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Designing a flood-risk education program in the Netherlands

Adwin Bosschaarta , Joop van der Scheeb , and Wilmad Kuiperc
a
Hogeschool van Amsterdam, University of Applied Sciences, Amsterdam, The Netherlands; b Utrecht University, Utrecht, The Netherlands; c Netherlands Institute of Curriculum Development, Enschede, The Netherlands

A B S T R A C T

This study focused on designing a flood-risk education program to enhance 15-year-old students' flood-risk perception. In the flood-risk educationprogram, learning processes were modeled in such a way that the arousal ofmoderate levels of fear should prompt experiential and analytical informationprocessing. In this way, understanding of flood risk in the surroundingsshould prompt students' threat and coping appraisal. To accomplish this, theprogram consisted of a variety of student-directed parts, such as seriousgames and flood simulations. The design of the program was based ontheoretical understandings from learning theory, information processing, andrisk communication. Furthermore, empirical findings about students' riskperceptions were incorporated. The design process was guided by theprinciples of Educational Design Research and had an iterative character.

KEYWORDS flood-risk perception; beliefchange; blended learning;information processing

Introduction

Worldwide, flooding is one of the main natural hazards that causes tremendous damage and a great many casualties. Due to climate change, it is expected that flood risks increase in low-lying coastal areasand flood plains (Maaskant, Jonkman, & Bouwer, 2009). This also applies to the Netherlands where25% of the country lies below sea level and about two-thirds would be flooded frequently without flooddefenses. The probability of flooding will increase due to sea level rise and increased river discharges(Bouwer & Vellinga, 2007; Pinter, van der Ploeg, Schweigert, & Hoefer, 2006). Besides the consequen ces of flooding, both loss of lives and economic damage will increase because of the population growthin the flood-prone areas (Maaskant et al., 2009; te Linde, Bubeck, Dekkers, de Moel, & Aerts, 2011).Although the Netherlands is well known for its low elevations and zealous efforts to protect thecountry against flooding, the Dutch population is hardly aware that flooding still is a threat that mustbe reckoned with (OECD, 2014). For many people flooding belongs to the past because they assume that authorities have done everything they can to protect the country, as if safety could be guaranteed.Although people in the Netherlands live in a country with dikes and barriers combined with an ageold flood history, flood risk is not salient at all; even thinking of flooding would not evoke fear.

This conception is deeply embedded in society and Heems and Kothuis (2012) call this “the myth of dryfeet.” Previous studies (Bosschaart, Kuiper, & van der Schee, 2015; Bosschaart, Kuiper, van der Schee,& Schoonenboom, 2013;) showed that this myth also applies to Dutch students. Within this frameworkeducation and communication about this risk is a challenging task.This study covers the role formal secondary education, i.e., geography education, can play in achieving or facilitating the goals of flood-risk communication in the Netherlands. Until now, the opportunities of formal education with respect to flood-risk communication are hardly acknowledged. It seems obvious that geography as a compulsory subject in the first three years of secondary educationin the Netherlands should play an important role on this topic.Therefore, this study aims at designing a flood-risk education program that contributes to raisingstudents’ flood-risk perceptions and their preparedness intentions. The main task of this program willbe to deconstruct “the myth of dry feet” (Heems & Kothuis, 2012). Lindell and Perry (2004) put thisinto 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. (p. 46)

Until now, risk communication as well as geography education with respect to flood risk paid attention to the Netherlands in general (Bosschaart et al., 2013). There are various reasons to adjust a floodrisk program on the regional situation. First, 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 arewell aware of flood risk in the Netherlands in general. The optimistic bias is applicable to flood risk perception concerning their own surroundings (Bosschaart et al., 2013). Therefore, the program to bedeveloped was adjusted to a particular location of schools in a flood-prone area in the Netherlands: West-Friesland, a region in the province of North-Holland. The program was designed with the characteristics of this region in mind and making use of information of the regional water board, theauthorities that are responsible for water safety.Because the design of a flood-risk education program is complex and challenging, we have based thedesign process on the principles of Educational Design Research (EDR). According to Plomp andNieveen (2009) systematic study of designing, developing, and evaluating an educational interventionis necessary in order to be successful.In the Netherlands various authors have dealt with environmental education in relation to sustainable development (Hesselink, van Kempen, & Wals, 2000; Kopnina, 2014).

As the focus of environmental education with respect to flood-risk perception differs from education concerning sustainable development, the work of these authors was not incorporated.

Method and aims

The main research question of this study is: What are the characteristics of a flood-risk education pro gram in the Netherlands that contributes to improving 15-year-old students' personal flood-risk percep tions and flood-preparedness intentions? In developing a flood-risk education program or product, we have reasoned from the key principles of Educational Design Research (Plomp & Nieveen, 2009; vanden Akker, Gravemeijer, McKenney, & Nieveen, 2006). This type of research can be characterized asinterventionist, iterative, involvement of practitioners, process-oriented, utility-oriented, and theory oriented. This means that next to the practical aim of an effective flood-risk education program, thisstudy focuses on finding valid design principles as the scientific yield of this type of research. Designprinciples are preliminary assumptions that represent the essential functions and characteristics of theprogram to be developed. These "substantive" principles are also called "heuristic statements" or"intervention theory" (Wademan, 2005).

Figure 1 shows the way the main research question has been elaborated into seven more specific research questions, as well as the iterative character of the design process. This article seeks to addressquestions 1–5; questions 6 and 7 will be addressed in a forthcoming article. During each stage the prod uct of the prior stage has been evaluated formatively on the basis of the specific research question. Dur ing focus group discussions seven geography teachers and four geography teacher educators evaluatedthe product. With respect to the research questions 3, 4, and 5, the participants gave their commentsindividually by using the format of a SWOT-analysis after which a group discussion took place. The

Stages of the design process			Participants	Research questions
Analysis	1	Previous studies +Theoretical principles	Discourse with water boards	1 What theoretical and empirical understandings are relevant in designing a flood-risk education program?
Design, development and formative evaluation	2	Global design (Design principles, curricular components)		
		▼	Evaluation by geography teachers (5) geography educationists (4)	2 What is the relevance of the tentative design principles? 3 What is the internal consistency of the curricular components?
		Adaptations		
	3	First draft of product (teaching and learning material)		
		▼	Evaluation by Geography teachers (7)	4 What are the expected practicality and the expected effectiveness of the program?
		Adaptations		
	4	Second draft of product (teaching material) ▼ Pilot in school		
		▼	Evaluation by Geography teachers (2)	5 What is the actual practicality of the program?
		Adaptations		
Summative evaluation	5	Definitive product (teaching and learning material)		
		▼ Intervention		
		▼	Results and evaluation by geography teachers (7)	6 What is the actual effectiveness of program? 7 What is the relevance of the design principles?
		Recommendations		

Figure 1. Overview of the design research process.

discussions were recorded, reported, and analyzed. The representative themes were listed. The partici pating geography teachers came from schools that are located in the area for which the flood-risk edu cation program was developed and from schools in flood-prone areas in the same province. Because of a tight schedule it was decided to limit the formative evaluation to teachers and educationists. The evaluation could have benefited from the inclusion of students' evaluations.

The first stage consisted of an analysis of theoretical understandings and empirical findings. This resulted in a set of tentative design principles and a global design of the program. The global design(appendix 1) consisted of a general description of the aims, pedagogy, and content of the flood-

risk education program and the role of teacher and students. The development of the flood-risk educationprogram took place during stages 2, 3, and 4. Stage 2 consisted of evaluating the global design. Thisresulted in adapting the design principles and pedagogical approach and elaborating the content of theprogram. During the third and fourth stages the flood-risk education program, consisting of teaching and learning material1 for use in the classroom, was evaluated and adapted. The fifth stage about the actual effectiveness of the program will be reported in a separate study.This study is part of a PhD study by the first author, which coincides with a nationwide program bythe Ministry of Infrastructure & Environment and the water boards to enhance flood-risk awareness.The authors as a team combine their expertise on design research (Wilmad Kuiper), pedagogicalresearch with respect to geography (Joop van der Schee) and teaching geography as well as physicalgeography (Adwin Bosschaart), which is necessary for this type of research.

Analysis

The main aim of the flood-risk education program is raising awareness and strengthening risk percep tion and preparedness intentions. Therefore, we based the design on empirical findings about the way Dutch students perceive flood risk as well as theoretical understandings concerning learning theory,information processing, and risk communication.

Students' perceptions and mental models with respect to flood risk in the Netherlands

Previous studies (Bosschaart et al., 2015; Bosschaart et al., 2013;) made clear that although Dutch students know there is a flood-risk in the Netherlands in general, they hardly apply this to their own situation. Stu dents' personal flood-risk perception is low and they hardly perceive fear when thinking about flood risk.Furthermore, students' trust in water safety is high and their level of knowledge about flooding in the surroundings is low. Regression analysis made clear that students' flood risk perception is influenced posi tively by fear and knowledge. Furthermore, it has been found that flood risk is not at all salient, evenwhen prompting students with images of dikes and rivers at familiar spots in the surroundings. Thismakes clear that elements related to the river and flood-protection are not associated with thoughts aboutflood risk, let alone flood-related feelings. Therefore, we may conclude that both the affect heuristic andthe availability heuristic, that function as "mental shortcuts" (Slovic, Finucane, Peters, & MacGregor,2004), are applicable to students' flood-risk perception in the Netherlands. This implies that intuitive feel ings and (the lack of) experienced events largely determine students' perceptions.

According to Bostrom, Fischhoff, and Morgan (1992) and McClure, Walkey, and Allen (1999) the extent to which mental models are sophisticated determines risk perceptions. Students' mental models

in two Dutch cities in flood-prone areas, turned out to be fragmentary and consisted mainly of factual or declarative knowledge (Bosschaart et al.,2015). Knowledge consisting of understandings about the where and why of flooding and its effects is lacking largely. Mental images of dikes and their locationare lacking in relation to height differences in the surroundings, which play an important role in understanding the inundation and inundation depths. This also applies to mental simulations of the pro cesses connected with dike bursts and flooding. Based on the aforementioned, it is not surprising thatstudents possess fundamental misconceptions with respect to flooding and its consequences and thatthe way they reason about flooding is based on analogies and heuristics. Because of a high degree ofignorance with respect to prevention and disaster response, students' trust in water safety can be char acterized as blind faith.

Learning theory

According to Illeris (2007) various learning theories emphasize different aspects of learning. Therefore, many learning theories are more or less one-sided. Illeris has tried to combine these existing theoriesinto his model of the "three dimensions of learning," consisting of the cognitive, emotional, and socialdimensions of learning. With respect to internal learning, Illeris distinguishes a cognitive and an emo tional dimension. Besides a psychological or internal process, social interaction is needed for learningto take place. Based on the work of Piaget and Kolb, Illeris (2007) distinguishes two learning processes:assimilation and accommodation. Assimilation is the type of learning whereby knowledge is added tothe existing mental schemes, and accommodation takes place when the existing schemes do not correspond to the presented knowledge. In the latter case, students need to reconstruct the existing schemes. Compared to assimilative learning, accommodative learning is more demanding and chal lenging and more mental energy is needed. Therefore, there is a tendency to avoid this type of learningunless people are convinced to do so. Accommodative learning is facilitated when teaching methodsare problem oriented and students can co-determine the direction of what is to take place and teachershave a more or less supportive role. According to Illeris (2007), cognitive and emotional processesintertwine, especially with respect to attitudes. Emotions affect interpretations and interpretationsprompt emotions. It is said that positive emotions intensify existing knowledge structures throughassimilative learning, whereas negative emotions prompt problem solving through accommodativelearning.

Knowledge construction takes place by building on existing knowledge; therefore, it is important for the teacher and the student to know to what extent the existing knowledge consists of misconceptions,otherwise, these misconceptions operate as a barrier to successful learning. The social dimension in Illeris' (2007) model builds on the ideas of Piaget and Vygotsky. Vygotsky has stated that

tions have a social-communicative origin and thinking is restructured when it is expressed into language. Because mental concepts arise in the dialogue between children and adults, but also among children, verbalizing plays an important role. In order to put Illeris' (2007) model into practice, weassume that learning should be blended.

Information processing

In social and cognitive psychology various dual process models are used to describe the way informa tion processing takes place (Smith & DeCoster, 2000). Under normal circumstances people process information heuristically or associatively by using simple rules of thumb and making quick evaluationsbased on spontaneous associations, experiences, and intuition. When the situation or the informationcauses more arousal and makes one feel threatened, the information will be processed systematically oranalytically. This mode of information processing can be characterized as deliberate, analytical, andeffortful, and will only take place when there is enough time and cognitive capacity.

According to the Elaboration Likelihood Model (Petty & Cacioppo, 1986) and the Heuristic-Sys tematic Information Processing Model (Chaiken, 1987) the chance that communication will lead to persuasion and enduring attitude change is enhanced when information is processed systematically.Motivation and the ability to comprehend are a prerequisite for this mode of information processingto take place. Heuristic processing would lead to bias and to not more than temporary attitude change.On the other hand, Smith and DeCoster (2000) make clear that there are also dual-process models thatstate that both modes of information processing are necessary in order to process the information successfully. Finucane, Peters, and Slovic (2003) described this as the "dance of affect and reason" andSlovic, Finucane, Peters, and MacGregor (2004, p. 314) add to this that "it is unlikely that we canemploy analytic thinking rationally without guidance of affect somewhere along the line." Accordingto Visschers and Meertens (2008) the first spontaneous reaction to a risk is affective and has to do withgut feeling and prior experience. Also Zajonc (1980) has emphasized the affective primacy, and thisinescapable affective reaction influences the nature of the continuation of information processing.Besides, Loewenstein, Weber, Hsee, and Welch (2001) made clear that affective response could also be the result of cognitive evaluations.

Risk communication

With respect to risk communication many authors have emphasized the importance of incorporating the two modes of information processing (Marx et al., 2007; Visschers & Meertens, 2008; Zaalberg,Midden, Meijnders, & McCalley, 2009). Possibly the most apparent advocates of this approach areSlovic and colleagues (2004).

In situations where people do not have experience with a hazard and the probability of the hazard is low, cues from the environment are mostly reassuring. Then, risk communication or risk education isthe only way to influence people's risk perceptions. The Protective Action Decision Model (PADM;Lindell & Perry, 2004) describes the way people decide about protective actions as a stepwise process.This process starts with the reception of, attention to, and comprehension of information. These socalled pre-decisional processes determine subsequently people's threat appraisal, their assessment ofthe personal relevance and the assessment of potential coping behavior. In order to design successfulrisk communication, Lindell and Perry have stressed the importance of taking into account all thesesubsequent steps.

When people are confronted with information that is contradictory to their existing knowledge, they often try to find a justification for their existing beliefs (Lindell & Perry, 2004). This is called theconfirmation bias. Furthermore, the intrusiveness of the information determines the way people areinclined to process the information and adapt their beliefs. Within this framework Lazarus (1988)made clear that when information processing has no connection with personal stakes, "knowledge iscold cognition (p. 282)."According to the Protection Motivation Theory (PMT; Rogers, 1983) the arousal of fear couldstimulate cognitive evaluation of the threat and the response. However, Ruiter, Abraham, andKok (2001) made clear that fear appeal could also have inhibiting effects on protection motivation. When the level of fear is too high, the cognitive response could lead to ignoring or denialof the threat. This type of response is called "emotion-focused coping". "Problem-focused cop ing," the strategy to reduce the physical threat or vulnerability, is the adaptive response whererisk communication is aiming for.

Various authors have emphasized the effect of previous experience with flood hazards on risk perception (Grothmann & Reusswig, 2006; Siegrist & Gutscher, 2006; Terpstra, Lindell, & Gutteling, 2009). In case people have no experience with a hazard because of the low frequency ofoccurrence, risk communication could focus on producing vicarious experiences through experimental manipulation. A traditional way is the use of fear-evoking images. In an experimentalstudy Terpstra et al., (2009) found modest results. Zaalberg et al. (2009) suggested the use of3D-technology in order to mimic a disaster experience that is experienced as "real." A high-endvirtual environment should not only produce bodily experiences but also emotional arousal. Inthe aforementioned, risk perception has been described as an internal construction. On the otherhand Joffe (2003) has emphasized that the formation of people's beliefs with respect to risks isguided by ideas and judgments that are predominant within related groups: "Explanations andjudgments are not constructed within individual minds but in the 'unceasing babble', the 'permanent dialogue' that people have with each other and with institutions." (Joffe, 2003;

p.68). Breakwell (2001) has called this the "subcultural base for any individual's mental model (p.344)." In Rohrmann's risk communication model (Rohrmann, 2000) the societal discourse plays an important role.

Outcomes of the design process

Underpinning of the flood-risk education program

In order to design a flood-risk education program that contributes to belief change with respect to flood-risk perception and preparedness intentions, it is necessary to consider the way peoplethink and judge regarding this topic as a stepwise process: (1) extending knowledge and understanding about flood risk; (2) raising awareness and strengthening personal flood-risk perception;and (3) influencing preparedness intentions (Figure 2). It must be emphasized that the cognitionsconcerning the first step differ from those with respect to step 2 and step 3. Whereas the firststep focuses on information processing that should lead to knowledge about the way things areand how they work, step 2 and 3 deal with the appraisal or evaluation of that knowledge in relation to personal well-being.

Figure 2 shows the sequence of steps as well as the obstacles that are applicable to that step. We assume that presenting information not automatically leads to knowledge and understanding.

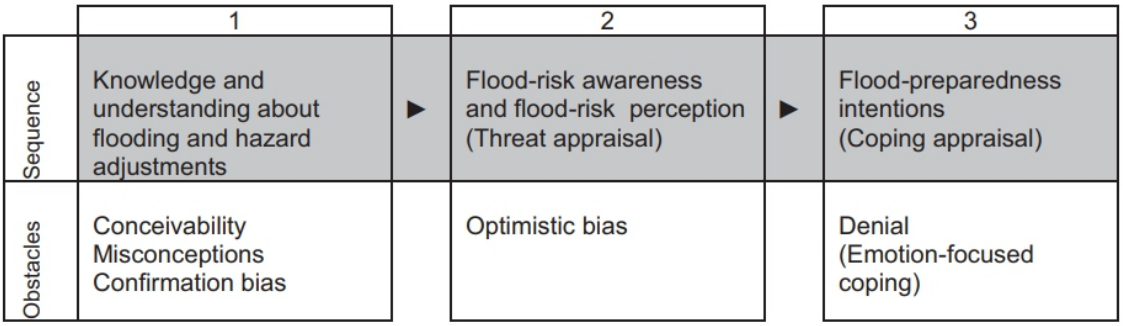

Figure 2. Thinking of flood-risk as stepwise process.

Furthermore, knowledge and understanding do not automatically lead to awareness and personal risk perception. Finally, risk perception does not automatically lead to preparedness intentions.In order to overcome these obstacles, we assume that a combination of both analytical and experiential information processing has to be initiated in such a way that both assimilative andaccommodative learning can take place. In the stepwise process, analytical and experiential information processing are intertwined and are a requisite for proceeding the sequence. This meansthat we assume that the conscious analysis of information (step 1) will be initiated by intrusiveinformation about flooding, like virtual dike breaches and flood simulations.

The analysis of intrusive information, which will enhance knowledge and understanding about flooding in thesurroundings, should in turn evoke affective reactions that motivate students to appraise thethreat of flooding and the coping possibilities. The challenge lies in selecting and presentinginformation in such a way that moderate levels of fear are evoked. It must be emphasized thatthe stepwise process is not necessarily linear. Following Lazarus and Smith (1988), we assumethat knowledge and appraisal, although different kinds of cognition, could function simultaneously.

In the course of the research process the design principles evolved and were sharpened. Initially, we thought that the essential functions and characteristics of the program could best be described with theprinciples motivation, systematic processing, and interaction with the surroundings. This stemmedfrom empirical understandings and the first reading of the literature. In hindsight, after evaluating thesubstantive part of the design process, we assume that the design principles are affect, availability, andblended learning. Affect can be described as feelings of "goodness" or "badness" that are tagged to mental images (Slovic et al., 2004). These feelings influence information processing and the perception ofrisk. Availability has to do with the salience, conceivability, and understanding of flood risk. Withrespect to blended learning we use a wide interpretation, which means a variety of pedagogical methods. Because learning that contributes to both knowledge and understanding as well as belief change isthe result of learning activities that should prompt the two modes of information processing, all threedimensions of learning (Illeris, 2007) should be dealt with (see also section "Description of the designprocess and the design principles").

Flood-risk education program

The flood-risk education program consists of teaching and learning material that is designed for 15-year-old students at pre-university education level (VWO) and senior general education level (HAVO).

Pedagogy

The pedagogical approach aims at evoking both experiential and analytical information processing. Therefore, a variety of learning activities or mental processes is needed that facilitates both types ofinformation processing (Figure 3). These learning activities are combined within the student-directedparts and reinforce each other. During the first four lessons, teacher-directed learning parts are alternated with student-directed parts. The last three lessons consist of inquiry-based group projects that

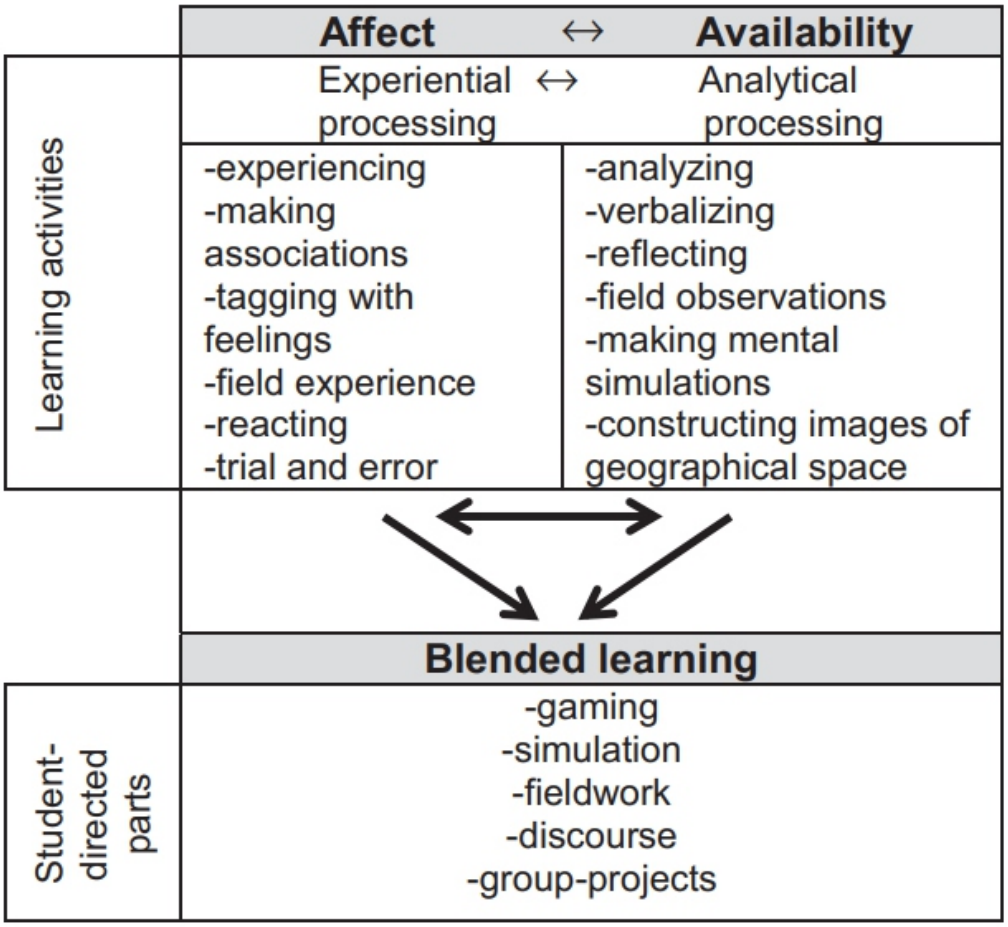

Figure 3. The design principles elaborated.

are largely student-directed. In the description of the student-directed parts it will be made clear how the various learning activities play a role in the successive parts.

Content

The content of the program has been adapted to the regional and local setting of the participating schools. The threat of flooding has been elaborated as a chain of successive events that take place priorto and during a flood (Figure 4: lesson 1,2,3):

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

We assume that understanding flood risk depends on different types of mental representations. First, mental representations of water levels and the land surface on both sides of the dike, as well asheight differences in geographic spaces that are too large to perceive at once, must be combined. Therefore, field observations combined with mental maps are necessary. Furthermore, imagining low probability events with higher water levels and stronger winds than usual is a requisite. Moreover, tagging

historical flood information to local situations around dikes is needed. Finally, dike failure mechanisms that are presented on a draft must be tagged to dikes in the surroundings in order to elicit mental simu lations of dike breaches. We suppose that virtual flood simulations tailored to the local situation as well as dike breaches in a 3D-setting may contribute to this understanding.

In order to prevent students from emotion-focused coping by emphasizing unilaterally the threats and effects of flooding, an important part of the content is related to hazard adjustments (Figure 4: lesson 4,5,6, and 7). These adjustments deal with measures concerning prevention, mitigation, and emergency preparedness, by the water boards and the inhabitants themselves. For the inhabitants it isnecessary to know what they can expect from the water board with respect to prevention and emergency measures in order to appraise their own coping response.

The learning outcomes of each lesson are presented in appendix 2. As the order of the lessons follow the chain of successive events prior and during a flood, each lesson builds on the previous lesson. Inaddition, the successive lessons are experienced as a whole through the overlap between the studentdirected parts. Figure 4 also shows how the stepwise process (Figure 2) and the two types of information processing (Figure 3) are incorporated in the successive lessons. The cyclic process of informationprocessing underlies the formation of knowledge and understanding as well as beliefs and intentions.

Flood-risk education program with respect to West-Friesland				Student directed parts	Teacher / student direction	Information processing (Figure 3)	Thinking as a stepwise process (Figure 2)
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	Experiential ↔ Analytical	Knowledge and understanding ↔ Awareness, perception and intentions
	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+S tudent		
	4	Water management in the province of North-Holland	Authorities (prevention, mitigation, disaster preparedness)	Fieldwork-assignment	Teacher+S tudent		
	5 6 7	Flood preparedness and mitigation measures in the surroundings	Self (prevention, mitigation, disaster preparedness)	Group project	Student		

Figure 4. Overview of the flood-risk education program.

Student-directed parts

Serious games and flood simulation. Serious games and interactive simulations offer the opportunity

to prompt both experiential and analytical information processing. Squire and Jenkins (2003, p. 8) made clear that "games are imaginary worlds, hypothetical spaces where players can test ideas andexperience their consequences." In this way games and simulations stimulate imagination and curiosity. But above all, the two modes of information processing are involved. According to Taatgen (1999)people can use two different learning strategies when playing a game. The experiential or search strategy is characterized by looking for cues in the digital environment, reacting on feedback and trial anderror. This will result in intuitive knowledge that people find difficult to verbalize. As soon as the searchstrategy fails, the reflective strategy will be used. This strategy is about analyzing, comprehending, andmemorizing consciously and takes more time and is much more demanding. Squire and Jenkins(2003) argued that learning occurs when the game or simulation is alternated with other activities. Furthermore, they state that challenging games urge people to discuss the strategies with others, which isan important aspect in reflecting on the learning itself.

3-D game levee. In the 3D-game Levee Patroller (Figure 4, lesson 1), students had to put themselves in the role of a levee patroller. In a virtual environment, students had to look for various types of weakspots in the dike during a period of high water. The weak spots had to be classified according to a listof dike failure mechanisms. In case they performed the task insufficiently, a virtual dike breachoccurred. Playing this game will increase students' involvement and makes dike failure conceivable.

2-D Flood simulation. Based on information of the regional water board, an interactive digital flood simulation that was useful for students (Figure 4, lesson 2) was developed by the first author. Theregional water board played an important role in making available the digital flood simulations. Theglobal design convinced them of the potential success of the use of the simulations. This simulationhad a regional map of the school surroundings as a starting point and enables students to create dikebreaches at various spots along the dikes in their own surroundings. Subsequently, the effects of theparticular dike breach (inundation area, inundation depth, casualties, and costs) are shown and students analyze the effects.

Societal discourse. By giving students the task to question their relatives and friends about flood risk perception and preparedness (Figure 4, lesson 3), we intended to create a situation in which they get

Figure 5. SWOT analyses in relation to research questions 3, 4, and 5

into conversation. In this way, students will be urged to verbalize and explain what they have experi enced already. Furthermore, in the conversation that arises students will have to react and reflect on the topic. This societal discourse is very important in the shaping of their opinion and beliefs.

Fieldwork. The fieldwork assignment (Figure 4, lesson 4) consists of closed-ended observations of a small part of a dike in the surroundings. By observing the dike and encouraging students to assess thestrength of the dike on site, we assume that students are in the position to tag elements such as dikes,ditches, and water levels with flood-related images and mental simulations, which they experiencedduring the lessons prior to the fieldwork. These associations between experiences, elements in the surroundings, and flood risk, should make it possible to pick up from memory flood-related and affectladen images more easily, thus making the information personally relevant and understandable.

Group-project. In contrast to the fieldwork assignment that has a closed style, the group projects are more open. The group-projects (Figure 4, lessons 5, 6 and 7) are problem-oriented around hazardadjustments by water boards and the people themselves. Students can choose different projects ofwhich the enquiry questions are fixed. The way students gather the information and make a presentation is more or less open-ended and the students are encouraged to describe their opinion and beliefsabout the various topics. In this way students are involved in the topic, which becomes more meaningful to them. In this group project students are urged to combine the topics of the previous lessons,therefore various learning activities such as making associations, reacting to each other, analyzing, verbalizing, and reflecting play an important role.

Description of the design process and the design principles

In this section we describe the way the authors used the iterations or stages to evaluate the design prin ciples as well as the manner in which the participants' evaluations of the intermediate products were used. In the course of the successive stages of the design process, the authors questioned which designprinciples best described the functions and characteristics of the flood-risk education program(research question 2). The first set of three design principles, motivation, systematic processing, interaction with the surroundings, originated from stage 1. During the stages 2, 3, and 4 the tentative designprinciples evolved and were sharpened. In hindsight, after an iterative process as described in the stages1 to 4, we conclude that a program that aims at changing flood-risk perceptions and preparednessintentions should start with intrusive information and extending knowledge and understanding. Byevoking both experiential and analytical information processing, the appraisal of the threat of floodingand the coping strategies will be initiated. This could lead to belief change. Therefore,

the functions and characteristics of the flood-risk education program could best be described with the design principles affect, availability, and blended learning, as described previously.

The design process consisted of five stages. During stages 2, 3, and 4, the design products of the pre ceding stage were evaluated by experts in a focus-group discussion. In this study the first four stages of the process are described starting from the research questions presented in Figure 1. The developmentof the global design and the first and second draft of the teaching and learning material took place during stages 1, 2, 3, and 4. Stage 2 focused on the soundness of the design ideas and coincides with thephase of "alpha testing" as described by McKenney and Reeves (2012). Stage 3 and 4 had to do withthe viability of the teaching and learning material. These stages coincide with the phase of "beta test ing" (McKenney & Reeves, 2012).The participants' comments are categorized in a SWOT-format as listed in Figure 5. The consis tency of the curricular components (research question 3), the variety of pedagogical methods, the prob lem-oriented character, and the 2D-simulation were judged positively. Suggestions were made about amore prominent role of affect and the more student-directed parts concerning coping strategies. Thiswas addressed in the first draft of the teaching material. The expected practicality and effectiveness ofthe teaching material (research question 4) were studied during stage 3. Core issues of geographyteachers' comments are listed in Figure 5. In general, geography teachers assessed the material as inspiring and stimulating because of the pedagogical variety, the use of a 3D-game and 2D-flood simulation, and the focus on the surroundings. Their main concerns had to do with the explicitness of the 2D-flood simulation, the possibility for students to reflect, and the feasibility with respect to required time. These comments were addressed in the second draft.

Stage 4 consisted of a pilot in school. Two geography teachers used the teaching material during their lessons with two groups of 15-year-old students at pre-university education level (VWO) and senior general secondary level (HAVO). The teachers found the material very useful (Figure 5). Theywere extremely enthusiastic about the 2D-flood simulation. The main problem concerned the instruc tion prior to the 2D-flood simulation and the time for reflection afterward. Futhermore, the motivationfor the fieldwork assignment was less than expected because of conflicts with obligations of otherschool subjects at the same time. This clarifies that coordinating with the school organization plays animportant role while carrying out such an intervention with pedagogical methods that substitute ashomework.

Conclusions

This study reports on the development and formative evaluation of a flood-risk education program in the Netherlands, based on an educational design research approach. The objective of this study lies in

describing both the design product and design process. Furthermore, this study aims for design princi ples, theoretical notions about the functions and characteristics of the program that evolves during thedesign process.The challenge of this study lies in designing a flood-risk education program that contributes to improving 15-year-old students' personal flood-risk perceptions and flood-preparedness intentions. Based onrisk communication research, we assume that students' thinking about flood risk should be modeled as astepwise process that consists of knowledge and understanding, awareness and perception, and preparedness intentions. In order to overcome various obstacles in this stepwise process, we have made use oflearning theory and understandings about information processing that proved to be complementary.Learning processes must be modeled in such a way that accommodative learning occurs. This can beachieved when learning activities consist of both experiential and analytical information processing.

In the flood-risk education program, students are confronted with intrusive flood-risk information about the local situation that should arouse moderate levels of fear. In this way, students are promptedto process flood-risk information analytically, without causing panic and emotion-focused coping. Byincorporating serious games, simulations, fieldwork, and discourse, students should experience different aspects of flood risk in the surroundings. This enables students to tag elements in surroundingswith flood-risk information and affect-laden imagery. By emphasizing both the threat of flooding andcoping measures, students should get a balanced picture of flood risk.During the development of the flood-risk education program that consists of teaching and learningmaterial, experts evaluated the intermediate products formatively. Consistency, practicality, andexpected effectiveness were evaluated successively. Although experts evaluated the alternation of pedagogical methods and flood-risk related topics positively, they were critical about achieving the affectivegoals; therefore, reflection assignments and group-projects were incorporated. Finally, the pilot showedthat geography teachers were convinced that exposing students to intrusive information, in combination with attention to coping strategies, could bring about belief change without causing panic.

In hindsight it can be mentioned that the regional water board as well as the Dutch Ministry of Infra structure and Environment were so pleased with the program that they sponsored an online version (www.overstromingsrisicoatlas.nl).In the course of the development of the flood-risk education program, the design principles affect,availability, and blended learning evolved. For the time being, we assume these principles are the maincharacteristics of this program that should contribute to realistic flood-risk perceptions as well as preparedness intentions. As soon as the intervention has taken place, it will be clear whether these principles will last.

Limitations

The main research question of this study is about determining the characteristics of a flood-risk education program that contributes to improving flood-risk perceptions of 15-year-old students in floodprone areas. Within this framework, we must take into account the limitations of this study. These limitations involve the character of this study and the position of the flood-risk education program in thegeography curriculum.First, the formative evaluation could have benefited from incorporating students' evaluations. Furthermore, as this study focuses on the design process of the flood-risk education program, a summativeevaluation of the program (phase 5 in Figure 2) is not part of this study. In order to judge the effectiveness of the program and finally answer the main research question, it is necessary to test the flood-riskeducation program experimentally in schools in the targeted area. This experiment, consisting of a pretest/posttest design, will be the only way to determine the effect of the flood-risk education program onbeliefs with respect to flood risk.

Both Harries (2008); Heems and Kothuis (2012) made clear that risk perceptions and attitudes toward preparedness are deeply embedded in more fundamental beliefs that are prevalent in society.Perceptions and attitudes should be influenced by notions about the man-nature relationship , themanipulability of the environment, and the distribution of responsibilities in society. In order tochange these fundamental notions, it might be possible that a flood-risk education program of sevenlessons would be too short. Possibly more fundamental changes in the geography curriculum of juniorsecondary education are necessary.

Note

1. This material consists of a course book with student assignments, a teacher's guide with power points, an online serious game, an online simulation program.

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ppendix A

Global designA

Global design, part 1 - Aims and pedagogy	
Rationale	**With respect to the topic:** Despite the fact that the government indicates that 100% safety cannot be provided with regard to flooding and it is imperative that people know what to do at the time of a flood, risk perception among students is low. **With respect to learning:** Knowledge construction takes place through personal and social processes whereby the existing cognitive structure and motivation play an important role. A variety of learning strategies is necessary. Students' own surroundings are central.
Aims and objectives **Learning outcomes**	-Students are able to mention what waters in their surroundings can be threatening. -Students are able to explain under what circumstances high water causes a threat. -Students are able to mention the dikes and dunes in their surroundings that contribute to their safety.

	-Students are able to explain what mechanisms cause the breakthrough in a dike or dune. -Students are able to explain how the spatial distribution of flooding water is influenced by height differences, the position of the (possible) breakthrough in the dike and the location of minor dikes. -Students are able to describe the height of flooding water in familiar places like their home and school. -Students are able to describe what the effects of a flood in their surroundings are on daily life of themselves and their relatives. -Students are able to describe what activities the water board undertakes in order to maintain and reinforce the dikes. -Students are able to mention what parts of the dikes and dunes in their surroundings do not meet the standards. -Students are able to mention the extent to which the authorities are able to support the inhabitants during a flood. -In case of a flood in their surroundings, students are able to argue whether they had better evacuate to another place or flee to the upper floor.
Student roles	-attending instruction lessons interspersed with making assignments -analyzing digital flood simulations -conducting fieldwork in their surroundings -entering into dialogue with the social environment -constructing and presenting a presentation
Teacher roles	-Instruction/ inspiring -tutoring -giving them free rein -assessing

Materials and resources	-Coursebook with assignments -Teacherguide and powerpoints -Digital flood simulations -The social environment (Parents, relatives, friends)
Grouping	-Individual and in groups
Location	-In the classroom -At home -In the field
Assessment	Test and report

Global design, part 2 - Succession of lessons	
Lesson 1	Introduction about flooding in the school surroundings
Lesson 2	Flood simulation and map analysis
Homework	Fieldwork concerning dikes in the surroundings
Lesson 3	Working out fieldwork: PowerPoint presentation with photos and maps
Lesson 4	Water management by the water boards: prevention, mitigation and disaster preparedness
Homework	Surveying family and friends
Lesson 5	Analysis and interpretation of survey results
Lesson 6	Presentations about survey results and group discussion

Appendix B

Flood-risk education program with respect to West-Friesland				**Learning outcomes**	
				Cognitive	**Affective**
Content per lesson	1	Dikes and dike breaches in the province of North-Holland and the region West-Friesland	Causes (high water+ dike failure mechanisms)	-Students are able to describe with what frequency flooding in their surroundings took place in the past. -Students are able to explain under what circumstances high water causes a threat. -Students are able to mention what waters in their surroundings can be threatening. -Students are able to relate landmarks in their surroundings to flooding in the past.	-Students experience how weaknesses in the dike are related to dike failure

				-Students are able to mention and explain dike failure mechanisms.	
	2 3	The effects of flooding in the province of North-Holland and the region West-Friesland	Effects (inundation area and depth + casualties + costs)	-Students are able to describe the height of flooding water in familiar places like their home and school. -Students are able to describe what the effects of a flood in their surroundings are on daily life of themselves and their relatives. -Students are able to explain how the spatial distribution of flooding water is influenced by height differences, the position of the breakthrough in the dike and the location of minor dikes.	-Students experience the effects of flooding in their surroundings. -Students believe that the consequences of flooding in their surroundings can be devastating. -Students experience and respond to the way their social environment thinks about flood risk.
	4	Water management in the province of North-Holland	Authorities (prevention, mitigation, disaster preparedness)	-Students are able to describe how the water board in their surroundings deals with flood prevention and water levels in polders. -Students are able to discern polder ditches and pumping stations in their surroundings. -Students are able to mention what parts of dikes and dunes in their surroundings do not meet the standards. -Students are able to describe the relation between the water level and the land surface with respect to their surroundings. -Students are able to mention the extent to which the authorities are able to support the inhabitants during a flood. -In case of a flood in their surroundings, students are able to argue whether they had better evacuate to another place or flee to the upper floor.	-Students perceive and experience a dike in relation to height differences between the water level and the land surface. -Students are convinced of the limited role authorities can play during a flood and hence of the importance of preparedness.
	5 6 7	Flood preparedness and mitigation measures in the surroundings	Self (prevention, mitigation, disaster preparedness)	-Students are able to search for and analyze information with respect to flood prevention, mitigation and preparedness -Students are able to evaluate information in order to use it in a presentation.	-Students are able to cooperate on a flood related topic. -Students are able to create a presentation which persuades others of the necessity to pay attention to flood preparedness. -Students believe self efficacy in case of a flood is necessary in order to enlarge the chance of survival.

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Exploring youth eco-literacy through lived experiences. 'When you purchase a pair of jeans, you bear the burden of child labor

Turkan Firinci Orman
alto University, Espoo, Finland

A B S T R A C T

This study explores youth eco-literacy and its role in addressing the climate crisis, consumption, and socio-political challenges. Eco-literacy involves environmental understanding, skills, and critical perspectives, enabling active engagement and informed decision-making. Through geo-social lenses, I examine how Turkish youth participate politically, both online and offline, in climate change and con sumerism dialogues, considering local, global, and planetary perspectives. The analysis focuses on young people's interpretive agency, creatively expressing environmental ideologies and shaping values with a political stance characterized by reflexivity, agency, and commitment to daily activism and eco-friendly life styles. Qualitative data collection included discussions on daily environmental practices and essays on environmental citizenship, covering eco-literacy sources, responsible actors, and ecological awareness strategies. Findings illustrate how young participants address opportunities and disparities, utilizing the research environment for collective learning and action. The study further investigates young people's showcase of their eco-literacies and advocacy for a public (eco) pedagogy beyond traditional education.

KEYWORDS eco-literacy; climate change; consumption; political participation; public (eco) pedagogy

Introduction

The youth in contemporary society face disparate consequences stemming from ecological challenges, such as climate change and biodiversity loss (see Díaz et al., 2019; IPCC, 2021). These impacts can be attributed to the escalating influence of consumer capitalism and associated destructive actions (Marques, 2020). Furthermore, the growing prevalence of digital media and popular culture often relegates traditional education to a secondary role (McNeill & Engelke, 2014; Mustola et al., 2018), thereby rendering many children passive observers and victims of an ecologically unstable era (Firinci Orman, 2022a). Acknowledging that these transformations affect young individuals disparately, contingent upon their distinctive social and geographic contexts is essential.

In response to these dynamic developments, the concept of eco-literacy has emerged as a central construct among the younger generation within the domain of environmental education. Coined by Capra (1997), eco-literacy fundamentally involves comprehending the organizational principles of eco

systems and responsibly applying these principles to foster sustainable human communities and societies. An eco-literate individual not only possesses a comprehensive understanding of the world but also actively engages in environmental endeavors, striving to make substantial contributions to sustainable societies through the application of intellectual, emotional, and practical efforts (McBride et al., 2013). Furthermore, an ecologically competent society is typically self-sustaining and seeks to minimize interference with the natural environment upon which it relies (Häggström & Schmidt, 2020).

The literature underlines the great importance of eco-literacy by drawing insights from diverse scholarly perspectives, including ecocriticism, environmental education, critical environmental literacies, and global education approaches, all aimed at promoting environmental awareness (Deetjen & Ludwig, 2021). Scholarly research has explored various facets, such as place-based approaches (Häggström & Schmidt, 2020), eco-feminist and new materialist perspectives (Gough & Whitehouse, 2018), global environmental concerns (Thomashow, 2003), texts influenced by postcolonial viewpoints and nonliterary eco-media (Beach et al., 2017), and critical environmental literacies that delve into deconstructing environmental oppression and advocating sustainability (Misiaszek, 2018).Moreover, environmental education (EE) assumes a pivotal role in this context, with the Belgrade Charter and the Tbilisi Declaration prominently establishing ‘environmental literacy’ as a central objective (McBride et al., 2013).

Education for Sustainable Development (ESD) has likewise emerged as a significant force, exemplified by the United Nations initiatives, including the Decade of Education for Sustainable Development (UNESCO, n.d.) and the 2030 Agenda for Sustainable Development (UN, n.d.) where the Sustainable Development Goals (SDGs) were adopted by all United Nations Member States in 2015 (UNDP, n.d.). Furthermore, global education and global citizenship education have fostered opportunities to incorporate eco-literacy into the educational framework, cultivating awareness of environmental issues and instilling a commitment to sustainable behavior among students (Gough, 2018; Misiaszek, 2016).While the literature on eco-literacy has made these significant strides in debating its implications for education and in providing a solid foundation for environmental awareness and stewardship within educational paradigms, there exists a noticeable gap in research focusing on how everyday encounters influence the eco-literacy of young people and how young people enact their (environmental) literacies. Despite the significance of the school environment and educational settings (Levy & Zint, 2013), comprehending the intricate interplay between ecological knowledge and the diverse geo-social contexts in which individuals and communities exist is equally essential.

As Rousell and Cutter-Mackenzie-Knowles (2020) emphasized, there is a need for more participatory research that empowers children and young people to address the multifaceted implications of climate change within their respective communities and environments. Trott (2021) highlights youth activism as revealing adult shortcomings in and out of classrooms, advocating for a transformative approach that assesses both the actions and their impact, suggesting children's active participation and imaginative thinking.

The literature shows the importance of cultivating eco-literacy in both citizens and governance, placing particular significance on place-based knowledge, and understanding (Capra & Stone, 2010; Greenwood, 2008; Louv, 2005; Orr, 1992). Additional studies point to the importance of youth political participation in shaping environmental identities, as well as examining the lived and performative aspects of youth environmental citizenship and everyday activism building on Isin's (2008) relational citizenship theory (see Firinci Orman, 2022a, 2022b, 2023, Firinci Orman & Demiral, 2023; Kallio et al., 2020; Lister et al. 2003; Wood, 2010). This in turn connects with the public pedagogy as concerned with forms of education and learning occurring outside formal educational institutions. As such, public pedagogy is associated with citizenship and democracy, along with other dimensions such as popular culture's role in everyday learning, public spaces' educative potential, neoliberalism's impact as 'permanent education,' and learning opportunities within social movement activism. It could be perceived as a process of experiential learning (Sandlin et al., 2011). King (2022) proposes that public pedagogy, aligning with Sandlin's definition, can adopt a goal-driven trajectory, emphasizing participation, resistance, and creation. It fosters fluid and messy learning situations, often through public artifacts, spaces, and discourse, to redirect public experiences toward learning.

Eco-literacy represents a paradigm shift toward holistic, systemic, and sustainable environmental solutions (Simon, 2006). Despite differing philosophical, psychological, and political foundations, ecoliteracy often aligns with innovative approaches to environmental education (EE) and education for sustainable development (ESD), emphasizing experiential learning methods (e.g., Dunkley, 2016) such as outdoor education and hands-on experiments. These approaches prioritize critical thinking skills through methods such as role-playing, case studies, and problem-based learning to address environmental challenges (e.g., Gordon & Thomas, 2018). Moreover, they promote action and civic engagement, as seen in practices like Participatory Action Research (PAR), Community-Based Education (CBE), and/or Environmental Action (e.g., Bellino, 2016; Goldman et al., 2017; Iyengar & Shin, 2022).

Consequently, it is imperative to conduct a more comprehensive exploration of the lived worlds of young people to observe their eco-literacy. This understanding can inform contextually relevant environmental education strategies, particularly within the field of eco-pedagogy and other critical educational approaches. In this regard, the present study investigates how young people engage in political discourse, both online and offline, concerning climate change and consumerism, considering both local, global, and planetary perspectives. The study aims to contribute to the evolving body of literature on eco-literacy by highlighting that its impact extends beyond the classroom, enabling it to address realworld challenges within distinctive geographical and social contexts, particularly in Turkey.The current study revisited and expanded upon data collected as part of a previous multi-site project on environmental citizenship involving young individuals from urban and rural areas of Turkey, examining their consumer practices and climate change actions. The study explored geo-social factors such as young people's social networks, spatial attachments, the politicization of issues, and personal worldviews (see Kallio, 2018, 2020), and particularly shed light on the performativity of young people's everyday activism (Firinci Orman, 2022a). This exploration unveiled intersectional aspects of young people's socio-spatial environmental socialization, contributing to the understanding of the inequalities they face in terms of political and economic oppression that the country has experienced (Firinci Orman & Demiral, 2023). The previous study also showcased how young individuals manifest their environmental identities through seemingly mundane everyday actions that empower them (see Firinci Orman, 2023).

While Turkey has recently introduced an elective course on 'environmental education and climate change' (MEB, 2022), and there is extensive literature on the subject (Yıldız et al., 2021), existing studies primarily focus on the environmental aspect of education for sustainability, often adhering to traditional perspectives. These studies tend to overlook the socio-cultural dimension and neglect issues such as youth participation or environmental action. Recent research in environmental education has mainly emphasized attitudes, literacy, and teaching methods to promote environmentally responsible behaviors. However, applied environmental education and ecological identity development receive less attention (Arslan & Hamzaoğlu, 2023). Despite growing interest in innovative pedagogical approaches and critical perspectives (e.g., Saribas et al., 2023), their integration into school curricula remains limited in Turkey (Çakır Yıldırım et al., 2023). Additionally, youth political participation is severely limited by an authoritarian shift, confining their expression to public spheres (Bee, 2021). These circumstances show the need for further exploration of youthful perspectives on the climate crisis and the examination of their (eco) critical agency. Consequently, this article does not dwell on non-critical stances that young participants may exhibit but strategically emphasizes critical young individuals and their insights.

In the first section of this article, I provide a concise review of the limited literature on the relational and lived aspects of eco-literacy and discuss how these dimensions are interconnected with eco-pedagogy. Subsequently, the article delves into methodological considerations, including the general characteristics of the participants, insights into the educational materials employed, the empirical stages of the study, data analysis procedures, and the ethical principles that guided the research. Following this, the results of the study are presented, focusing on how participants with eco-literacy skills establish direct connections between causes and effects, such as the relationship between consumerist culture and climate change. This analysis also explores the intricate dimensions of the everyday actions of young individuals and how these actions intersect with local and global scales of criticality, which young people manifest through their daily performances and decision-making processes. Finally, the demand for a public pedagogy is discussed by examining youthful narrations.

Eco-pedagogy and eco-literacy through lived experiences

Eco-pedagogy, rooted in critical theories and inspired by the pedagogies of Paulo Freire, is a multifaceted approach to literacy education that goes beyond traditional frameworks. As Misiaszek and Iftekhar (2022) elucidate, eco-pedagogy aims to cultivate a deep understanding of the connections between human acts of environmental violence and social violence, emphasizing the intersections between ecological and social justice. As such, eco-pedagogy helps reveal socio-environmental connections for a deeper understanding, empowering citizens to take environmental action through critical reflection (Misiaszek, 2016).Eco-pedagogy involves critical thinking and transformability, seeking to unravel the layers of hidden oppressions that contribute to planetary unsustainability. It urges educators to teach the social aspects of environmental issues, encompassing local to global perspectives and embracing insights from various disciplines (Misiaszek, 2020a, 2020b). Blanc's concept of 'collective environmentalism' further reinforces the idea that eco-pedagogy involves collective action and democracy, transforming learners into active agents in the pursuit of social–ecological transition (Blanc, 2019).

Eco-literacy, part of eco-pedagogy, goes beyond traditional environmental education by focusing on broader ecological systems and emphasizing place-based learning, contrasting with the narrower scope of traditional environmental education. As discussed by Misiaszek (2022), eco-pedagogues play a pivotal role in widening citizenships from local to planetary spheres, encouraging individuals to recognize their interconnectedness with the Earth and promoting a culture of sustainability. The concept of planetary citizenship, introduced by Gadotti (2008), emphasized a new perception of the Earth as a single community, highlighting the need for a paradigm shift in education. Eco-pedagogy, as

a critical form of environmental pedagogy, aligns with the goals of global citizenship education, focusing on transformative action to address historical socio-environmental oppressions (Misiaszek, 2018). The geo-social aspects of eco-literacy, therefore, involve understanding the complex interplay between spatial and temporal elements within unique socio-ecological contexts, promoting a holistic and transformative approach to environmental education (Dunkley, 2018; van Herten & Perez, 2022). For example, Dunkley (2018) delves into the field of eco-pedagogy, focusing on its spatial and temporal dimensions, stressing the importance of space-time-aware learning experiences in fostering nature-culture inter-relativity. Dunkley's study shows that irrespective of specific spatial contexts, these encounters play a central role in the development of eco-pedagogy and eco-literacy.

Hence, this paper investigates the impacts of the environments in which eco-pedagogy occurs. It specifically delves into the spatial and socio-political aspects of both formal and informal environmental (learning) experiences of young people that can be regarded as eco-pedagogic. As such, I examine young people's interpretive agency (see Firinci Orman, 2022a, 2023), which creatively reinterprets environmental ideologies, allowing young people to shape their own meanings and values. This political approach is marked by reflexivity, agency, and a readiness to participate in daily activism and embrace eco-friendly lifestyles.I build on the concept of lived citizenship (Kallio et al., 2020), which received growing recognition as a generative approach, emphasizing the embodied, relational, and everyday experiences of being a citizen. Pointing to Noel Gough's work (2008, 2016), which demonstrates how places become pedagogical, I ground the study on young people's lived citizenship to comprehend their experiential lives and critical knowledge. As Pitman and Daniels (2020) showed, including education, there are other pathways toward eco-literacy such as the relationship with place, spending time in nature, valuing the natural world, and participation in activities.

Within this context, eco-pedagogy and eco-literacy could encompass various critical pedagogies. The literature includes, for example, place-based education (Nichols et al., 2016; Schild, 2016; Yemini et al., 2023) which emphasizes local environments and instills a sense of responsibility for the places learners inhabit. While some other studies focus on the significant life experiences that connect children with nature (e.g., D'Amore & Chawla, 2018) other studies stress the outcomes and impacts of place-based education programs (e.g., Powers, 2004).

Additionally, climate change education can focus on the global impact of climate issues (Monroe et al., 2019) on diverse communities. Furthermore, global citizenship education may highlight the interconnectedness of environmental issues across borders (see Goren & Yemini, 2017; Hinderliter Ortloff, 2011). In the current study, all of these approaches are regarded as critical geographies,

contributing to environmental awareness and eco-literacy. They provide a deeper understanding of the spatial dimensions of environmental issues, fostering a heightened environmental consciousness.

Research design and methodology

While studying the eco-literacy of young people, it is important to include the youth who are not usually represented in the research contexts. The scholarship on youth climate activism has mainly focused on the wealthy Global North, particularly in affluent urban contexts (Farrugia & Ravn, 2022; Neas et al.,2022), neglecting the experiences of millions of young people not actively engaged in public climate activism (Firinci Orman, 2022a). This study investigated Turkish youth who do not engage with climate activism publicly but who express their interest in climate change issues, and who live in urban and/or underrepresented rural areas. Utilizing a geo-social methodology, the research uncovers young people's lived experiences as consumers and (environmental) citizens. It examines their social and spatial engagements and the political as contextually significant matters in their lives (see Kallio, 2018, 2020), revealing situated truths from their perspectives through spatially embedded narratives on everyday consumerism and climate change actions (see Firinci Orman, 2023).

Drawing upon interdisciplinary perspectives from geography, sociology, environmental studies, and related fields, the geo-social methodology engages with relational ontological orientation, thus enriching existing qualitative approaches (see Creswell, 2013). It discerns the intricate interplay between social dynamics and spatial configurations, prioritizing the understanding of subjective experiences and meanings within specific socio-spatial contexts. Furthermore, it reconceptualizes socialization by integrating intersubjective, spatial, and political dimensions. These dimensions, as delineated by scholars such as Elwood & Mitchell (2012), Kallio (2018), Joronen (2016), and others, serve as analytical layers within the framework of the geo-social methodology.

General characteristics of the participants

With a pragmatic approach to sampling, the researcher included 21 young people aged 13–17 from diverse regions in Turkey, leveraging teachers' networks and municipal child rights projects to reach participants. The sampling reflects varied social positions related to gender, ethnicity, religion, and class, as subjectivities were studied. Seven participants self-identified as male, while others identified as female. Three participants had different ethnic backgrounds (Kurdish, Armenian, Arab), and one had a significantly different religious orientation (Christian), while only three came from lower-income families, with the majority representing various segments of middle-class families. None of the young

participants were involved in public environmental activism or youth movements, but the vast majority had prior experiences with institutional participation through school and municipal projects on climate change; except for two participants. This is also linked to their willingness to participate in the study voluntarily. All participants had past mobility experiences, ranging from relocating to different neighborhoods or moving to larger cities, including cases of reverse migration or external immigration.

Materials and methods

Data collection occurred digitally through online mapping activities, followed by online in-depth inter views and essay writing sessions, conducted sequentially with each individual to collect data.

Mapping activity

The fieldwork commenced with an online mapping exercise (see Kallio, 2020, 2021) conducted digitally on a Padlet1 map. This collaborative platform enabled interaction and accommodated both synchronous and asynchronous participation, enhancing accessibility and flexibility. Participants designated significant places, ranging from specific spaces to neighborhoods, cities, countries, and regions, reflecting on their climaterelated experiences. The mapping exercise, where participants attributed colors to represent their affectual reflections, served as a semipublic space fostering the sharing of experiences and perspectives (see Figure 1).In line with Kallio's (2021) suggestion, this topological mapping involved tracing individuals' lived experiences through spatial narratives, grounded in a threefold conceptual foundation. This foundation considers subjectivity as a human capacity, views spatial attachments as a relational context for living, and understands the political aspect as matters of importance subjectively experienced and socially shared within a contextual framework. Through this collective activity, participants had the opportunity to learn from each other's lived experiences and share their personal worldviews on consumerism and climate change actions.

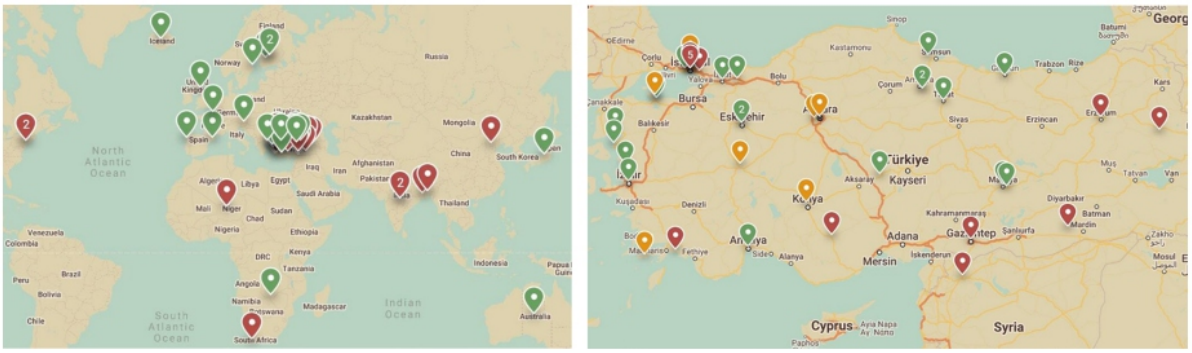

Figure 1. Collective Padlet mapping activity where participants pinned their notes of lived experiences on different scales.

In-depth interviews

In-depth, semi-structured online interviews followed the mapping exercise, encompassing topics such as lived experiences, everyday life, consumption habits, and actions related to climate change in the context of eco-literacy. Previous notes on the map, including attained colors of affectual expression and spatial information, were used to open up and deepen the conversation on lived experiences during the interviews. Guided by the geo-social methodology, these interviews aimed to collect and analyze data on the social, spatial, and political aspects of participants' experiences, with a focus on everyday consumer practices and climate change mitigation efforts. Questions were designed to uncover the situational nature of their lived realities, exploring social interactions with friends, family, pets, and nature, as well as experiences of places and mobility. The interviews emphasized the significance of politicization in participants' lives. All interviews were recorded, transcribed, and thoroughly analyzed to understand the interconnectedness within young people's relational worlds based on their experi ential knowledge.

Essay writing

The essay writing task with the theme of "Me as an environmental citizen and consumer" followed the interviews where participants actively questioned their views and actions on climate change examining their consumption practices this time in writing. Participants were instructed that the essays could be as short as a paragraph, with no maximum length limit. Essays, representing the latest stage of individual data collection, also functioned as self-evaluation and reflection tools following the experience of taking part in the research project and increased self-awareness.

Data analysis procedures

The data collected for the project were revisited under the current study to observe young participants' critical viewpoints and evaluate the geo-social aspects of their eco-literacies through integrated individual reports for each participant, where all data types were triangulated and interpreted to study their environmental socialization. The individual reports involved analytical layers of the geo-social methodology, building on a threefold conceptual baseline: social relatedness, spatial relationality, and experience-based politics (Kallio, 2020). Additionally, performative aspects of youth environmental citizenship (see Firinci Orman, 2022a) served to examine various lived experiences in the context of mundane consumer practices and climate change actions, considering different political participation modes of young people (see Firinci Orman, 2023).

Three themes (identified by hand only, due to the small sampling size) were recognized as generating the results in the context of eco-pedagogy and place-based learning: critical thinking as establishing direct connections between causes themes and effects; insights into local to global perspectives on environmental issues; and understanding socio-environmental connections as actionable aspects for deeper comprehension through critical reflection. Hence, the study strategically revisited the individual reports and triangulated data to examine shared significant aspects of eco-literate viewpoints among participants who demonstrated youthful critical perspectives on climate change and consumerism through expressing their lived experiences.

Ethical principles guiding the research

Ethical considerations were carefully followed throughout the project. Participants and parents were informed about the study's purpose and procedures, providing written consent. The researchers assured participants of their right to withdraw at any stage without negative consequences. Principles of confidentiality and anonymity were maintained, using pseudonyms, and omitting identifying details. The research design promoted collaboration and individual expression, fostering digital social interaction and environmental socialization among participants in a semipublic space. The ethical aspects of the research were addressed throughout the project to ensure the well-being and rights of the participants.

Study results

In this section, the study's findings are showcased, with a particular emphasis on individuals possessing eco-literacy skills who establish explicit links between causes and effects. This includes delving into the relationship between consumerist culture and climate change. The analysis extends to examining the nuanced aspects of daily actions among young individuals, illustrating how these actions intersect with both local and global dimensions of criticality. Young people expressed their critical awareness through daily performances and decision-making processes. Additionally, the study unveiled the participants' advocacy for public eco-pedagogy, indicating a call for educational interventions to combat climate change, as most participants also expressed concern and distress about their uncertain futures. The presentation of results followed a simple logic of compare and contrast by delving into the triangulated data reflecting subjectivities as depicted earlier, reporting on the shared critical and youthful worldviews of the participants, demonstrating eco-literate viewpoints through analysis.

Eco-Literacy at the nexus of youth consumerism and climate change

Climate crisis activism by children challenges mainstream lifestyles, envisioning a more sustainable good life (Nissen et al., 2021). Young people adopt eco-friendly consumption patterns to address global ethical concerns, believing that reversing environmental degradation hinges on embracing new lifestyles, particularly in modernized sectors (Firinci Orman, 2022a; Kyroglou & Henn, 2022).

Nevertheless, some studies show that young people may be inconsistent in their thinking about the relationship between consumer behavior and its consequences on nature (see Autio & Heinonen, 2004). In this context, I present examples of how the connection between consumer actions and climate change awareness is closely linked to their situated and embodied everyday activism, demonstrating their eco literate worldviews.

For example, Ekrem (15) from the countryside of central Turkey discusses in his essay that his con sumer actions could cause serious damage to the planet. Despite being small, he feels empowered to share the same values with people around him

I've minimized my meat consumption, even though vegan products are limited in the stores of our city. I also try to encourage my friends to do the same. The idea that even one person can cause significant change pushed me to do this. Neither I nor the people around me use deodorant, and perhaps these seemingly small changes are leaving a priceless positive impact behind when viewed from the outside.

Typically, numerous young people reduce their consumption for the sake of sustainability (Ziesemer et al., 2021). However, the literature suggests mixed views on young people as potential sustainable anti-consumers. They utilize tools from consumer society to shape identities, challenging traditional values, while also raising awareness about the drawbacks of mass consumption . In his own words, Ekrem shares the following during the interview:

I do buy second-hand clothes online, but the options are quite limited. After watching videos about how fast fashion is destroying our planet and lives, it really scared me. I didn't think it was right for so much harm to come from the things we wear. At least from my perspective, it's not ethical

In green consumption, individuals actively learn about eco-friendly practices to distinguish themselves from mainstream consumers. This learning phase, driven by a desire for environmental knowledge, involves utilizing information technology, especially mobile applications, for constant access to

pertinent information (Perera et al., 2018). Another example is Selim (17), who comes from a coastal small town in the Marmara Region of Turkey. During the interview, he shared that he reads about veganism and has learned a lot from relevant websites:

It's not very common in Turkey, but I'm trying to accustom myself to plant milk for example, which I've read a lot about. I really try to pay attention to how mass milk production is harmful to the environment, and how it is harmful to our body.

Similarly, Beyza (15), from Istanbul, reflects in her essay on how she better realized that her consump tion choices could unintentionally contribute to the climate crisis, thanks to her participation in the current research project.

For instance, I've been considering the impact of food choices on the climate crisis and the broader issue of consumption. Realizing that I need to delve deeper into this topic and be more attentive, I've decided to conduct additional research.

Eco-literate practices involve considering factors like animal welfare and ethical production in indi vidual consumption choices, all aiming to use personal consumption behavior to impact collective responses to public issues. Pelin (15), being one of these participants from the capital city Ankara, finds a direct connection between consumerism and climate change. She even complains about the available options for buying vegan products during the interview:

In the climate crisis, even small actions can significantly impact the environment. Take Zuber's vegan products—they offer sugar-free options but package them in plastic. Choosing it for health reasons inadvertently harms the environment since recycled plastic still affects nature. Makes me wonder, can't there be a better packaging alternative?

Pelin, while expressing concerns about the economic crisis and high prices, emphasizes that her decision-making is guided by an assessment of the environmental impact. She chooses to consume products that have the least harm on the environment: "I also find it more sensible to buy local products so that we can contribute, even if only a little, to our own economy".

Undoubtedly, participants who recognize the interconnection of consumer decisions with environ mental crises showcase an eco-literate consciousness, as illustrated by Emine (17) from the city of Izmit in Northwest Turkey in her essay:

Environmental issues, linked to consumption, concern me. Despite efforts like recycling, some neglect environ mental care. The pressing climate crisis, seen in changing seasons and polar melting, is worsened by human activities. Notably, forest fires persist in our country, fueled by waste problems and intensified by climate change.

The level of concern and approach that consumers adopt regarding environmental protection is rooted in eco-literacy and/or awareness of environmental issues. Studies support these findings, indicating that consumers' understanding of the environment is a fundamental requirement for shaping their attitude toward it (Kharbanda & Singh, 2022).

The critique of the intersection of consumerism and climate change reflects the critical reasoning and responsible decision-making practiced by young people in their everyday environments. This connection also aligns with the impact of neoliberalism and the consumerist culture to which youth is exposed, serving as a form of permanent (public) education.

Everyday activism and critical perspectives at local, global and planetary scales

The strength of the relationship between individuals and their surroundings has been demonstrated to significantly influence the extent of ecological knowledge and comprehension (see Pitman & Daniels, 2020). This, in turn, relates to the experiential knowledge of young people and their lived citizenship.Young people's local environmental experiences matter (Börner et al., 2021) and encompass material, social, and political aspects. This is evident, for example, in the case of local hazards such as disaster experiences. Two-thirds of participants found it easier to relate to local environmental experiences, especially in discussions about climate change. Their awareness was shaped by lived experiences and subjective perspectives, influenced by spatial factors such as travel and mobility, and the socio-political environment (Firinci Orman & Demiral, 2023).

For instance, participants from the Marmara Sea region mentioned the mucilage phenomenon, an environmental disaster affecting the ecosystem and marine life, worsened by the increase in pollution and water temperatures in the Sea. Two-thirds of participants also discussed high summer temperatures and wildfires in the southwestern part of the country, three of them sharing personal lived stories. The findings also demonstrated how socio-spatial and political socialization is influenced by young partici pants' everyday environment (see Firinci Orman & Demiral, 2023; Kallio, 2018), enabling them to embody their environmental identities.

Participants with critical viewpoints toward consumerism and climate change showcased their ecoliteracy perspectives through local, global, and planetary scales of environmental awareness and sensitivity. Dilara (15), for example, marks her hometown Bandirma in yellow color on the map, underscoring her love for the local environment and her neutral feeling, despite the dirty seaside and beaches. Sharing her experiences during the interview, she mentions:

Last year, mucilage was a widespread issue in the Marmara Sea. We tackled the problem through school-led garbage collection projects. While the beaches are stunning, especially in summer, they often end up littered. Unfortunately, nobody seems to care.

A young participant from the capital city, Pelin (15), who is conscientious about water conservation, restricting her water consumption, and making environmentally conscious choices such as avoiding new denim purchases, and opting for secondhand items when necessary, discussed the wildfires that occurred in the last two years which through "many living beings, especially trees, were severely affected" and calls everyone to be more cautious in hot summer days. She also reflects her planetary sensitivity:

Besides, there's the side of other creatures in this environment, like animals. I'm big on animal rights and believe many animals can be better pals than humans. It's not just cats and dogs; even simple ones like bees play a crucial role. Most people don't realize the immense impact bees have, and they're probably unaware of the consequences if bees go extinct.

In the mapping activity, Istanbul was distinctly marked in red, signifying negative feelings, as Pelin notes the following:

But there's a point that everyone seems to overlook, which is environmental issues. I can list many reasons, such as the mucilage caused by marine debris, excessive exhaust, and gases contributing to air pollution, numerous buildings, and sporadic unplanned urbanization.

Pelin discusses the issue of water pollution and depletion also on a global scale, using Cape Town highlighted in red on the map as an example: "The decrease or even depletion of water is a clear problem not only in Cape Town but worldwide."

Emine (17), coming from a big industrial city in the Marmara Region, questions the role of states as the primary exploiters in the creation of the climate crisis and refers to colonialism during the interview, stressing the imbalances of power and inequalities:

You know, when it comes to the climate crisis, I'm thinking these big countries, like China, the United States, or even the United Kingdom and France, might be the real troublemakers. Cause, like, they used to be all into colonial stuff, and that gives them the power to mess with other countries big time. And that's causing problems, especially in places like Africa. It's like, they got this power, and that's what's stirring up all these problems.

Melike (17), a participant from a city in Northwest Turkey, expresses that environmental considerations are inextricably linked to the global level, as reflected in the following evaluation during her interview:

When you purchase a pair of jeans, you bear the burden of child labour in South Asia. When you buy a flower for your lover, you are unaware of its origins or how it was grown.

Her eco-literacy and awareness of relationship between human actions, consumption and production and climate crises is evident in her narration. Similarly, in her essay, she emphasizes the collaborative nature of her everyday activism, valuing her responsible actions as small yet highly effective, and stresses how she acts and participates:

The question of 'What can my individual effort really change?' often crosses my mind, but finding the answer becomes inevitable. Even a small eco-friendly change in my daily life, if noticed by someone around me and influencing them, would create the first link in a chain. That's why every action we take actually has much larger effects than we perceive, and perhaps the most constructive impacts can be seen in increasing environmental awareness. Starting this from our own homes makes the most sense because our current outlook and actions towards the clmate crisis have been shaped by the social environment and family atmosphere, we grew up in.

Call for a public (eco) pedagogy: Youthful voices and suggestions

In the context of public pedagogy, the study results illuminated several prominent dimensions, especially the influence of popular culture on everyday learning, and the educational potential inherent in the public realm, alongside the pervasive impact of neoliberalism as a dominant discourse (see Sandlin et al., 2011). Notably, the young participants underscored the imperative of state responsibility and advocated for the integration of public pedagogy into societal discourse, advocating for enhanced participation and dynamic learning environments facilitated by both state apparatuses and public discourse.

For example, Pelin (15), from Ankara, demands macro solutions and discusses the state's responsibility in her interview as follows:

I think it is important here to raise the awareness of the states of the countries and the people. Because as I said, I am a tenth-grade student after all. How many people I could affect? But if they do this on a state basis, for example, if there are such mandatory informative publications. Or they already charge taxes on everything. For example, they can cut back on certain things and get more taxes on the climate-related issues.

Pelin adds that she believes a cooperative model among countries would be more effective in tackling the climate crisis.

European countries, for example, can unite and deal with climate change on a large scale by developing further projects. If they managed to bring restrictions regarding Corona and managed to quarantine everyone, I think they might also have the same impact on a climate change issue.

elim (17) from the western small town, in his essay, expresses concern about the lack of environmental consciousness in his local community and emphasizes the need for community education and awareness, especially among local authorities, to address issues such as insufficient green spaces and urban settings. Through these aspects, he points to the educative potential of public spaces and thinks the climate crisis urges collective action to preserve a green world for future generations.
Like multiple other participants, Selim stressed the importance of public awareness and public pedagogy in various forms. During the interview session, he also evaluated the role of popular culture in everyday learning, as he believes traditional education is not effective in raising awareness:

If I were to ask what the most effective way to combat climate change is, it would be direct education. People are more likely to act on what they already know. However, I don't think it should be done in a classroom setting. Trying to educate people like that may not capture their interest. There are much better ways to do this. When you show something to people, especially young people like me who often prefer watching short videos on TikTok rather than long ones, and gradually start spreading it this way, everyone will pay attention.

Pelin (15), from Ankara, however, debated the importance of mundane activism during the interview as one influential factor. She believes she has the power to impact her social environment, mostly her immediate circle, including family members and friends, and successfully convinces them about the significance of their daily practices, such as consumption and their carbon footprints. She stresses the importance of making a real impact and criticizes the event she participated in, which was organized by her school.

Once, we cycled 22 kilometres around Lake Eymir for awareness, but it didn't feel like enough as we didn't reach anywhere. Riding into the city and reaching our school would have been more impactful for the public, but nope, we were shuttled there and back, wasting emissions all the same.

As a contrasting example some participants such as Emine (17), from Izmit, advocated for and demanded better environmental education at school. In her interview, she explains:

I mean, the environmental crisis is already widely visible through social media. But, in my opinion, the foundation of this should be education. People need to receive education on these matters, you know, to raise awareness. And, well, these things should be instilled in people from a very young age.

Conclusion

This study, employing geosocial data, delves into the eco-literacy of Turkish youth by studying subjectivities, shedding light on their consumption practices, climate change activism, lived environmental experiences, and critical agency performances (see Firinci Orman, 2023; Firinci Orman & Demiral, 2023).The examination of the critical perspectives and eco-literacy of young people, who demonstrate interpretive agency and engage in everyday activism (Firinci Orman, 2022a), revealed their active involvement in discussions related to climate change and consumerism. They critically connected these two aspects as relational, emphasizing local, global, and planetary perspectives, underscoring the need to comprehend the interconnected nature of environmental issues. The analysis of young people's interpretive agency reflected their creative expressions of environmental ideologies and value formation. The political stance adopted by the young people is characterized by a commitment to mundane activism and eco-friendly lifestyles.

Significantly, the research environment itself provided space for collective learning and action for the young participants; particularly through the mapping activity, contributing to the development of their eco-literacies. An intriguing observation is that participants become more proactive in contemplating their environmental behavior, thanks to their participation in the research where they expressed them selves freely. Moreover, the results indicate that young people commence their learning journey starting from their local environments, with their understandings gaining meaning when linked to their experiential lives and perspectives. The impact of this research extends to cultivating a deeper understanding of young participants' environmentally aware and responsive citizenship practices. This gives important insights and advocates for developing effective environmental pedagogical strategies for early youth, while also empowering them to communicate youthful solutions for a more sustainable future.

As the results highlight, young participants from Turkey who demonstrated environmental awareness and an eco-literate understanding of the climate crisis demanded a public (eco) pedagogy as they aspired to influence their society at large and make a difference. Consistent with the advocacy of Rousell and Cutter-Mackenzie-Knowles (2020), there is a pressing need for more participatory research, empowering children and young people to address the multifaceted implications of climate change within their communities.In the broader context of eco-pedagogy, the study focusing on environmental subjectivities, aligned with the perspective emphasized by Misiaszek (2022), stressing the pivotal role of eco-pedagogy in expanding citizenship from local to planetary spheres. This encourages individuals to recognize their interconnectedness with the Earth and fosters a culture of sustainability. Critical pedagogies, encompassing place-based education, climate change education, and global citizenship education, are considered essential in cultivating environmental awareness and eco-literacy. While speculative, it is plausible to suggest a strategy for designing educational processes for young people that promote responsive subjectivities, then, could begin with lived experiences and the local scale as a starting point, connecting to the importance of particularly place-based pedagogy (see Häggström & Schmidt, 2020).

Considering the comparatively small sample size utilized to explore subjectivities and the limited number of participants (albeit yielding rich in-depth geo-social data) to study their eco-literacy, the results tentatively suggest that young people in Turkey may lack opportunities for active participation and responsive engagement in youth environmental movements and civic action. This deficiency could potentially underscore their call for enhanced public pedagogy. Contrasting the participation modes and responsiveness of young people through active participation in environmental movements in Western countries (e.g., Crouzé et al., 2024; Wildemeersch et al., 2022), the study findings reveal divergence, illuminating the unique challenges faced by young people in Turkey, who navigate an authoritarian regime with constrained avenues for public engagement (see Bee, 2021; Firinci Orman & Demiral, 2023). Consequently, studies employing comparative frameworks and larger, more representative samples hold significant promise for delving into the subjectivities and collective perspectives of young people to elucidate their environmental worldviews, as potential case studies (see Bartlett & Vavrus, 2017). Finally, for future studies, I would like to emphasize the importance of studying eco-socialization (see Foster, 2023; Keto & Foster, 2021) through lived citizenship practices (see Firinci Orman & Demiral, 2023; Kallio et al., 2020). Situated in politico-spatial environments we integrate into human society through socialization within human communities and simultaneously become part of multispecies communities. Consequently, the study of eco-literacy should be explored in a more comprehensive, systemic, and intricate context.

Disclosure statement

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ORCID

Turkan Firinci Orman

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Learning at eco-attractions: Exploring the bifurcation of nature and culture through experiential environmental education

Ria Ann Dunkley
Cardiff University, Cardiff, United Kingdom

ABSTRACT

This article explores informal environmental education (EE) experiences at eco-attractions. A consortium of three UK-based environmental charitiesdesigned an eco-attraction-based EE program aiming to inspire responses toenvironmental change. Over six months, educators at six eco-attractionsdelivered this two-day program to 430 young people. This article conveysqualitative insights into learning experiences at three participating eco attractions. The study illustrates that experiential learning at eco-attractionsprovided unique opportunities to explore nature-culture connections. Theprogram also appeared to enable novel confrontations of current ecologicalcrises, including climate change. Furthermore, the experience influenced some young people's perceptions of how such crises might affect the irfutures.

KEYWORDS botanical gardens; eco attractions; environmentaleducation; experientiallearning; nature reserves;plant blindness; sustainabilityeducation

Introduction

From school gardens (Bowker & Tearle, 2007), to forest conservation pedagogy (Dickinson, 2011) and citizen science (Brossard, Lewenstein, & Bonney, 2005), informal EE programs are burgeoning. EE scholars have explored how these and other examples of experiential learning influence environmentalattitudes and behavior (Ballantyne & Packer, 2009; Duerden & Witt, 2010), nurture systems thinkingfor sustainable development (Dieleman & Huisingh, 2006) and encourage action for sustainability(Higgins, 2009). They have also begun to consider how teaching beyond the classroom inspires relational understandings (Hung, 2014; Mannion, Fenwick, & Lynch, 2013) and enhances educationalattainment (Payne & Wattchow, 2010; Skinner & Chi, 2012). In addition to these examples, many ecoattractions, such as botanical gardens and nature reserves, appear to offer valuable opportunities forexperiential EE. For example, Drissner, Steigmuller, and Hille (€ 2013) revealed that learning in botanicalgardens enhances children's biodiversity knowledge. Moreover, Sellmann (2014) and Sellmann andBogner (2013a, 2013b) have noted the effect of botanical garden EE programs on young people's environmental knowledge and attitudes. Notwithstanding these recent contributions, there remains muchscope for in-depth, qualitative studies of such learning experiences (Zhai & Dillon, 2014).

This article explores the impacts of an eco-attraction EE program developed by a consortium of three UK-based environmental charities. The program was State-funded for six months. It aimedto enhance young people's understandings of connections to nature to improve their capacities torespond to ecological crises. In total, 430 13- to 24-year-olds participated at one of six eco-attractions, operated by the three consortium partners. These young people were recruited from 26schools and colleges across England. Presented within this article are findings of a qualitativestudy involving three cohorts of young people, each participating at one of three eco-attractions selected as research settings. This article highlights emergent research themes using extracts from interview narratives of 24 secondary school students and four accompanying schoolteachers whoparticipated in these cohorts. The study illustrates that experiential learning at eco-attractionsappears to provide unique opportunities to explore nature-culture connections. The program alsoseemed to enable novel confrontations of current ecological crises, including climate change. Forsome, the experience influenced perceptions of how such crises might affect their futures. The article concludes with implications for EE theory and practice. These implications will also interestthose studying social responses to ecological crises. I begin by briefly contextualizing EE withineco-attractions, connecting to a broader discussion of experiential learning within current EE literature.

Literature review

The term eco-attraction emerged from ecotourism studies, referring broadly to natural attractions (Orams, 1995). Here the narrower definition adopted by The Eco-attraction Group (www.ecoattrac tions.com) is used to consider attractions that emphasize conservation goals. These include aquariums,arboretums, and—of particular interest here—botanical gardens and nature reserves. Contemporaryeco-attractions are increasing in number, yet botanical gardens have been publicly accessible since the17th-century (Alexander & Alexander, 2007). Such eco-attractions often fulfil research and educationalroles, provide public entertainment and advocate nature appreciation (Davis, 1996). Sites typically hostnumerous school visits each year and offer public engagement courses. As is the case with many eco-attractions, EE was a central component to the work of those in this study. Recently, researchers have begun to argue that EE ought to go beyond celebratinglearning within natural environments to address human disconnections from nature (Bonnett,2007; Rennie, 2008).

Eco-attractions arguably provide ideal settings, where "experience, perception, cognition and behaviour" (Kolb, 1984, p. 21) combine to engage people with ecological issues holistically. Forexample, plant-centered eco-attractions may provide opportunities to overcome what Wanderseeand Schussler (1999) term "plant blindness." These authors suggest that many modern youngpeople have been socialized to regard animals as more significant than plants, resulting in

ignorance of the role of plants within ecosystems. By offering opportunities to enhance individuals' plant knowledge, while also facilitating human-plant interactions, eco-attractions could play akey role in tackling "plant blindness," which is arguably becoming increasingly common (Struwe,Poster, Howe, Zambell, & Sweeney, 2014, p. 159). Moreover, Braund & Reiss (2006) argue thateco-attractions such as botanical gardens are repositories for exotic specimens, which act as a reference for teaching about environmental crises and sustainability. Although acknowledging thatthese attractions offer encounters with a "presented world," as opposed to the "actual world,"they suggest they are credible and complementary environments for out-of-school learning. Inthe context of ecological crises, the opportunities that eco-attractions provide for experientiallearning, albeit within a "presented world," may become increasingly significant. This is especiallythe case when we consider that some eco-attractions offer opportunities to confront the effects ofglobal issues, including climate change, through their collections (Sellman & Bogner, 2013).

Methods

The previous review implies there is scope for exploring impacts of experiential EE in an eco-attraction context. This study, therefore, aimed to gain deeper understandings of young people's experiences at three ecoattractions. Difficulties associated with determining causal, attributable results from EE interventions (Hendee, 1972) have created a shift toward critical understandings of EE pedagogy (Huckle, 1993; Stables & Scott,2001). A qualitative, interpretive research approach has thus been adopted here, providing meaningfulinsights into individual learning experiences, rather than generalizable findings (May & Williams, 1998).

Research settings

The study included one site operated by each of the consortium's three environmental charity partners. This equated to three of the six participating eco-attractions. The first site was a botanical garden inCornwall, founded at the beginning of the 21st century. The second site was a country estate in WestSussex, which hosted conservation areas. The third site was a large nature reserve and wetland in Essex.The three investigation sites were selected based on cohorts' willingness to participate, sufficient cohortsize, and convenience for education teams. Conducting studies at three sites enabled reflection on thediverse contexts offered by each partner while ensuring the study size was manageable. I gained a richappreciation of learning at eco-attractions by conducting in-depth interviews with secondary schoolstudents and their accompanying schoolteachers. I also gathered further contextual insights by observing the two-day program at the three sites and through analyzing course materials.

Environmental education program outline

The EE program understudy had five key aims. These were to demonstrate human dependency upon a non-human world, to share the contemporary thought on climate change and related implications,and to explore business responses to environmental challenges. More broadly, it aimed to examineopportunities that might exist in a changing world, for example, in the emerging Low Carbon Economy(LCE) and to provide encouragement for sharing ideas. Each eco-attraction used its unique experientialsetting to explore different human-non-human network dynamics. For example, the botanical gardenhoused a large tropical display, providing a locale to discuss dependency on unseen destinations. Thecountry estate hosted a seed bank, which provided a tangible focus for understanding the significanceof retaining seed stocks for future generations. At the nature reserve, teams used geographic informa tion system (GIS) devices to explore interdependence through an ecosystem services approach.Throughout the two-days, all education teams also used soundscapes, everyday material objects, andtheir collections to emphasize human-nature connectivity and the complexities associated with actingsustainably. For example, an emphasis was often placed upon how non-human actors provided habitable atmospheres and supplied essential medicine, food, clothing, and building materials.

Study participants

The three study cohorts each involved 12 to 13 students who were currently completing compulsory secondary education. Of the 38 students who participated in the three cohorts, all were in school year10, except for two from year nine. The cohorts were of mixed abilities and backgrounds. Table 1 provides a comprehensive summary of their profiles. The first study cohort participated in the program atthe botanical garden. This cohort was comprised of 13 students. Ten of these students came from a secondary school in Derbyshire; the remaining three were from a Cornish school. Interviews were conducted with 11 students, four females and seven males, aged between 14 and 15 years. The secondstudy cohort participated in the program at the Country Estate. This cohort was comprised of 12 students from a school in East Sussex. Interviews were conducted with five 13- to 15-year-olds from this

Table 1. Interviewee profiles.

Site	No. of Participants	No. of Interviews	No. of Teacher interviews	Student Gender	Student Age	Student Ethnicity	School
Botanical Garden	13	11	2	4 female 7 male	14–15	7 White 4 Asian	Derbyshire & Cornwall
Country Estate	12	5	1	3 female 2 male	13–15	5 White	East Sussex
Nature Reserve	13	8	1	1 female 7 male	14–15	7 White 1 Black	Essex
Total	38	24	4	8 female 16 male	13–15	19 White 4 Asian 1 Black	N/A

cohort, two males and three females. At the nature reserve, the third cohort of 13 students from a local school participated. For this final cohort, seven males and one female (14- and 15-year-olds) wereinterviewed. In sum, 24 interviews were conducted with students. The four schoolteachers who accompanied the cohorts were also interviewed. Constraints to involving full cohorts in the interview process included student availability and program time constraints.

Analysis and interpretive approach

This article seeks to provide meaningful insights into key themes arising from student experiences, rather than attempting to generalize indisputable truths. Therefore, it uses excerpts from participantinterviews to support emergent themes. The interview process was guided by conversational (Clandinin & Connelly, 2000) and interactive interviewing (Ellis, Kiesinger, & Tillmann-Healy, 1997) principles. This process encouraged participants and their schoolteachers to direct discussions.Interviews were transcribed, analyzed and interpreted using poetic structure narrative analysis (Gee,1991). This technique is based upon the perspective that all speech is a form of poetry. It provides acomprehensive structured process for deconstructing interview accounts. It also gives credence toresearch participant subjectivities throughout transcription and interpretation. It is attentive to bothwhat is said and how it is said (Riessman, 1993). Within this study, employing this analytic techniqueinvolved multiple listenings of audio recordings noting linguistic devices used, such as metaphors, similes, verb tenses, and keywords. This notation was overlaid onto written transcripts. Transcripts werethen organized in accordance with structural poetic devices employed by interviewees, includingframes, parts and stanzas. Finally, texts were interpreted within the wider program and social context.Poetic structure narrative analysis provided access to the most significant memories for participantswhile avoiding imposing the researchers' viewpoint. The next section discusses extracts from schoolteacher and student narratives. Participants consented in writing to being involved in the study.However, all names have been changed within this study.

Learning narratives

The three main themes emerging from narratives as program impacts (connections with plants; sensiti zation to our role in ecological crises; and questioning future ecological provocations) are analyzed and interpreted here.

Awe in nature: Connecting to plants

A new appreciation of plant roles within ecosystems was a major theme emerging from many student narratives. This alone is not a new insight given that several studies have identified that learning withineco-attractions, such as botanical gardens, encourages such knowledge acquisition (Braund & Reiss,2006, Nyberg & Sanders, 2014; Sanders, 2007, Winther, Sadler, & Saunders, 2010; Zhai, 2012). What isnovel is that the EE program understudy explicitly connects plant life to everyday objects and experien ces. In reflecting upon the programs' value, Gabriela, a schoolteacher at an urban school in Sussex,where sustainability was being given increasing attention, felt the program benefited her studentsbecause, as she states "they had no idea how important plants were." She describes a lunchtime sessionwhen students were told they could only eat foods that had not encountered plants. She suggests:No matter what you teach them in a classroom, it's when all of a sudden they are told they can't eattheir lunch [because] it has had contact with plants, you couldn't touch anything, not even plastic. Ithink that made them sit back and think.

Similarly, the exercise that Jo, a schoolteacher from a city school in Derbyshire, felt had been most significant for her students tasked them with visiting the eco-attractions captive rainforest. Once there,they recorded the 10 plants they would like to carry into their futures. Jo stated:

I've had a few say about the biome, how wonderful that was. They just didn't know that there were that many things there because you hear about the rainforest going all the time, but to actually go in there, and to have seenall that. They suddenly had to think "I'm going to need all of this. I'm going to need that." I think that sank in.

These two schoolteachers suggest that the eco-attractions' experiential learning environment enabled their students to appreciate the role of plants in sustaining human life. This may be significantgiven that, as Latour (2014) argues, it is increasingly difficult to witness interconnections between cultural life and the non-human world, particularly on a global scale. This difficulty arguably manifestsitself through a phenomenon such as "plant blindness" (Wandersee & Schussler, 1999). However, theseschoolteachers appear to suggest that visiting eco-attractions enables appreciation of human-natureconnectivity.

For some students who participated in the program, a novel appreciation of plant roles was coupled with a sense of awe inspired by nature (Davis, 1996) and greater respect for the non-human. For exam ple, 14-year-old John from Sussex felt the course had "opened his eyes" to the role of plants in sustain ing human life:

I didn't realize that everything came from plants that was really quite an amazing thing.

John's narrative reveals that this insight "hit him the most." This seemed to encourage him to want to respond to ecological crises and he proclaimed:

If they come about something that individuals can do well, then I will definitely do it, I'm definitely up for helping doing something.

As a year-nine "eco-prefect," John was motivated to take part in the program to "find out more" to share his knowledge with younger students. He appears to see himself as acting as a representative forthese students in a larger peer-learning process for sustainability (de Vreede, Warner, & Pitter, 2014).The experience therefore also fulfilled a social function, enabling him to provide leadership within his school.

Sensitization to our role in ecological crises

Davies, Sanders, and Amos (2015) have recently suggested that outdoor classrooms may enable stu dents to reimagine their place in nature. The previous accounts reveal that the EE experience under study appeared to encourage many participants to question some established views and to want to take ownership of ecological crises. This is promising in light of the lack of political will to tackle suchissues. Currently, collective unresponsiveness leads the media to present ecological crises as "not only astory, not only a drama, but also the plot of a tragedy" (Latour, 2014, p. 14). Resultantly, many individ uals arguably adopt a state of "climate quietism," or "practical climatoscepticism" (Latour, 2013, p. 4).Indeed, some students appeared apathetic about issues such as climate change and resource depletion.However, many also told stories about how the program had changed their perception of their relation ship to the environment. For example, for 15-year-old Helen from Essex, participating in the programat a nature reserve was an experience that, she explains, encouraged her to "look at things differently."She emphasized that the visit enabled her to appreciate the scale of human dependency on plants. Tothis end, she states:

I see people pulling plants off trees and they're just like mucking about with it and now I realize that they're taking away a bit of someone's breath …I look at things differently now. Like, if I see a condom I'm likethat's actuallymade out of a plant.

Helen describes what she feels are the personal implications of this in the following extract, where she explains that previously, she had assumed that lack of collective action on climate change was areflection of inconsequentiality:

I thought climate change; they're going on about it …but then no-one's making such a big deal out of it. So we shouldn't. So it won't be as bad as they're saying and then when I found out a bit more, I actually realized that people are a bit ignorant to ignore it because this is our futures they're affecting.

For some students, like Helen, experiential learning at an eco-attraction helped to make nature-culture connections explicit, through highlighting the significance of plants to contemporary society (Hall, 2011). Moreover, the program seemed to offer her an opportunity to appreciate the magnitudeof current ecological crises. Nature appears as indispensable for the first time. She thinks her:

…whole [school] year [group] should take part… [in the program because] …when you get there [the nature reserve], you just get a complete change of mind.

The program also appeared to have had a cascading effect upon Helen's daily life. For example, after the experience, she continued to engage her friends and family in conversations about themes discussed during the visit to the eco-attraction:

I just keep on remembering it, and then spread the word to my friends. Now my friends know that most of the things we use have got plants in, which they didn't know before.

This suggests that experiential EE, which makes nature-culture connections visible, can also expose the "feedback loops" (Latour, 2011) between nature and culture that lead to ecological crises. Moreover,the effects of such learning appear to reverberate into young people's everyday lives.

Reverberations: Questioning future ecological provocations

Many students and their schoolteachers felt the EE experience would lead to greater reflection on everyday decisions, rather than to immediate pro-environmental behaviors. For example, school teacher Gabriela referred specifically to the effectiveness of a gift shop-based activity at the naturereserve. Students conducted a stock audit while reflecting on the attractions procurement strategy.Gabriela believed that:

because it moved them on to look at how we care for our environment …I know they are going to go back from yesterday, looking at some of our food and looking at whether they are going to be fair-trade, organic, or buy locally.

Furthermore, some students appeared to demonstrate an ability to think critically about sustainability's triple-bottom line. For example, 14-year-old John used an occurrence during the stock audit as a metaphor to describe what he felt were the complexities of adopting sustainable be haviors:

in the shop, we found a book and it was all about recycling and telling you, "you should do this," "you should do that" and the book wasn't actually made out of recycled material! So at first glance, it's really sustainable, butwhen you actually look on the back, it's not that great, but then I guess the shop has to make a profit.

This passage demonstrates how students become aware of the contradictions of sustainable con sumption (Kopnina, 2014).

Although the program may not have inspired significant immediate pro-environmental action, many students and schoolteachers stated they had developed capacities and critical faculties, whichmay lead to further involvement with conservation efforts (Wals, Brody, Dillon, & Stevenson, 2014).For example, many stated that the program was part of their own and their school's sustainability journey. In discussing its longer-term effect, Jo, a schoolteacher, said it had "planted a seed." Anotherteacher, Susan, stated that now students were attentive to ecological issues "it just needs accommodat ing." Some students and schoolteachers had already begun to make plans, resulting from the program.This was encouraging, given that actions for sustainability are intricately intertwined within daily life.Many of the actions they proposed extended beyond pro-environmental behaviors already encouragedat school to include, for example, assuming leadership roles. For some, this involved plans to establishschool gardens and to facilitate discussions with peers. Some students had also begun to think abouthow ecological issues and sustainability thinking might affect their future careers.

Conclusions

It is challenging to isolate the impacts of short-term courses, such as the two-day program discussed here. Individual personal life courses, prior experiences, and wider sociocultural contexts will also havea strong influence on perceptions, motivations, and resulting actions. Therefore, by exploring learningjourneys at eco-attractions, this article instead provides in-depth insights into how young people from a variety of backgrounds responded to particular experiential techniques and settings of

EE. Doing so enabled us to appreciate how such pedagogy helps young people to see and sense ecological issues (Tillmann-Healy, 1996). This article has focused upon three central insights emergent from participant'snarratives. Such insights into the impacts of experiential learning within eco-attractions may well beuseful to educators and other practitioners, and to policy makers and academics working within sustainability education. A key study insight is that pedagogic experiences offered by eco-attractions can help to re-establishaffective connections between the natural world and young people's everyday lives. In particular, theexperience appears to have afforded them a new appreciation of the significance of plants. This hasimplications for environmental educators, conservationists, sustainability scientists, and eco-attractionsthemselves, given that making human-nature connections visible is recognized as central to addressingcurrent ecological crises (Latour, 2014).

Furthermore, once young people had begun to appreciatehuman-non-human connectivity, these experiential milieus also appeared to help sensitize many ofthose interviewed to human roles in ecological crises. This may have been heightened, in some cases,by the capacity for exotic plants and wildlife within these "presented worlds" (Braund & Reiss, 2006)to resonate with students (Genovart, Tavecchia, Ensenat, & Laiolo, ~ 2013). For example, in many cases,witnessing exotic plants appeared to enable contemplation of how local actions affected a global environment. This takes on additional significance when considering climate change, a global and abstractchallenge that can be difficult to comprehend.

Finally, the study also enabled understanding of factors influencing outcomes of EE learning processes. This EE program aimed to encourage individuals to question their existing ecological knowledge and to explore and discuss sustainability further, rather than seeking to establish fixed pro-environ mental behaviors. This progressive approach to EE appears to be effective. This is perhaps because the program sought to accommodate young people's intricate social and cultural contexts, which seemedto affect their capacities to comprehend and address ecological issues. To this end, though the youngpeople involved in this study were of similar ages and while many demonstrated ecological awareness,motivations to respond to ecological crises varied based on student influences and interests. This sug gests that those seeking to engage learners in EE need to recognize participant subjectivities within pro gram design. The study highlights that effective EE program outcomes ought to accommodate a varietyof responses from individuals and groups. This has implications for informal education at all levelswithin eco-attractions, as well as for EE more generally.

Within a broader context, this study supports arguments that suggest gardens and nature reserves offer intrinsically valuable opportunities to reconnect with the natural world. Over thepast half century, the importance of natural spaces within urban contexts has been increasinglyacknowledged (Goode, 2011). For instance, botanical gardens in the United States have come tobe regarded recently as "urban nodes of science-based education that can harness urban interestin agriculture" (Novy & Dotson 2015, p. 40). All study sites exist within urban or peri-urbancontexts. This study provides insights into interactions within unique eco-attraction contexts thatappear to influence perceptions of and responses to ecological crises. EE initiatives delivered ateco-attractions may therefore complement other urban programs, such as community-based sci ence programs and nature festivals that contribute to addressing disconnections between thehuman and natural world (Goode, 2014).

There is much scope for exploring informal learning within eco-attractions empirically (Ardoin, Clark, & Kelsey, 2013), despite burgeoning consideration of EE and related sustainability education.This article makes a clear contribution to EE, by interpreting the effectiveness of learning within eco-attractions, which emerge as spaces for nurturing ecological citizenship. It challenges the

assumption that short-term EE programs are inconsequential. Experiential learning within eco-attrac tions appears to have the capacity to challenge the nature-culture dichotomy. Resultantly, such pro grams appear to facilitate the telling of the new "geo-stories" that Latour (2013) argues will be crucial to addressing ecological crises.

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Stability in the heart of chaos; (Un)sustainable refrains in the language of climate crisis

Sarah Evans
Manchester Metropolitan University, Manchester, UK

ABSTRACT

Set in the Capitalocene, this conceptual paper examines 'sustainability' in ecolog ical education through a posthuman lens. I demonstrate how the Deleuzoguattarian concept of the refrain helps reconfigure the function of 'sustainability' as an affec tive force of unstable-stabilizing when facing increasingly violent climate crisis events. Currently, ecological education and 'sustainability' are presented as solu tions to these effects. How 'sustainable' something is, is increasingly used as a standard to expound its virtues – especially in the marketing of products, consum ables, and energy. However, aligning with eco-feminist new material critiques, I propose that sustainability has sedimented into a regime of inertia, functioning to perpetuate practices known to be harmful to the environment as an order-word of stoppage. This paper offers new perspectives to problems presented in the language of environmental education, in order to suggest radical reimaginings for practice in the development of pedagogy capable of harnessing the chaos of climate crisis.

KEYWORDS sustainability; Deleuzoguattarian concepts; posthuman methodologies; refrain; material-discursive; curriculums for chaos

Introduction

This paper considers the concept of sustainability as an affective force on human practices, and the impact of its increasing presence in formal education policy. I argue that the concept of 'sustainability' functions in environmental education—and indeed in wider society—to articulate the continuation of harmful human practices and lethargic attitudes toward climate crisis. In offering this reading of sustainability, the paper gives a demonstrable account of its material-discursive (Barad, 2007) capacities, and implications of detrimental practices therein, as definitive of the Capitalocene epoch (Moore, 2017). As curricula in diverse contexts increasingly focus on sustainability and ecology (cf. Ardoin et al., 2020; Dunlop & Rushton, 2022), this work offers a distinct and timely contribution to reconceptualizing 'sustainability' in education. Exploring various conceptual shifts in the language of sustainability through a posthuman, Deleuzoguattarian methodology, I suggest alternative perspectives of the issues present in how we conceptualize (and thus come to embody) our impact, role, and position on/in/through/with ecologies, aligning with eco-feminist new material critiques. My proposition is that, when viewed through the Deleuzoguattarian concept of the refrain (Deleuze & Guattari, 1987/2013), it is possible to consider how 'sustainability' belies a form of safety in the

frightening chaos of climate change events. Demonstrating this as a false sense of security, I consider how sustainable endeavors thus come to function in education within the dangerous territory of apathy. The work culminates in suggesting educational imaginaries in response to this, and a call for research that radicalizes ecological1 pedagogies by developing curriculums for chaos. Cole (2022) incites the 'unwriting' of climate crisis to disrupt distancing tendencies that traditionally position academics as objective observers. Taking up this call, I attempt to unwrite sustainability through 'diagrammatic features' (Deleuze & Guattari, 1994, p. 75) such as found in ants, the Divine Right of Kings, fungi, carpentry, and death—examples to "follow the witch's flight" (Deleuze & Guattari, 1994, p. 41) in their capacity for generative thought (MacLure, 2022). The hope is to create a demonstrable conceptual bridging of phenomena, acting as a membrane between the abstract/virtual and the animate/material connections affected through the concept of sustainability in education. I bring together philosophical understandings of language and environmental education practice that are affective, material, bodily, and sensed (rather than comprised in scientific categorizations, rationalism, and objective truth—traits of Modernity critiqued below).

The paper's methodology deviates from analytic approaches traditional to mainstream language-based inquiry (such as discourse analysis). A growing area of interest within critical language studies (see Gurney & Demuro, 2023; Toohey et al., 2020), posthuman scholars increasingly ask questions about the ontological basis of language. I utilize the conceptual thinking tools of Deleuze and Guattari to explore the material-discursive, affective possibilities of language as an immanent force. In attempting to also map a contemporary conceptualization of sustainability, I draw from critical perspectives of sustainability found in eco-feminist new materialism2. Whilst I recognize the distinct trajectories and genealogies of ecofeminism, new materialism, and Deleuzoguattarian theory (for the first two, cf. Gough & Whitehouse, 2020), the 'plugging into' (Deleuze & Guattari, 1987/2013) of diverse paradigmatic positions offers new potentialities for thought. Furthermore, as Gough and Whitehouse (2020) state;

…strictly delineated 'schools of thought' are possibly more relatable to the modernist project than the post[s]…scholars are running out of the luxury of time in which to debate the fixities of categories…[as] climate emergency is forcing the realization that no one conceptual model is going to see us through (p. 1422).

In current posthuman permutations, environmental education critique takes significant influence from eco-feminist new materialism. Naming but a few, scholars such as Alaimo (2010, 2016, 2019), Myrstad et al. (2022), Gough and Whitehouse (2018), Cutter-Mackenzie-Knowles et al. (2020), MacGregor

(2021), have explored persuasive arguments concerning the role of human, non-human and more-than human relationalities with/in environmental education. Thus, following established thinking practices converging Deleuzoguattarian philosophy with feminist new materialism (cf. Cole & Mirzaei Rafe, 2017), these concepts and critiques are put in conversation in this paper to contribute to posthuman perspectives on environmental education. As such, I do not explore the 'meaning' of sustainability, or delve into a sociolinguistic perspective to mine the depths of representational significance (cf. MacLure, 2013). Instead, language is understood as coming into being through ontological relationality; as a becoming. The broad project of Deleuzoguattarian methodology is to create generative spaces for thinking new thoughts through concepts, paying close attention to how a phenomenon may be functioning within the event in which it is deployed (Deleuze & Guattari, 1987/2013). Essentially, I aim not to understand what 'sustainability' means, but what it does.

Following my previous work (Evans, 2021; Evans et al., 2022), I am interested in the possibilities generated when normative terms are read through theoretically diverse means. Whilst accepting that the idea of a normative term is not an innocent one, it is fair to state (as others have, e.g. Seghezzo, 2009; Scoones, 2007) that the word 'sustainability' is now so integrated into everyday vocabulary we might assume an accepted definition. And therein lies the problem, and indeed the difficulty with all normative, generalized, agreed upon phrases; it gives sense of stability to something in constant flux. The 'something' here not only relates to language generally, but also to the practices and implications of human/non-human ecological relationships. Indeed, the idea of sustainability becomes futile and even a little absurd when considering that everything is in a constant state of relational variation. This understanding therefore begs the question (alluded to by O'Grady (2003), and Alaimo (2016)); what is actually sustained in sustainability?In addressing this question, I begin by briefly mapping out the origins, and subsequent evolutions, of sustainability as a concept, and the impact that Modern epistemic scientism has on a contemporary understanding of it (cf. Bonnett, 2019), specifically in the dawning of the Capitalocene (Moore, 2017).

I situate the thinking so to foreground recent pedagogical movements toward sustainability and the assumptions inherent therein. The discussion moves to posthuman conceptions of language to critically examine the functions of material-discursive practices involved in 'sustainability', ultimately suggesting potentialities for practice in the harnessing of the chaos of climate crisis. Applying a posthuman concep tual framework, this work makes an important contribution to the field of 'eco' pedagogies by offering alternative readings of 'sustainability' and its material-discursive functions.

Sustainability and the Capitalocene; Modern thinking and ancient problems

Concerns over ecological reserves heavily relied upon as resources, such as woodlands, are documented in Europe as early as the Domesday Book (Hemery & Simblet, 2021), but the emergence of 'sustainability' in the eighteenth century formalized articulation for mitigating exhausting natural resources in the pursuit of economic gain (Grober, 2007; Scoones, 2007). The Modern notion 'sustainable yield' in nineteenth century forestry spoke to the need for wood in shipbuilding to expand empires and industry (Grober, 2007; Lumley & Armstrong, 2004), evolving into 'sustainable development' in light of emergent tensions between neoliberalism and climate change in the 1970/80s (Scoones, 2007). What is evident in the genealogy of sustainability is its concurrence with Western humanist ideals of scientific and economic progress (Mensah, 2019), and the rise of the Capitalocene (Moore, 2017). Also evident therefore is that, used as shorthand for ecological conservation in contemporary understandings, 'sustainability' is a misnomer.

Common usage of 'sustainability' might assume understanding within the same issues/contexts, which is far from true (Mensah, 2019; Seghezzo, 2009). Multi-dimensional understandings of 'sustainability' suggest that the conflation with ecological conservation likely stems from ambiguity of its meaning and assumptions therefore inferred (Seghezzo, 2009). However, situated as a purely utilitarian pursuit, the true intentions of sustainability lie in the practicalities of human domestication and not with non-human habitats or ecologies, as many might assume (or are led to believe). Alaimo (2016) explains that sustainability "is frequently invoked within economic and other news stories that do not, in any way, question the capitalist ideals of unfettered expansion" (p. 170). Taking this further, she argues that:

sustainability has become a plastic but potent signifier, meaning, roughly, the ability to somehow keep things going, despite, or rather because of, the fact that we suspect economic and environmental crisis render this impossible (Alaimo, 2016, p. 170).

In arguing for recognition of the Capitalocene epoch, Moore (2017) demonstrates capitalism's endeavor to wring as much profit as possible from natural resources depends on ideological constructs of ontological prioritization. In the Capitalocene, he argues, nature is commodified and endlessly mined under the premise of "the separation of Humanity and Nature…[wherein] we inhabit something called Society, and act upon something called Nature" (Moore, 2017, p. 7). The indelible mark of humans on earth begins with "'human supremacism' in the distribution of earth's resources" (Bonnett, 2019, p. 254), and illustrates the ontological privileging of humans foundational to Modern thought. This is an ancient problem as, even in the Holocene—regarded as the most 'stable' epoch for (human)

life—the rapid and often violent social developments invariably affected geographical environments (Leichenko & O'Brien, 2020). For millennia humans farmed, recoursed rivers, built cities, waged wars, industrialized and so gouged marks onto the earth in a way no other species has (excepting the hard work of mycelium, per haps). This understanding offers a tidemark in the antecedental factors from which we find ourselves in the current climatic moment. For the past few centuries, humans have been preoccupied with futile attempts to force order on an infinitely chaotic and utterly indifferent universe. In categorization is the possibility for knowable and stable entities and phenomena, things that we could perhaps even claim a mastery over in our naming them so (an idea explored further below). Modernity relies on humancentric blunt cuts of precedence, and the problem of sustainability lies in the prevailing epistemological dogma of objective scientism and Cartesian rationalism (Bonnett, 2019). However, using the refrain as a tool of rethinking such a priori knowledges, Kleinherenbrink (2015) explores the problems associated with defining 'being', suggesting Deleuzoguattarian ontology as a counterpoint to that which currently serves the doxa of rationality. The operation of dialectic division, such as in how we might understand dichot omized nature≠culture, mind≠body, natural≠artificial3 , is the basis from which practices and 'accepted' knowledge foundational to formal education emerge. It is thus important to consider the implications for sustainability when it becomes schooled to conceptualize alternative potentialities for practice.

Schooling sustainability

here are increasing educational initiatives concerning sustainability across contexts (cf. Greer et al., 2023). Such environmental education interventions broadly aim to promote awareness of ecological issues in the hopes of widening participation in conservation (cf. Valderrama-Hernández et al., 2017; Sommerville & Williams, 2015). Taking examples from the English schooling context4, interventions usually fall within either formal curricula (i.e. specific legislative policy, such as the inclusion of the Natural History subject in Key Stage 3 and 4 in England by 2025 (DfE, 2022)) or arise through adjunct projects in by-proxy settings (such as the National Education Nature Park (Natural History Museum, n.d.) and Forest Schools). However, what is incredibly difficult to parse, is the foundational assumptions of such initiatives and the resultant implications for practice. There are two apparent readings (though undoubtably multiple tacit ones) situated respectively into either the economic or ecological camps for understanding what is intended in educational approaches to sustainability (Bonnett, 2019). Though much of the literature situates environment education practices generally within a broad framework of ecological conservation strategies (Ardoin et al., 2020), a more critical view exposes political and ideological nuance, such as that introduced above.

As such, there is a conflation of economical sustainability and ecological sustainability. At the time of writing, the GCSE Natural History curriculum framework is still under development, with climate crisis and sustainability otherwise absent from policy in England (Dunlop & Rushton, 2022; Greer et al., 2023). However, the Department for Education's (DfE) 'Sustainability and climate change: a strategy for education and children's services' (DfE, 2022) policy paper alludes to the agendas and perspectives that will inform future legislation. What is clear from this document, is the vein from which this new subject will draw in its objectives for;

…giving young people a further opportunity to engage with and develop a deeper knowledge and understanding of the natural world. In studying this GCSE, young people will explore organisms and environments in more depth, gain knowledge and practical experience of fieldwork and develop a greater understanding of conservation (DfE, 2022, Climate education).

What compounds 'the problem' explored in this article, is how sustainability is constructed within the epistemological assumptions of mainstream education. Pedagogy in mainstream settings being grounded in a structural framework of logic and objective truth impacts how sustainability is positioned, such as in the too-simplistic binary notions it affirms. Rhetorics of 'doing our bit to save the planet' tend toward rational hierarchies, wherein nature and culture are separated and need falls to humans to swoop in to save what cannot save itself (glossing over humans' role in creating environmental jeopardy in the first place). This is embedded within policy initiatives through the language afforded to how environmental education can "engage children and young people with the natural world" (DfE, 2022, Initiatives to drive the strategy), so they might "do their best to protect it" (DfE, 2022, The challenge and the opportunity), by studying GCSE Natural History to "develop a greater understanding of conservation" (DfE, 2022, Climate education). Here, the Capitalocenic relationship between humans and nature is reflected—the distant observer, occasional tourist, and rapacious consumer "of pristine nature, [that is] awaiting our protection, fearing destruction at our hands" (Moore, 2017, p. 4). These discourses thus give rise to paradoxical notions and practices such as; 'rewilding nature', the 'reintroduction' of wolves in western Europe, the monetized 'foraging industry', and often disregard non-human life's capabilities to thrive in places deemed 'hostile' (the narwhal of the Arctic, and Sahara's sand viper are perfectly comfortable in places regularly taught as 'inhospitable', and Chernobyl's Elephant Foot fungus is positively thriving). Bonnett (2019) suggests similar arguments in his long-established project critiquing the dialectic in environmental education, understanding the division of nature and culture as ultimately futile and dangerous. He states:

I have explored the idea holding sway in Western culture of a superordinate 'metaphysics of mastery' whose ambition is to make all subject to the human will. I have argued that this—and the scientism that it spawns—are both precisely the root cause of our current environmental crisis and the chief obstacle to human flourishing: they alienate us both from nature and our own nature (p. 252).

Indeed, this 'metaphysics of mastery' runs throughout the DfE's sustainability strategy. For example, learning about nature with the National Education Nature Park initiative, will "develop young people's data and analytical skills" (DfE, 2022, Climate education), leading to increased numbers of "young people that become data scientists, ecologists and biologists, which are needed for nature's recovery" (DfE, 2022, Green skills and careers).

Paramount to understanding the complexity of issues in this policy, is the tension between sustain ability's broad aim of 'continuing human flourishing' and the dominant humanist understanding of nature. At the heart of this tension is how we teach children about humans' place in the world, the resulting image situating us at the top of an ontological hierarchy. To unravel where this tension is most fraught, it is worth exploring what is meant by 'nature' and 'natural' - slipperier ideas than they might first seem. "What is nature?" asks Bonnett (2019, p. 251) as he sets the stage for an interrogation of, not only our direct relationship with ecologies, but fundamental questions about how nature and the natural world can be understood in the twenty first century. Dualisms inherent in dialectical modern thought offer over-simplistic, and often pointless, delineations between human and non-human ecologies (Moore, 2017). Positioning nature as other to and separate from human society creates a hierarchical view of being—one that assigns us responsibility to 'conserve' nature which, as suggested above, is what many understand by 'sustainability'. Of course, it must be recognized that this is a specifically Western, European viewpoint. Indigenous lifeways necessarily understand the symbiosis of human and non-human worlds and all constitutive forces therein (e.g. Abram, 1997; Alaimo, 2019; Cutter-Mackenzie-Knowles et al., 2020; Donald, 2019; Tuck et al., 2014).

Such onto-epistemological knowledges do not assign humans the role of custodian for an axiomatic 'natural world', but as being just one element wholly and inseparably enmeshed-with, and co-constitutive of, everything else. Drawing from these understandings, eco-feminist new materialisms amplify non-dominant voices to challenge and subvert normative doxa that promote harmful, exclusionary practices. Scholars such as Alaimo (2016, p. 1) deride the "commonsensical assumption that the world exists as a background for the human subject" wherein the "lively world [is rendered] as a storehouse of supplies" (p. 169). Reading this with policy perspectives given above, sustainability in education can therefore be viewed as teaching human exceptionalism—what is 'worth' conserving is

ours to say. Afterall, the leaf cutter ant does not strive to conserve the trees a colony can decimate—the trees fight back, but the ants do not try to sustain their natural resource (or perhaps they do, and my limited human understanding is too reductive for sophistication of ant society?).However hegemonic a concept, 'the natural environment' is a Modern invention. The extent of human activity's impact on every ecological system, including interventions to preserve that which has been pushed to the brink of destruction, suggests that the earth cannot be considered 'natural' (cf. Alaimo, 2016; Garoian, 2012), some having gone further to state that "earth…is already very largely an artificial construct" (Adcock, 1992 cited in Garoian, 2012, p. 294). Indeed, it is not outrageous to suggest that we may now be in a 'post-nature' paradigm. If this is the case, what is being sustained by the project of sustainability is undoubtably the pursuit of economic growth through the 'survival' of destructive shorttermist human practices (Bottoms, 2007 cited in Garoian, 2012). However, as will become apparent below, there may be a more complex material-discursive (Barad, 2007) ontological function at play in how sustainability is conceived.

Refrains; stabilizing the unsustainable

Chaos, in Deleuzoguattarian terms, is the unknowable 'virtual' components of reality that we encounter as a heterogenous collection of affective forces (Deleuze & Guattari, 1994; Plotnitsky, 2006). The disturbance of external forces felt by lived5 beings, chaos holds within it all potentiality for becomings as the 'milieu of milieus' (Deleuze & Guattari, 1994). The 'chaosmos' is the ephemeral yet infinite plane of existence from which everything originates, the virtual space as likely to snuff out a possible life as create it. An incomprehensible paradox, pure chaos is inhospitable. Providing regularity in cosmically chaotic flux, refrains (or ritornello, see Kleinherenbrink (2015)) function as articulatory mechanisms by forming sites of recognition, allowing subjectivities to be understood in alien territories. Life experienced without the filter of recognizable features would be an unbearable cacophony of sensation and incomprehensibility (Plotnitsky, 2006), meaning the refrain is an essential ontological instrument. A refrain is a motif that recurs within an assemblage and works toward the creation of a territory (an organized body/collection of understanding), with recognizable haecceity. Through these territory defining functions, the refrain creates familiar and knowable centers within the maelstrom of chaos, allowing for safe passage to new or existing territories. Offering respite and restoration, a security against the threats and turbulence in the chaos of existence, becomings in unstable territories are made hospitable in the rhythm afforded by a refrain, giving stability in "the heart of chaos" (Deleuze & Guattari, 1987/2013, p.362). However, these territories are not ridged and stratified, refrains have malleability.

Deleuze and Guattari explain that; "…the refrain is rhythm and melody that have been territorialized because they have become expressive—and have become expressive because they are territorializing…there is a self-movement of expressive qualities" (2013, p. 369). As unstable stablizers, refrains therefore offer a platform from which to leap; a territory from which to deterritorialize and reterritorialize elsewhere, configuring becomings. This functions "like a rough sketch of a calming and stabilizing" able to "open onto a future…[and] meld with it" (Deleuze & Guattari, 1987/2013, pp. 362-363). From this, we can begin to imagine how understandings and knowl edges move with us ontologically, immanently unfolding in new ways with developing need.

The refrain is a helpful thinking tool in this conceptual project as it allows for alternative epistemological understandings to prevailing Modern 'common sense'. Here we can conceive of knowing as ontologically emergent, not presupposed or self-evident. Understanding how the refrain helps beings establish their subjectivities demonstrates why it is such an important tool when thinking about how language functions in becomings. 'Language' here, is not confined to the boundaries of verbal or written expressions, but is understood as 'languaging' that is affective and material (see Gurney & Demuro, 2023). Hence, the term 'material-discursive' (Barad, 2007) is used in attempt to encapsulate an affective, limitless, heterogenous understanding of language. However, one of the difficulties of working with/through language is its paradoxical operations. Whilst language creates incorporeally recognized boundaries, categories and typologies, it does so with an infinitely limitless array of possibility for transformation (Deleuze, 1990/2015). When specific, continuous discursive practices coalesce and repeat, the formation of bodies is actualized. That is to say, things become. Habits, material-discursive habits, are how a refrain creates the dependability key to all becomings through its brittle rigidity—form enough to build on, but that can be shattered to make way for the new. However, some refrains are more robust than others. Recurring patterns within political ideology, for instance, are hard dying habits. This is seen in discursive motifs of England's 'world class', 'excellence', and 'high quality' education peppered throughout policy documents, such as the sustainability strategy paper (DfE, 2022).

The forces of repetition in such rhetorics create obstacles for critical views about education, embedding mentalities into the fabric of policy through its wording. However, that is not to say that such strong forces are totally immoveable; the Divine Right ofKings once held much of European society in its grip, until the Enlightenment broke its power and established a new paradigmatic stronghold, paving the way for capitalism (Stengers, 2008). Helpfully, Enlightenment thinking bridges us back into the problematic of sustainability and prevailing eighteenth century epistemologies in education.

As explored above, sustainability in policy operates on practical and ideological levels that reveal tensions in implementation. On a practical level, curriculums that strive to be sensitive of ecological issues, and thereby don the mantle of sustainability, encounter issues due to a lack of resources and competing priorities and agendas (Abegglen et al., 2021). As demonstrated in the DfE's (2022) sustain ability strategy, an overarching priority for environmental education is employability in 'green' careers that serve Britain's role 'leading the Green Industrial Revolution'. Capitalocenic agendas for "the endless accumulation of capital" (Moore, 2017, p. 3) are further emphasized in this strategy by commitments to retrain and reskill employed adults "in line with the needs of the green economy" (DfE, 2022, Green skills and careers). This continued concern for economic growth is emblematic of climate crisis, and indeed the place of mainstream education therein, exposing the heart of the conflict. The practical issues of sustainability in a mass schooling context are further demonstrated by the (perceived) inequalities of access to nature in urban settings (DfE, 2022)—an understanding that begets ideological issues of how decisions are made about what is, and is not, 'nature'. Furthermore, sustainability in the curriculum often falls short of the task (Leichenko & O'Brien, 2020) when tacked onto the 'proper learning' of siloed subjects (Dunlop et al., 2022; Everth et al., 2023).

Such 'proper learning' is conceptualized on the assumptions of Modernity's dialectic and the powerhouse of scientific civilization. Thus, on an ideological level, epistemic scientism being foundational to mainstream schooling, gives a vision of the world wherein everything is knowable, and climate crisis "can be dealt with by providing more knowledge and under standing" (Dunlop & Rushton, 2022, p. 1088). Indeed, the policy (DfE, 2022) positions sustainable futures, possible within 'green' education and careers, exclusively within STEM subjects. When considering the felt and sensed chaos of being in the time of climate change, trouble arises as "we are unable to shed the sense, so endemic to scientific civilization, of nature as a rather prosaic and predictable realm" (Abram, 1997, p. 16). When 'nature' proves itself otherwise we falter on our stable ground of sustaining that which we know. Suggesting that there is unrelenting and inevitable chaos, and feeling its affects in climate change events, is terrifying. In the need for solid ground, ideas are cleaved to and linked by "a minimum of constant rules" (Deleuze & Guattari, 1994, p. 201), wherein understandings and knowledges can proliferate. In doing so, rules, constants and solid lines are created in otherwise chaotic, unwieldy places and understandings are created by way of control. The habitual reassurance of being able to 'sustain' is so powerful and affective because the alternative is to accept the terror of chaotic uncertainty. So, we teach that sustainability is not only desirable, but possible.

The repetition of 'sustainability' in education acts as a refrain that generates comprehensible spaces from which we can operate within an otherwise volatile and uncertain future. In the coalescence of

anguage and material affects a stable space is created in the chaotic plane of immanence, giving form to an understanding from which behaviors and practices can generate. Indeed, educational policy demands teachers "integrate sustainability into their teaching, through modelling sustainable practices and promoting sustainable development principles in relation to their subject specialism" (DfE, 2022, Climate education). However, even the United Nations (whose 2030 Sustainable Development Goals serve as the context to the DfE's strategy) have long recognized that "education often contributes to unsustainable living" through dangers of "reproducing unsustainable models and practices" (UN, 2012, p. 6). The material-discursive interplay in saying that something is un/sustainable is affective; the way in which we talk about it creates lived sensations that become behaviors/systems of operation. Considering the origins of the concept as a way to create an understanding of and processes for resourcing societal growth, as a plastic construct, sustainability has moved with humans as a means reach new territories of need despite feeling the resultant affects of climate crisis it has wrought. An example of this mechanism is the global dependance on fossil fuel, compounded by the invention of the car in response to the 'unsustainability' of horses as modes of transport. Thus, the habitual reassurance of sustainability gives us a safe center in the storm of terrifying and violent uncertainty, from which we can continue with daily life without suc cumbing to the terror of the pure sensation of climate crisis events. I would therefore go as far to suggest that the refrain of sustainability is a machine that responds to the understanding of an impending endangerment event, allowing society to carry on in the sensed knowledge of becoming-extinct—the mechanism through which we can compartmentalize our grief.

In a more nefarious reading, it has been suggested that sustainability in education enables Capitalocenic greenwashing (Grindsted, 2018; Dunlop et al., 2022). Applying the concept of refrain, it is possible to see how in the stagnant pool of denial, there is safety from the threat of accountability. In the exploitative consumption of capitalism, the refrain of sustainability functions as a machine within the assemblage of the preservation of destructive human practices, the habitual reassurance of which becomes sedimented into a regime (Deleuze & Guattari, 1987/2013). Deleuze explains that with regimented language, "children are supplied with syntax like workers being given tools, in order to produce utterances conforming to accepted meanings" (Deleuze, 1995, p. 41). These territories being so established, the refrain of sustainability can be seen as dangerous—it creates a space of safety in the threat of our own undoing, but also one of inertia (Alaimo, 2016), one of stoppage.

No longer a concept of refrain capable of movement in relation to the continuous variation of life, the stoppage of 'sustainability' calcifies into an order-word (Deleuze & Guattari, 1987/2013). Sustainability now demands a sense of safety, but a false one—a hiding under the covers from the realities of climate change, destruction by atrophy. Curriculums established on the order-word

sustainability thus become part of a regime of signs that work to formalize specific practices within an assemblage. Conley explains this process;

Order-words function as explicit commands or implicit presuppositions. They lead to immanent acts and the incorporeal transformations expressed in their form. They also lead to assemblages of expressions. At a certain moment these variables combine into a regime of signs (2005, p. 199).

The regime now established, lethargy takes hold and "'sustainability' reveals the desire for inertia, propelled by denial" (Alaimo, 2016, p. 170). Formal education then becomes foundational to sustainability as a practice, some arguing that it thus can only be a vehicle for unsustainability (Gough, 2017) and the continuation of destructive behaviors (Donald, 2019). In this process, capitalism's rapacious mining of resources is not only continued, but organized into packages of acceptability. Mainstream schooling being established on knowledge-economy ideology, the link between capitalism and education is made stronger by the demands of the order-word sustainability—the sustenance of economy. The order-word of sustainability and its economical regime of signs are then sown at the most fundamental epistemological level, and belie the need to sustain current practices on the false premise of environmentalism. Indeed, the very notion of sustainability falters when considering that everything is in a constant state of flux through multiplicious intra-action (Barad, 2007). As Deleuze and Guattari (1987/2013) state, "you will never find a homogeneous system that is not still or already affected by a regulated, continuous, immanent process of variation" (p. 120, original emphasis). Every entity and/or phenomenon—organic, sociological, political, metrological—is always in a state of greater or lesser fluctuation, the only real constant of existence is chaos and the change it brings. Even in conceptions of death there is no stasis; organic matter melds into different compositions, strata erode into sandy beaches, historical events are framed through myriad subjectivities and sociocultural filters. In its immanence, all manner of death is still very much 'a life' (Deleuze, 1995/2005).

The Modern habit to want to fix and 'deal with' problems, to science our way out of trouble by producing products and services (that one can purchase for a competitive price!) to make life comfortable in adapting to climate change, only continues the cycle of telling ourselves we can sustain and then acting on it to produce and use more and more. But, 'adaptability' is no more a solution than sustain ability, as recognized by atmospheric scientist Katherine Heyhoe (Harvey, 2022); we are beyond the point of simply developing new technologies to adapt our way out of climate crisis. Whatever comes next needs to be far more radical, it needs to force humanity out from under the covers and stop "changing the environment rather than itself, relying on technological 'fixes'—either actual or hoped for" (Bonnett, 2019, p. 254). In its unique position to influence foundational perspectives, education should

respond appropriately; rather than teaching to sustain, we need to learn to harness the chaos.

Curriculums for chaos

In charting the fluctuations of the refrain of sustainability from its origins to its current application in education, I hope to have illustrated not only how language works as a material-discursive force, but also that sustainability is not the panacea it is held by many to be. I now put forward initial suggestions for how educators might respond with radical shifts in pedagogy. Posthuman pedagogy reimagines how we educate—or reeducate—the very notion of existence between connections of human, non-human and more-than-human worlds through non-dominant, flattened, ontological understandings (e.g. Abegglen et al., 2021; Cole, 2021; Cudworth & Hobden, 2018, as well as many more; Everth et al., 2023; Leichenko & O'Brien, 2020; Valderrama-Hernández et al., 2017). As explored above, part of the issue that needs to be reconciled is humanism's tendency to render blunt cuts in ontological prioritization. Abram encapsulates this viscerally;

Caught up in a mass of abstractions, our attention hypnotized by a host of human-made technologies that only reflect us back to ourselves, it is all too easy for us to forget our carnal inherence in a more-than-human matrix of sensations and sensibilities. Our bodies have formed themselves in delicate reciprocity with the manifold textures, sounds, and shapes of an animate earth—our eyes have evolved in subtle interaction with other eyes, as our ears are attuned by their very structure to the howling of wolves and the honking of geese. To shut ourselves off from these other voices, to continue by our lifestyles to condemn these other sensibilities to the oblivion of extinction, is to rob our own senses of their integrity, and to rob our minds of their coherence. We are human only in contact, and conviviality, with what is not human (Abram, 1997, p. 23).

Many posthuman, eco-feminist, new material and posthuman works (to name a few: Cole, 2019; Cutter-Mackenzie-Knowles et al., 2020; Myrstad et al., 2022; Abegglen et al., 2021) have already begun to suggest ways for reconciliation of human, non-human and more-than-human lifeworlds. Aligning with this work, I agree that education oriented toward environmental concerns should be sensitive to posthuman onto-epistemologies. Indeed, there is much scope for pedagogies of multiplicity for education that can respond to the flux of existence. However, implementing such practice within the demands of teaching in a neoliberalised, Capitalocenic schooling system is incredibly challenging—the two positions being paradigmatically, ideologically, diametrically opposed. Despite (and perhaps because of) these tensions, it is imperative that environmental educationalists seek practical ways to meet climate crisis in their practice as it unfolds. Therefore, I suggest there may be radical potential in harnessing the possibilities of chaos in creating curriculums that are empirical, not

epistemic. Building on nomadic notions of education (Semetsky, 2008), I propose the possibility of a minoritarian (Deleuze & Guattari, 1987/2013) toolbox of concepts for educators as a remedy to schooled sustainability, allowing for ways into thinking with (and thereby confronting) climate chaos as it unfolds and the reconciliation of human and non-hu man worlds therein. Importantly this would need to be enlivened with potentialities enough for radical change in how climate crisis is conceptualized in mainstream education, whilst not falling into the trap of 'the model' common to educational research (Cole & Mirzaei Rafe, 2017). Whilst this might help to stave off sedimentation possible in refrains that become regimes, Jukes, et al., explain that when "practices become normalised, they can lose their radical potential" (2022, p. 3).

Therefore, a 'solution' to the problem of sustainability in the curriculum, needs to be akin to a solution at hand6. The implementation of a 'type' of education always runs the risk of formulaic sedimentation, but proposing the tool that makes the tools within the immanent conditions in which they are needed, offers a solution to 'the problem' (Deleuze, 1991). Thus, I suggest developing a pedagogical toolbox of plugged-in Deleuzoguattarian concepts and eco-feminist New Materialist critique, that "pack a potential in the way a crowbar in a willing hand envelops an energy of prying" (Massumi, 1987/2013, xiii). Generating subversive reimaginings of sustainable agendas within the National Curriculum new territories may be created, interrogated, and unmade; unsticking the stoppages created in the order-word sustainability. This continual process is not an easy one, but it is the anthesis of, and hopefully antidote to, lethargic attitudes toward climate crisis. The tools to make the tools for a solution at hand would be a practical, minor, toolbox for practitioners. After all, Deleuzian philosophy is a practical philosophy of pragmatics, a 'tool box' of concepts that "that do not add up to a system of belief or an architecture of propositions that you either enter or you don't" (Massumi, 1987/2013, xiii). Such practices could provide practical ways for educators to address how climate issues are embodied with and through language, in order to actualize changes in behaviors whilst averting the dangers of reproduction of models in learning heeded above (UN, 2012). As Deleuze famously states of learning:

…there is an innate or acquired practical familiarity with signs, which means that there is something amorous - but also something fatal - about all education. We learn nothing from those who say: 'Do as I do'. Our only teachers are those who tell us 'do with me', and are able to emit signs to be developed in heterogeneity rather than propose gestures for us to reproduce (Deleuze, 1968/2014, p. 27 emphasis added).

In seeking to develop these ideas, I propose more empirical work that utilizes radical methodologies, such as proposed by MacLure (2022), in order to explore reimagings of environmental education.

Education crafted through immanently emergent means, would be generated through the Deleuzoguattarian notion of "'minor' knowledges [that] evade the striations or the straight jacket of official science" (MacLure, 2022, p.4) that currently dominates environmental education. However, I recognize the difficulty in doing so whilst having to operate in ways unoffensive to neoliberal rationality in order for ideas to be taken seriously enough for larger-scale change (cf. Cole, 2019; Dunlop et al., 2022). Indeed, MacLure (2022) acknowledges the danger of failure fraught in "trying to harness the dark forces of the cosmos, we can get the mixtures wrong, and fail to effectuate anything" (p. 4). Whilst this is something yet to be attended to, I believe it is not insurmountable. Therefore, I call for more radical empirical work into the potentialities for the development of a minor toolbox of concepts for environmental education that develop pedagogy that is; generative, co-constructed, situated, responsive to sensation and forces—in short, curriculums for chaos.

Notes

1 There is a difficulty in articulating the parameters of this context, as 'ecology', 'environment' and 'natural/nature' are not innocent terms, but blunt cuts made in humancentric representations of non-human worlds. Indeed, ecologies can be abstract and sociological, environments exist in a laptop circuit board, and picking apart what may or may not be considered 'natural' and 'of nature' far more than a simple process of delineation – it's now natural for microplastics to be apparent in nature. Alaimo (2010) illustrates the point that terms concerning 'environment' and 'nature' have been "drained of [their] blood" (p. 1), and now signal different understandings than is wise to assume innocence of. However, in seeking some stable ground for myself in this work, I identify words regularly used to denote the context of environmentalism and use them interchangeably throughout the text. There is now a whole lexicon of words that are often employed to lend a sense of virtuous legitimacy to practices, products and services in capitalist practices. 'Eco', 'green', 'organic', 'natural', 'kind' (to the environment) – all of these words and more are often used in place of or tandem with 'sustainable/ity' to signify some form of sensitivity to ecological concerns.

2 Whilst I am aware of the significant implications in the terminologies associated with feminisms, new materialisms, and broader 'environmental' theoretical frameworks, I do not have the scope to address these in this paper. For an in-depth discussion on this matter, see Gough and Whitehouse (2020).

3 The use of '≠' here is to illustrate the hierarchical view of Cartesian logic that places the cognitive, human, and progressive above that which it deems lesser, ie. That human rationality, logic and culture are privileged above nature, sensation, matter, etc.

4 School governance in the UK is devolved between England, Wales, Scotland and Northern Ireland. All examples pertaining to this context in this paper refer to the English school system.

5 Deleuze and Guattari do not restrict the concept of 'life' to biological lifeforms, but to any arrangement of events that encounter one-another creating an assemblage.

6 n keeping with the Deleuzian notion of the 'toolbox', the solution at hand is an idea that comes from a woodwork ing manual of the same name (Wearing, 2019), in which simple but effective tools and guides (often called jigs) can be made by the woodworker in response to the specific requirements of a workpiece.

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ORCID

Sarah Evans

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