DESD, 2011), ‘Can e-learning help educators to convey risk knowledge?’ is the main motivation for us to conduct this research. From the results of this pilot study, we conclude that the Web-based flood walk did show the same effect on developing pupils’ risk knowledge of flood issues. However, the physical flood walk group presented a better enhancement on their knowledge transfer flood issue, and their interests and motive to explore flood related knowledge in the future. From the results of the pupils’ attitude towards flood issue, it tells us the importance of creating “physical experiences” for learners in both of the arenas of formal and informal education to promote their learning interests. For example, using multi-media (showing a video with a flood problem happened in reality) in teaching and providing different experiences (hands-on activities with physical models developed for flooding issue education or experiencing tsunami in a simulated environment) for students to learn knowledge could be helpful.

In sum, we want to address that a Web-based learning environment did save us time to convey knowledge, but it is necessary to point out that a Web-based environment cannot replace a real physical learning environment. A good teaching and learning context should consider the support from both ICT and physical teaching-learning interaction. The way of organizing students (individual, a pair or a group), educational levels (pre-school to upper secondary levels) and different concepts to be taught are all important to consider while using ICT in school education (Lee, Waxman, Wu, Michko, & Lin, 2013). Concerning the limitation of this pilot study, we were aware of the pre-assessment (Table 2 and 3) and the differences of the students of the both groups that might influence our results. However, based on the knowledge tests after stop 2 and 5 (Table 4), there was no significant differences found in both group of students. In sum, we view this study as a case study and there is a need to conduct research further to provide a holistic view to contribute to flood risk education and learning environment research. In particular, aspects of investigating students' learning process in depth during the flood walk as well as adding different levels of knowledge concerning flood risk are both important to be studied in the coming future.

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Appendix 1: The instrument

Part 1: Background information

(1) Name (Initial): ______________________

(2) ID (the last 4 numbers of your ID): __________________

(3) Age: ____________

(4) Gender: ☐ Female ☐ Male

(5) Location of living:

City name: _________________________

☐ In the town

☐ Countryside

(6) Educational background:

☐ NV (sciences) ☐ NVSP (science combined social sciences)

☐ S (social sciences)☐ Other

(7) Educational level

☐ Grade 1-6

☐ Grade 7-9

☐ Grade 10-12

☐ University

☐ Master

☐ PhD

(8) Professional

☐ Students

☐ Teachers

☐ Industry

☐ Housman and housewife

☐ Politician

☐ Farmer

☐ Technician

☐ Others: ______________ (Please write down your job)

Part 2: Please present your ideas before starting your flood walk.

	Disagree strongly	Disagree	Disagree a little	No opinion	Agree a little	Agree	Agree strongly
I am aware of flood issues	☐	☐	☐	☐	☐	☐	☐
I have experienced flood problems in my life	☐	☐	☐	☐	☐	☐	☐
I think that learning about flood issues is important	☐	☐	☐	☐	☐	☐	☐

Part 3-pre: The following three questions are open-ended questions.

1. Which are the factors that cause flood problem?

2. What are the consequences of a flood?

3. What can we do to prevent flood problems?

Part 4: During flood walk	
1 ( )	We call it a flood if the water level is a) above the average water level b) much higher than normal c) overflowing land that is normally dry d) all options above is true e) don’t know
2 ( )	Which is the most common reason for flooding in River Klarälven? a) heavy rain b) snow melt c) ice thawing d) all options above is true e) don’t know
3 ( )	What kinds of water hindrances are conceivable in Klarälven? a) Stenbron (the old bridge) b) sand c) ice d) all options e) don’t know
4 ( )	What do we call critical infrastructure? a) Mitt i City shopping mall b) hospital c) sports arena d) all options above is true e) don’t know
5 ( )	How can future climate changes influence flooding problems in Karlstad? a) decreasing b) stable c) increasing d) don’t know

6 ( )	What methods can be used in urban planning to prevent impact from flooding? a) embankment b) construction restrictions c) floating platforms d) all options e) don't know

Part 3-post: After the flood walk

The following three questions are open-ended questions.

1. Which are the factors that cause flood problems?

2. What are the consequences of a flood?

3. What can we do to prevent flood problems?

Part 5: Please give your feedback about the flood walk activity.

Questions after the walk	Disagree strongly	Disagree	Disagree a little	No opinion	Agree a little	Agree	Agree strongly
1 This learning environment improved my ability to communicate with other people	☐	☐	☐	☐	☐	☐	☐
2 This learning environment helped me to understand the complexity of flood issues	☐	☐	☐	☐	☐	☐	☐
3 This learning environment added knowledge of preventing flooding for me	☐	☐	☐	☐	☐	☐	☐
4 This learning environment improved my awareness of flooding	☐	☐	☐	☐	☐	☐	☐
5 This learning environment helped me to understand flood issues in other places (e.g. Bangkok in 2011)	☐	☐	☐	☐	☐	☐	☐

6 This learning environment made me understand the connection of different sectors (e.g. transportation and hospitals) in society	☐	☐	☐	☐	☐	☐	☐
7 Sharing the experiences with other sectors (i.e. transportation and hospitals) was the most interesting part of this learning environment	☐	☐	☐	☐	☐	☐	☐
8 This learning environmentpromoted my learning interests and motivation to learn about flooding	☐	☐	☐	☐	☐	☐	☐
9 I would like to participate the same activity in the future	☐	☐	☐	☐	☐	☐	☐
10 I would like to explore flood-related knowledge by myself in the future after this learning activity	☐	☐	☐	☐	☐	☐	☐