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The Cre@tive Expedition for science literacy

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Students experience the natural science subjects as lacking relevance in relation to their everyday lives. New solutions are needed to maintain students' interest in science subjects. Students' interests are closely linked to the experience of relevance and meaningfulness, which can be promoted by experiential learning with a high degree of student involvement. Students acquire knowledge and skills through practical experiments and scientific data collection and analyses, which can increase their interest in science and increase their science literacy. Citizen science projects involve the public in research, including the problem-definition and development phases. The current project is embedded in education science with the purpose of designing, testing, and evaluating innovative learning activities with the active involvement of students and teachers. These learning activities involve experiential learning and integrate participants' bodies, senses and physical activities, with the goal of increasing participants interest in science and developing their scientific literacy. By an exploratory and emerging process, which involved researchers, practitioner, and students, we created The Cre@tive Expedition. In The Cre@tive Expedition participants use their bodies and senses to solve tasks at the outdoor Active Living Laboratory. The concept is structured as an educational Escape Room designed for participants to problem-solve, collaborate, and be active and experimental. Until now, the concept has been tested in three settings, which has fueled the vision of the development of the Active Living Laboratory as a place where children, teens, and other citizens can engage with science, as well as scientists, and participate in experimenting through inspiring and physically active STEM learning activities. With a citizen science approach, we will explore and develop the involvement of students in all phases of the research project, which is currently in the initial development phase. Based on our participation in CitSci2022, we will further develop our involvement of the public in the research process and in the development of new ways of integrating the body, senses and physical activities through fun, inspiring, and challenging learning.

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1. Introduction

The Danish primary education system has a strong focus on promoting children and young people's interest in STEM (Science, Technology, Engineering, and Mathematics). But students experience the natural science subjects as lacking relevance in relation to their everyday lives, and new solutions are needed to maintain students' interest in science subjects [1]. Students' interests are closely linked to the experience of relevance and meaningfulness, which can be promoted by experiential learning with a high degree of involvement from the students [2].

Citizen science bridges the gap between research, science, and surrounding community by involving the public in studies and experiments [3]. One citizen science perspective is to increase knowledge production, while another perspective considers both scientific and non-scientific goals, such as citizen empowerment, education, awareness, and advocacy [4, 5]. Scientific literacy can be an outcome of both citizen science and science education, and entails understanding of science which is important for everyday challenges. In an educational context, an exploratory approach, where students acquire knowledge and skills through practical experiments and scientific data collection and analyses, has the potential to increase students' interest in science and increase their "science literacy", in the sense that students can gain greater knowledge of science and the critical approach they can take towards available knowledge, thereby strengthening their ability to cope with and navigate society [6].

This involvement of students can furthermore include the integration of the body, senses, and physical activities. In a natural science perspective, students can learn about, with and through the body, e.g., learning about the cardiovascular system and oxygen uptake while engaged in physical activities. The organization of physically active learning processes provides the opportunity to support holistic oriented learning [7].

The benefits of integrating physical activity into education and learning activities is supported by evidence [8]. In Denmark, schools are obliged to integrate 45 minutes of physical activity into the school day. This is however not always achieved, especially for older students, and teachers state that they lack the skills and inspiration needed to implement this requirement meaningfully in academic content [9].

The aim of this paper is to develop, test, and evaluate innovative learning activities that entail experiential learning and integrate body, senses and physical activities with the goal of increasing participants' interest in science and developing their scientific literacy.

The study is in its initial phase where students and teachers (citizens) mainly are involved in problem-definition and designing of the activities, which at later stages will be tested and evaluated. In these future phases, students and teachers will be involved in the development and collection of data, including data on their learning experience and scientific literacy, through interaction, engagement, development, testing and designing of The Cre@tive Expedition.

1.1 Active Living Laboratory

At the University of Southern Denmark (SDU), a large outdoor area is designated to be an outdoor laboratory where researchers can develop, integrate and evaluate science in relation to the local communities. The area is called The Active Living Laboratory and contains rainwater lakes, hills, a forest, and agricultural land. SDU, University College Lillebælt (UCL), Health Innovation Centre of Southern Denmark (SDSI) and Region of Southern Denmark are partners in making this outdoor area attractive for local institutions, citizens, and researchers. The area is envisioned as a place where children, teens, and other citizens can participate in experimenting through inspiring and physically active STEM learning activities.

2. An explorative design process

In creating new active learning activities, we used an emerging and exploratory approach when starting the project. The project is a developmental project in which we developed knowledge through practical work related to our aim. Insights, knowledge and reflections from our workshops and daily discussion, became stepping stones in creating and testing the concept. In future phases of The Cre@tive Expedition other citizen science-based research approaches will be employed including development of evaluation methods and involvement in testing and data collection and analyses. This will improve the data quality and our understanding of how students learn and experience science literacy, how they understand engaging and fun learning activities, and how teachers can stimulate and engage students in physically active STEM learning. In the following section, we highlight important insights so far from the project.

2.1 An expert workshop

The first workshop was held with experts from SDU, UCL, UC Syd, SDSI and Campus Odense, focusing on gaining ideas and knowledge of possible innovative and experiential learning activities in the Active Living Laboratory. In the workshop we sought to both create and validate ideas. As a result of the expert workshop, we decided that the concept should be inspired by an escape room approach with an exploratory, experimental and mysterious way of solving the tasks and completing the activities. The activities should also be realistic and of relevance to the students, to create a feeling of autonomy.

2.2 Test of first draft with a local school

Having created a first draft of our concept, we invited 25 8th graders to test the concept in the Active Living Laboratory. The initial concept was a GPS-based activity course, where students were equipped with a bag of utilities. After an hour of testing, the students were facilitated in an evaluation of the activities. The students expressed a liking for the collaborative aspect of the activities and “being on their own in nature”. And they were also very positive about having the materials from the bag to solve the activities. The students pointed towards a need for more creativity, and more collaborative and challenging activities, and herein clues that could help them, if they could not complete a task.

2.3 Escape rooms in Odense

As a part of the development process, we sought inspiration in existing outdoor escape rooms. Escape rooms advocate a collaborative trial-and-error approach when problem-solving, and furthermore facilitate motivation for the participants. Through City Escape Odense, we realized the value of the suitcase element. A suitcase contributes to an exploratory, hands-on, and mysterious approach to the activities while acting as a common foundation for a group. The City Escape Odense had emphasized a story, and we found that the storytelling is important to create an immersive experience and that the link between the activities and the story must be strong to support the immersion.

3. The Cre@tive Expedition

The development process ended with design of The Cre@tive Expedition. The @ symbolize the combination of an “a” and a “c”, indicating that the expedition is both creative and active. The Cre@tive Expedition contains learning activities, structured as an outdoor escape room, where teams move through the Active Living Laboratory to find, solve, and interact with various tasks.

The design of our expedition aims to stimulate active learning, creativity, and problem-solving by creating an experiential learning atmosphere [8]. This atmosphere is furthermore supported by autonomy for participants, so that they can control speed and need for clues and help. In The Cre@tive Expedition, the activities are supported by the figurative character, Professor Twitch (See Figure 1), who has forgotten his/her scientific knowledge about the body. It is the participants quest to help her get it back by rediscovering different knowledge-aspects of the body. The participants get a suitcase with a map, compass, stopwatch, pedometer, a pair of scissors, thread, and a balloon —props they must use when facing the challenges. When the



Figure 1: Professor Twitch has lost his/her memory.

participants solve a challenge, they will uncover a new part of the map, which will lead them to the next activity and so on. The activities include building the cardiovascular system using materials from nature, finding their way with a pedometer and a compass, exploring the area to find four digits, and finding and matching human bones. The design of the concept demands collaboration and communication between the participants to solve the tasks. The tasks are inductive and open, which leaves a possibility for the participants to think creatively and apply an experimental trial-and-error approach for succeeding.

4. Test of the concept

Test of the concept pushes further development and qualification. We tested the concept in different settings with different participants, to get different views and aspects. This includes testing with families, students, researchers and participants at the Engaging Citizen Science Conference (CitSci2022) in Aarhus.

4.1 The Danish Science Festival

As part of The Danish Science Festival, SDU was host for different research activities for the public. Here we tested The Cre@tive Expedition with participating families. We tested the concept with utilities for families with kids. Families were handed our suitcase and had to scan QR-codes using personal phones. The concept included the story of Professor Twitch, and the activities were placed outdoors. The feedback emphasized the "family-value" of participating in the concept. Although no formal evaluation was done, this test supported our idea of the concept.

4.2 School festival at Campus Odense

The second test of The Cre@tive Expedition was with local schools exploring the Active Living Laboratory. Here 10 classes from 4th grade (250 students) came to the area for a day of school at the university. We had redesigned the concept to contain three reduced activities. Based on our observation of how the students interacted with the suitcase and how they solved the tasks, we gained further confidence in the concept.

4.3 Demonstration at CitSci2022

A few participants tested the concept as part of a demonstration at CitSci2022 in Aarhus. Apart from the demonstration, we were inspired by the other existing and similar concepts from the participants. We gained new insights and perspective, increased our network with useful contacts, and were presented with useful apps and tools, which could be integrated into our concept.

5. Reflection and inspiration

Development, testing and evaluating innovative learning activities with students and teachers (citizens) are key elements of our research project. This entails experiential learning and integrates the body, senses and physical activities with the goal of increasing participants' interest in science and developing their scientific literacy. Based on our testing activities and the demonstration at the CitSci2022, we continue the development process and found the following new perspectives in relation to our concept.

The purpose of citizen science is to bridge the gap between research, science, and surrounding community by involving the public in studies and experiments. At the CitSci2022, we found inspirational examples of local engagement as a key part of research projects. This emphasizes that the role and responsibility of the universities in society is not only knowledge producing but also being an active part of engaging and involving local communities in education and promotion of science literacy. This fuels our vision of developing Active Living Laboratory as a space wherein citizens can engage with science and scientists and can participate in experimenting through inspiring and physically active STEM learning activities.

We were inspired to continue to actively involve the public in the research process and regard this as important as creating solutions for the public. In our concept, the research objective is related to the learning process i.e., how children and teens can develop scientific literacy and motivation for science through different learning activities. This is an important distinction, when comparing other citizen science projects with other research objectives, e.g., biodiversity, water quality or air pollution [5]. We involve the public in making, testing, and evaluation—and will continue to involve them in the research process, and the development of creating new ways for integrating the body, senses and physical activities in fun, inspiring and challenging learning.

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