SDGs VR-Play for KIDS: An education experience on local sustainable solutions using virtual reality to target vulnerable children

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Abstract
Lack of engagement of children in strategy design to achieve sustainable development is becoming a growing concern worldwide. This is especially evident and troublesome when tackling XXI century environmental challenges, such as climate change and resource consumption behaviors. Today, more than ever, young activists are raising their voices to drive the attention of both mass societies and political leaders to develop social, environmental, and economic policies that protect youth. While this appears to be a growing trend, there are knowledgeable gaps on the multitude of enabling factors and framing conditions that affect the planet's view from a child's perspective.

This study aims to bridge the existing gaps between children natural resource consumption and waste education and the United Nations Sustainable Development Goals. Through the development of the "Sustainable Development Goals Virtual Reality Play for Kids" (SDGs VRPlay for KIDS) Beta App to educate children and youth about the SDGs in a simple, fun, and child-friendly manner using gamification strategies, while viewing world problems "through the eyes of a child." The SDGs must be brought down to local realities to successfully integrate all members of society including children and youth to better the world by 2030. Children must internalize how the issues represented by the SDGs affect their own individual and daily lives and surrounding environments through awareness, story-telling, community engagement, collaborative and interactive activities, and data sharing. Such activities may include: improving health and nutrition, the importance of early learning and quality education, fostering peaceful communities where children live free from violence, or establishing more sustainable approaches (no child left behind) to the preservation of commodities (UNICEF 2015).

Keywords: Children; Virtual Reality; SDGs; Education; Gamification; App

1. Introduction

1.1. Background

According to Gilford (2011) a number of barriers to climate action are due to limited cognition, ideologies, comparison with others, sunk cost, discredence, perceived risks, and limited behavior. These "dragons of inaction" addressed by Gilford are some of the drivers that persuade humans when considering climate action. Thus, games can be regarded as a valuable tool to develop awareness on such climate actions. Games have the capability to affect and influence behaviour to a certain extent (Ferguson and Garza 2011). For instance, scholars have shown that they are able to engage and encourage learning activities (Huizenga et al. 2009). Over the past decades, games have evolved from 2-D to virtual reality, with mobile games being a powerful tool to reach out to a larger audience and deliver equal opportunities for engagement (Kurkovsky 2009).

Dating back to the sixties, Virtual Reality (VR), or immersive virtual reality, was developed to foster interaction between the user or learner and a subject for educational purposes (Nooriafshar et al. 2004). In its first applications, VR devices were mainly used to reproduce multi-sensory experiences combining color, sound, smell, and sense of movement (Freina and Ott 2015). As computer technology developed, computer-based VR offered a variety of features and applications to create virtual learning environments and fictional realities for educational and recreational uses.

As defined in the online Collins Dictionary, the term VR is used to describe, "An environment that is produced by a computer and seems very real to the person experiencing it." In particular, it refers to "the computer-generated simulation of three-dimensional images of an environment or sequence of events that someone using special electronic equipment may view, as on a video screen, and interact with in a seemingly physical way." VR offers multiple possibilities for education and training, especially through employment of future scenarios and changing external conditions. For example, when studying climate change and its long-term effects, VR can depict environmental changes that may occur by simulating extreme weather conditions and other concurring environmental hazards. Similarly, when approaching the study of waste and resource consumption, the use of VR can serve to generate future conditions that may be the result of our environmental practices. To this end, the device may visualize an ocean with more plastic than fish, an over-exploited habitat, or a plant-free forest that underwent heavily deforestation processes.

Finally, through VR it is possible to integrate a level of interaction and gamification to augment the learning experience. Not only is the learner immersed in a virtual world, but they can also interact with it through first-person experiences such as games, story-telling, and virtually connecting with other users around the world achieve the ultimate goal of transferring and building knowledge (Winn 1993).

1.2. Developing the idea

In 2017, the authors developed a campaign deemed "Urban Metabolism & Minority Pulse: An education and awareness campaign targeting minority groups" aimed at targeting minority education on sustainable development issues using the SDGs as a cross-boundaries communication platform. The campaign addressed seven target groups that the authors defined as "minorities" in our contemporary societies, with children being one of them (Fernandez and Maione 2018). General education purposes were addressed through both tailor-made workshops, seminars, and activities, within the boundaries of each minority learning environment and across-group activities, using the cities of Mantova and Milan, Italy as main case studies.

The children's educational activities were related to material, energy, and pollution flows. Interactive activities were as follows: (1) observing the impacts of climate change on the environment (e.g. how glaciers have changed over the last century and its effects on polar bears), (2) understanding the interconnections between natural systems and the built environment, (3) assessing resource consumption behaviors at the household level to determine good sustainable practices (e.g. energy, waste production, recycling, and travel mode - carbon footprint), and (4) visualizing pollution rates from all around the world (Fernandez & Maione 2018).

VR was introduced in the campaign to provide an inclusive learning experience and easy access to information through story-telling, games, and point-scoring activities. The twofold process included: (1) training of teachers and educators to facilitate access to virtual knowledge and the integration of VR-based learning to their classroom curricula, and (2) installation of VR devices (cardboard box mounted on a smartphone). The campaign's preliminary results showed benefits and opportunities of introducing VR as a learning platform.

In fact, such an approach is intuitive, low-cost, and it stimulates children's imagination while assimilating information.

1.3. Scope of the study

This study aims to use interactive learning VR technology to foster children's existing knowledge, perception and information gaps when considering environmental issues around the world. In addition, explores the applications of the SDGs VRPlay for KIDS App, a simple child-friendly, fun, and open source platform to learn about the SDGs through case studies, visualizations, games, VR, and interactive activities.

The central goal of this study is to tackle sustainable development education through civic engagement and empowerment of educators. Moreover, spur action amongst children and youth to raise their voices, social consensus to develop informed opinions on policy matters that affect their everyday lives. The second phase objectives of this study are as follows: (1) providing an easy to use and accessible App for online learning to deliver information on sustainable development and children, and the SDGs, (2) exploring the effectiveness of the beta App through a test and control group experiment where children are evaluated based on specific indicator measures and knowledge of the App vs. children without (e.g. pre-existing knowledge, access to computer systems, understanding capacity, and others), and (3) assessing the effectiveness of the learning process developed through the App by monitoring users, data, and testing acquired information.

2. Methods

2.1. Five phases

Figure 1 shows the VRPlay for KIDS Beta App test plan is composed of four phases. The phases will be tested and evaluated on children ages 5-12 under parental supervision and in full compliance of privacy laws in a test and control group environment setting in the northern Italian city of Mantova, Italy. Phase 1: Concept and Design develop the App concept and design tailored to children ages 5-12. Phase 2: Beta Test 1 addresses the effective education and awareness, including testing of awareness before and after playtest, and closed group testing of behavioral changes. Phase 3: Public Showcase generates public attention of game/App, and gauges public interest and correlation with the United Nations SDGs mission and values. Phase 4: Final Beta test includes testing of functions of the game's features and interest in different topics within game. Phase 5: is the release of the full game to the world in English and Italian language.

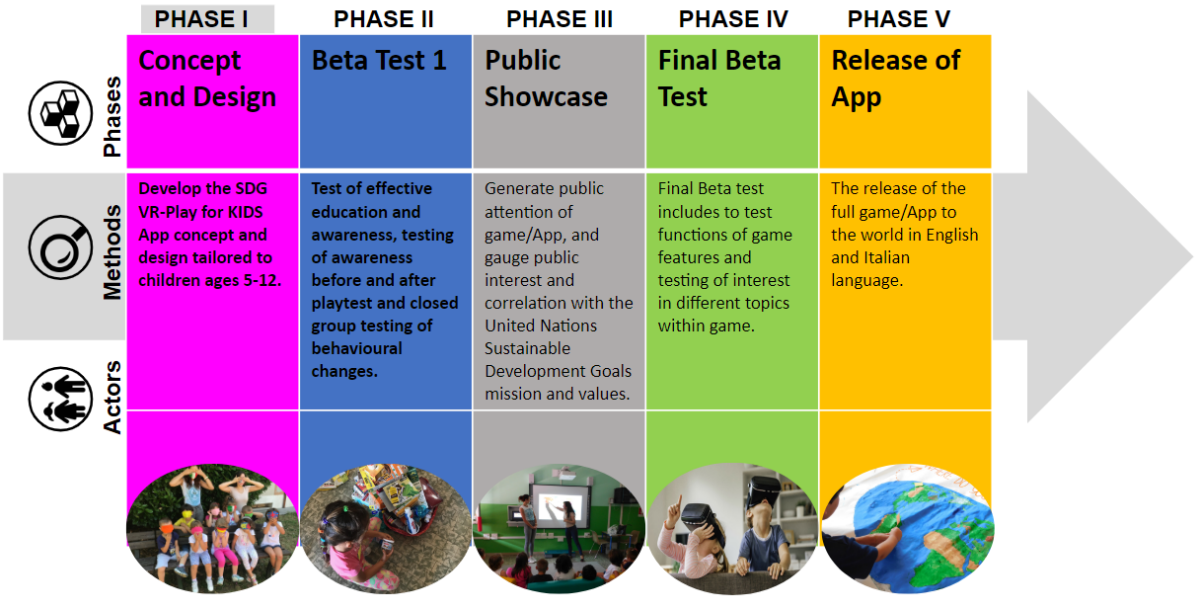

Figure 1. VRPlay for KIDS Beta App Research Phases

2.2. Future implementation

Figure 2 shows the beta App interface prototype composed of a number of thematic navigation setting selections:

- *SDG community*: provides a network of active/prospective children in connection to the SDG community;
- *Add find your school*: an option for schools/organizations and educators to become official members of the VRPlay for KIDS App school program network in order to localize the SDGs in their own individual school,
- *About*: provides further information regarding the navigation and usage of the App through the help of the *Super Hero Resource Flow Squad*;
- *Travel the world through storytelling*: provides a 360 degree VR experience as children across the world share their stories through cultures, habits and traditions when considering environmental mitigation; and
- *Education:* a library of fun key terms for children on the United Nations Sustainable Development 17 goals and games;
- *Photo tracker global positioning system (GPS):* the geographic coordinate data sharing bank allows children to explore and learn about their surrounding environments while playing interactive games, storing data, and exchanging knowledge.

As part of future research, Phase 2 will be followed by further tools and interfaces to extend functionality and scope. Future implementation includes: (1) incorporating user feedback to reach out to and work with organizations and communities, as well as to improve and promote the game, and (2) releasing the game worldwide in various languages.

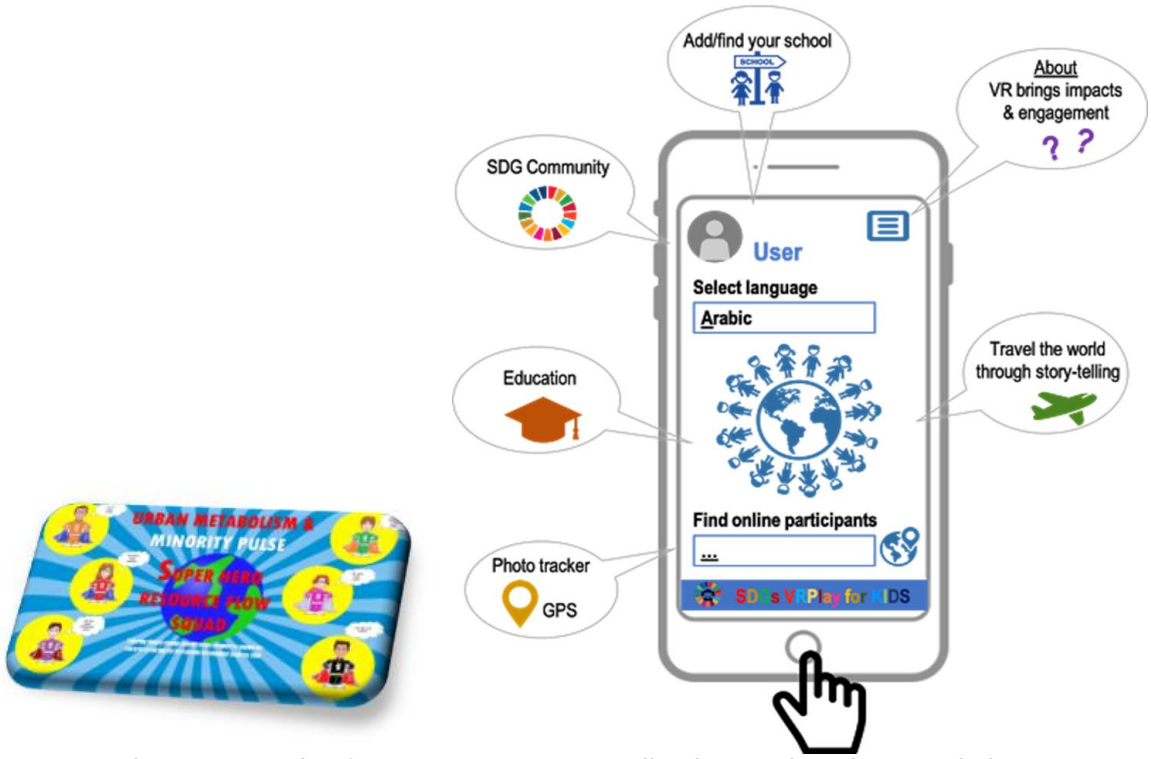

Figure 2. VRPlay for KIDS Beta App application setting characteristics

2.3. Users

The target audience focuses mainly on children ages 5-12 with the intent to educate players on sustainable practices and eco-friendly behavior, as well as the consequences of their environmental actions. Some examples are as follows: afforestation, water conservation, and energy conservation, waste management, recycling, and minimizing plastic waste.

3. Results and Discussion

3.1. Preliminary results

The VRPlay for KIDS App Phase 1 stage focuses primary on the concept and design process. This includes considering effective sounds, painting with time technique, reward point systems, feedback to their taps, and fun digital interaction on screen, spacing and sizing of elements, simple shapes, appropriate colors, and avoiding overloading the App with information and commands. However, avoiding outbound links that might put the child in danger. Thus, developing and designing an App that is intended for both children and parents. The idea is to illustrate to kids some of the difficulties of tackling world issues through a set of fun activities, games, VR 360 video experiences and SDG community network with children across the globe.

3.2. Expected results

Overall, expected results includes the development of an open-source prototype SDGs VRPlay for KIDS App platform to educate new generations of children. This platform allows users to learn about their own environmental dangers and human Anthropocene virtually while connected to a global network. Platform activities includes a process of data collection on children in their own environments by employing real-time geo-referenced photographic evidence and mapping applications. This study uses virtual reality technologies to educate children to view sustainable development solutions across the world through lessons learnt (e.g. pros/cons) and experimentation lenses across a sensory multitude ambience experience. Phase 2 aims to develop a treatment and control environment using children ages 5 to 12 in schools in Mantova, Italy. It is with this goal that we attempt to prove the effectiveness of the

VR App in children. The testing period will last between 1 and 3 months. Figure 3 illustrates the VRPlay for KIDS Beta App application stage matrix characteristics on the children reward system and design guidelines.

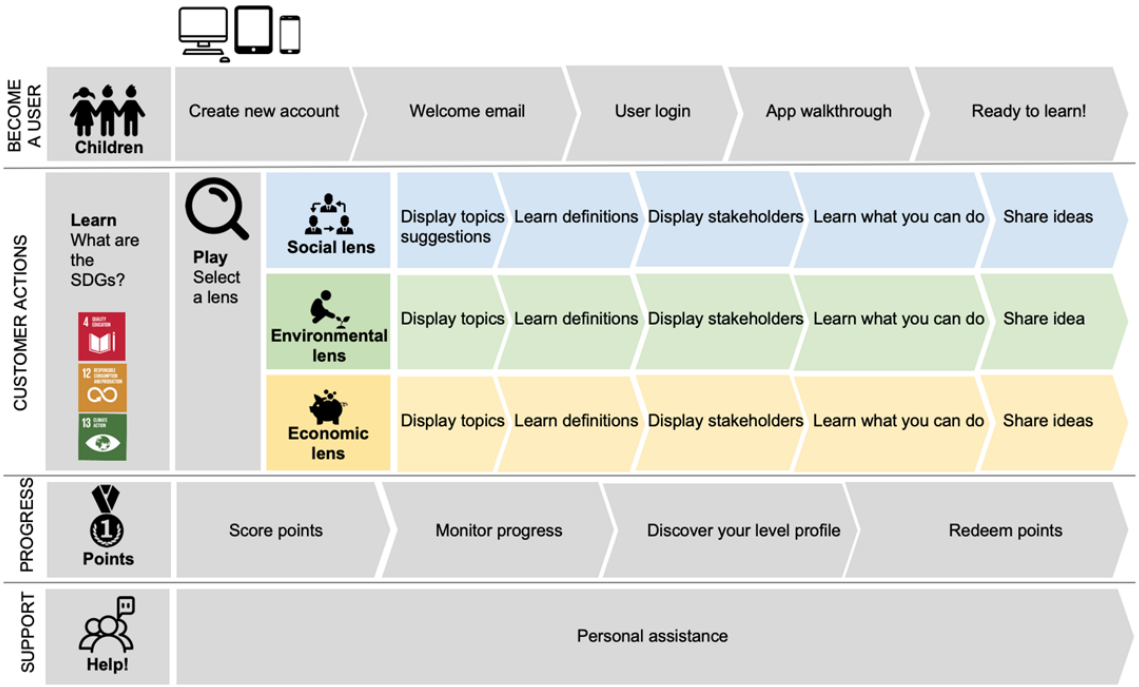

Figure 3. VRPlay for KIDS Beta App application matrix

3.3. Impacts and App applications

The SDGs VRPlay for KIDS App aspires to tackle environmental, social, and economic thematic areas to serve as a platform for children, educators, and young activists through virtual reality working groups, aimed at bringing people together. This serves for developing capacity building and youth empowerment by sharing of cultures, story-telling, habits, beliefs, and sustainable development practices. When that understanding happens, communities can be inspired to take action, resulting in sustained progress on these goals and long-term shifts in social norms and behaviors.

Finally, it has a role in processes related to the United Nations Agenda for sustainable development by tackling SDG11 (Sustainable Cities and Communities), SDG12 (Responsible Consumption and Production), and indirectly SDG4 (Quality Education), as well as other processes which are convened in the world on development issues related to children. The role of children in achieving the SDGs can be summed up as raising awareness, taking action, and holding governments, and other stakeholders to account on progress. Thus, through the SDGs VRPlay for KIDS App children can learn and engage local change makers on topics that affect them personally at home, school, and play.

3.4. Elements of innovation

The approach to the study of sustainable development explained hereinafter presents both content and methodological elements of innovation. (1) It fosters the use of creative and immersive learning to integrate more traditional classroom curricula, using multi-sensory experience (e.g. sense of motion, colors, sounds, feeling of weather conditions, and feeling of natural elements) to enrich story-telling with first-person experience. (2) While ideas of immersive learning have been circulating widely, this study investigates tangible applications at the level of the K-12 education system giving consideration to how the use of VR and computer-based technology affect children's understanding and learning capacity. (3) The use of an open-source App platform allows to generate learning analytics (e.g. generic information

on the users, App usage and frequency of use, and learner's progress). (4) Finally, this approach allows for the creation of a virtual network towards a digital environmentally-friendly society where citizens can connect with peers and collaborate to generate sustainable and smart solutions (e.g. sharing recommendations, think-tank activities, and sharing experiences).

4. Conclusion

Children are our future as they will be the next voice in striving toward a sustainable planet, they must first be aware of the problems and possible solutions. With an understanding of nature, children will have a better comprehension of climate change down the road. This means that they can absorb information through discussion and hands on activities. The goal of the App is to visually express the point and resonate with children by keeping in mind his or her interest while creating a fun and interactive environment. The idea is to allow children to keep the conversation regarding environmental issues to be ongoing.

Through the promotion of climate action using gamification and VR technologies children can reflect on world problems. Games often look at a single topic and rarely cover various problems. The proposed App design addresses real world problems to allow players to traverse their environment while exploring a world desolated by climate change. Guided by friendly avatars called the Super Hero Resource Flow Squad (Urban Metabolism Squad), players will seek out resources, information, and start asking smart questions, make better consumption choices, help create better policies, and transform our world into a green children-friendly paradise.

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