

**Climate Change Education through Games: Better Immersive and Interactive Digital  
Games Design Targeting Climate Change Education for Primary School Children**

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## Thesis Statement

This Capstone will investigate current climate change educational games for primary school student. It also proposes potential immersive and interactive educational games that can help promote better climate change education among primary school students.

## Introduction and Background

### Climate change

Climate change refers to the long-term shifts in temperatures and weather patterns. The number of climate refugees/environmental migrants (person or group forced to move permanently or temporarily out of habitual homes due to sudden or progressive change in the environment<sup>1</sup>) has been rising through decades. Climate change-related events such as rising sea-levels, extreme weathers (droughts, flooding, anomaly in temperature), the risk of famine, and loss of biodiversity all have been factors for the inhabitants' relocation<sup>2</sup>.

The future generations will carry over the weight of the burden that we put on our planet today. The Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC) reveals the potential impact of climate change under five Shared Socioeconomic Pathways, which are five synthetic socio-economic futures used for making predictions.<sup>3</sup> Figure 1 shows a probable temperature rise in the five SSPs. For example, the estimated warming between 2041-2060 shows that it is very likely that there would be a rise of 2°C if CO2 emissions maintain the current level while approaching net-zero by 2100 (SSP2-4.5). The

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<sup>1</sup> “Key Migration Terms,” Key Migration Terms | International Organization for Migration, <https://www.iom.int/key-migration-terms>.

<sup>2</sup> “What Is Climate Change?,” United Nations (United Nations), <https://www.un.org/en/climatechange/what-is-climate-change>.

<sup>3</sup> “Ar6 Climate Change 2021: The Physical Science Basis,” Sixth Assessment Report, n.d., <https://www.ipcc.ch/report/ar6/wg1/#SPM>.

IPCC also addressed that the increasing global warming is in direct relation to "the increases in frequency and intensity of hot extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic Sea ice, snow cover, and permafrost."<sup>4</sup>

SSP	Scenario (Likelihood <sup>[27]</sup> )	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP1-1.9	very low GHG emissions: CO <sub>2</sub> emissions cut to net zero around 2050	1.6 °C	1.4 °C	1.0 – 1.8
SSP1-2.6	low GHG emissions: CO <sub>2</sub> emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP2-4.5	intermediate GHG emissions ( <i>likely</i> ): CO <sub>2</sub> emissions around current levels until 2050, then falling but not reaching net zero by 2100	2.0 °C	2.7 °C	2.1 – 3.5
SSP3-7.0	high GHG emissions ( <i>unlikely</i> ): CO <sub>2</sub> emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	very high GHG emissions ( <i>highly unlikely</i> ): CO <sub>2</sub> emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

Figure 1: SSP in the IPCC Sixth Assessment Report<sup>5</sup>

From the report, the rise of global temperature and higher chances of extreme events are unpreventable. It is impossible to alter the past, and the current CO<sub>2</sub> emissions in the atmosphere will have a lasting impact on the future. To be fully prepared for future changes, it is vital to start teaching our younger generations about climate change. They need to learn what is happening today and raise their awareness of what's to come, what needs to be resolved, and eventually, what needs to be changed.

With our current climate, we see more and more land becoming unsuitable for crop production. According to National Geographic, by 2050 the climate change will cause the loss of yield in major crops, corn by 24%, wheat by 3%, rice by 11% and potatoes by 9%.<sup>6</sup> Rising temperature tends to also be an issue in much of the world. With increasing Green House Gas

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<sup>4</sup> “Ar6 Climate Change 2021:The Physical Science Basis,” Sixth Assessment Report, n.d., <https://www.ipcc.ch/report/ar6/wg1/#SPM>, 18.

<sup>5</sup> “IPCC Sixth Assessment Report,” Wikipedia (Wikimedia Foundation, October 23, 2021), [https://en.wikipedia.org/wiki/IPCC\\_Sixth\\_Assessment\\_Report#cite\\_note-26](https://en.wikipedia.org/wiki/IPCC_Sixth_Assessment_Report#cite_note-26).

<sup>6</sup> “How to Live with Crop Changes,” National Geographic, <https://www.nationalgeographic.com/climate-change/how-to-live-with-it/crops.html>.

(GHG) emission, which not only affect crop production, but also affect fisheries and livestock. This means within the next few decades, there needs to be some changes to be made, for the future generations' well-being.

### Learning methods for elementary school students

Environmental education can be done in various ways. However, the learning style of an elementary school student may not be the same as an adult, making it crucial to find out which is the best way for elementary school students between the ages of 8-12 to start understanding and learning the world we live in today. The problem can be divided into two parts: the first part being what is the most effective method for elementary school students to learn in the current era, and the second part being how climate change knowledge can merge into the practical method identified in the first step.

To target the method, looking at the learning patterns of elementary school students is essential. According to studies on best practices of teaching by Fleming and Mills from Lincoln University, who proposed the VARK Modalities, four perceptual modes in learning: visual, auditory, read/write, and kinesthetic. Visual learners are more sensitive to objects like space, graphs, charts, and maps. Auditory learners are better at learning from events like discussions. While the read and write learners would prefer learning from formats like notes and texts. The last type, kinesthetic learners, more efficiently learn through practical experiences.<sup>7</sup> From a journal published in the International Electronic Journal of Elementary Education (IEJEE), the dominant learning style at the elementary school level in Ambon-Indonesia is kinesthetic learning, which accounted for 56.76% of the students tested. Auditory, read, and visual

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<sup>7</sup> Neil D Fleming and Colleen Mills, “Not Another Inventory” (To Improve the Academy, 1992), [https://vark-learn.com/wp-content/uploads/2014/08/not\\_another\\_inventory.pdf](https://vark-learn.com/wp-content/uploads/2014/08/not_another_inventory.pdf).

accounted for 22.86%, 17.52%, and 2.86%, respectively.<sup>8</sup> This finding suggests that the elementary-level games should involve more practical operations while lessening content involving activities like map-understanding and graph-reading. Since climate change involves many human activities, it is feasible to make the climate change educational game kinetic-focused.

While the current technologies allow us to make a game kinetic focused via immersive and interactive gaming design, the true struggle is how to make and populate a game that properly incorporates educational content and meets the needs of current generation.

### Educational video games

The boom of technologies brings our generation infinite possibilities to learn and explore the world. The term edutainment, or educational entertainment, was first identified in 1970s while games were introduced. Edutainment includes games from various platform such as computer games, video games and apps that are available on phones and tablets.<sup>9</sup> The effectiveness of edutainment was proved in 1980s when math-based computer games was found to be more “motivating, engaging and successful in teaching student planned math concepts.” Until 2004, 20 quantitative studies (Appendix A) showed support for incorporating computer games, but none proved the effectiveness of computer based educational games over other traditional teaching methods. In other words, it was not clear whether computers or the activities that the participants engaged in boosted learning experiences.<sup>10</sup> More studies should be done to

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<sup>8</sup> Marleny Leasa, Aloysius D. Corebima, and Ibrohim bosluk, “Emotional Intelligence among Auditory, Reading, and Kinesthetic Learning Styles of Elementary School Students in Ambon-Indonesia,” International Electronic Journal of Elementary Education 10, no. 1 (2017): pp. 83-91, <https://doi.org/10.26822/iejee.2017131889>.

<sup>9</sup> Mariana Lopez De Castilla, “History of Educational Games”, Playful Learning, <https://commons.pratt.edu/playful-learning/history-of-educational-games/>.

<sup>10</sup> Egenfeldt- Nielse, Simon. Making sweet music: The education use of computer games. Center for Computer Games Research, 2008. University of Copenhagen.

identify what set the computer games aside from their traditional competitors in our current world's field of educational games.

One of the successful educational (game) websites is Sesame Street. Sesame Street is known for its longest-running children's TV show, it was created back in 1966 when the founder, Joan Ganz Cooney and Lloyd Morrisett, wanted to use television to help disadvantaged children for school. By creating an informational TV series, Joan incorporated information and entertainment, which was later defined as infotainment.<sup>11</sup> The key difference between infotainment and edutainment is the first one focuses on giving information while the second one addresses on the educational purpose. The company reached millions of preschoolers by the end of its first season in 1969, and it kept rising with continuous impact across the world.

Sesame Street continues with their infotainment, and at the same time, the company is also one of the frontiers of edutainment for children. Within the recent decades, Sesame Street made achievements such as preschool curriculum to address HIV and AIDS and supporting children with incarcerated parents. In 2018, the LEGO foundation granted \$100 million dollar to cooperate with Sesame Street to build a play-based curriculum to support the children affected by the Rohingya and Syrian crisis. Now Sesame Street does not only represent a TV show, but it also represents a brand, a mobile App and a website. The success of Sesame Street is not only due to its beloved character, but also due to the impact it has on the children and our world. The journey of Sesame Street also proves edutainment is powerful and influential on our future generations.<sup>12</sup>

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<sup>11</sup> “Infotainment Definition & Meaning,” Merriam-Webster (Merriam-Webster), <https://www.merriam-webster.com/dictionary/infotainment>.

<sup>12</sup> “Our History,” Sesame Workshop, <https://www.sesameworkshop.org/who-we-are/our-history>.

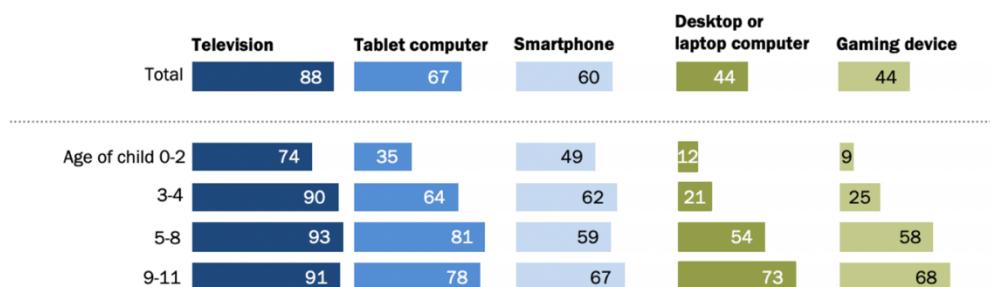
## The Growing Trend: Educational Games

### Time Spent on Games

One of the main issues that needs to be focused upon is how much time a child spends on electronics. Children between the ages of 2-10 are shown to have on average 18.6 hours per week just on screen-based play (Figure 2).<sup>13</sup> This can be seen as a positive if the time spent is

#### **Children's engagement with certain types of digital devices varies widely by age**

*% of U.S. parents of a child age 11 or younger who say that, as far as they know, their child ever uses or interacts with a ...*



Note: If parent has multiple children, they were asked to focus on one child when answering this question. Those who did not give an answer are not shown.

Source: Survey of U.S. adults conducted March 2-15, 2020.  
"Parenting Children in the Age of Screens"

PEW RESEARCH CENTER

*Figure 2: Children's free time distribution (aged 2-10)*

for educational purposes. We can see that on average, 67% of children under the age of 11 or younger already have a tablet computer (Figure 3).<sup>14</sup> If we can educate them at a younger age on the environment and the climate, it will last them for a lifetime. With 88% of the children from ages 11 and younger watching TV, we can have them watch channels that are related to nature so that way they would be more willing to see why it's important to preserve the environment. There is also the option of increasing more outside playtime to help the children understand what they are learning and preserving in the future. These are just one of the many

<sup>13</sup> Martin Armstrong and Felix Richter, "Infographic: Screen Time Dominates Kid's Play," Statista Infographics, November 1, 2017, <https://www.statista.com/chart/11651/screen-time-dominates-kids-play/>.

<sup>14</sup> Brooke Auxier et al., "1. Children's Engagement with Digital Devices, Screen Time," Pew Research Center: Internet, Science & Tech (Pew Research Center, August 27, 2020), <https://www.pewresearch.org/internet/2020/07/28/childrens-engagement-with-digital-devices-screen-time/>.

solutions to the issue stated, another way would be including more educational game-based homework to their weekly schedule. Homework only makes up 2.7 hours of their weekly activities, meaning teachers can assign educational games related to climate change or ways to help the environment at school for them to do at home.



Figure 3: Children's engagement with digital devices (aged 0 - 11)

### Feasibility of climate change educational games

Despite the lack of literature proving direct causal effect of incorporating computers into educational games, studies have showed the possibility of climate change educational games. The screen time of current US children also implies the potential opportunity to add educational video games into their “playlist”. As mentioned before, the most effective learning method among primary school students is the kinetic learning style, which indicates that primary school students learn best through practical activities.<sup>15</sup> When this setting is applied to the environmental education domain, it's possible to create a simulated reality that allows students to take actions by immersing

<sup>15</sup> Marleny Leasa, Aloysius D. Corebima, and Ibrohim bosluk, “Emotional Intelligence among Auditory, Reading, and Kinesthetic Learning Styles of Elementary School Students in Ambon-Indonesia,” International Electronic Journal of Elementary Education 10, no. 1 (2017): pp. 83-91, <https://doi.org/10.26822/iejee.2017131889>.

themselves into the simulations. In a plastic waste interactive game created by researchers following the Game Development Life Cycle (GDLC), researchers found that 71% of students participated gained plastic waste knowledge after playing the game. This result indicates the effectiveness of educational games in helping primary school students in gaining environmental knowledge.<sup>16</sup>

According to Kurt D. Squire, the director of the Games, Learning and Society program at University of Wisconsin-Madison, video games allow players to learn through doing and creating which teach them through decisions and consequences.<sup>17</sup> While it may be easy to simulate a math problem in the reality or on a computer, it would be costly to simulate a climate change scenario in the real world. Imagine teaching children counting numbers versus extinction of animal through physical simulations. In this case, the computers stand out as a media incorporating climate change knowledge into educational games.

## Challenges

While the idea of designing climate change educational game has been acknowledged, in a paper published on Journal of community Engagement and Scholarship, it is difficult gaining support for video games as a medium of social change in Canada, especially when it comes to independent and academic developers. One of the major concerns identified was “the lack of support from educational and funding organizations for climate change knowledge translation

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<sup>16</sup> Sheila Nurul Huda and Muhammad Fadillah Ramadhan, “Designing Educational Game to Increase Environmental Awareness,” International Journal of Emerging Technologies in Learning (iJET), n.d., <https://online-journals.org/index.php/i-jet/article/view/22661>.

<sup>17</sup> Mariana Lopez De Castilla, “General Science”, Playful Learning, <https://commons.pratt.edu/playful-learning/general-science/>.

using cutting-edge medium.” This implies there are insufficient resources to have the game fully developed and showcase to the public.<sup>18</sup>

Besides the hardships encountered at the developing stage of climate change educational games, another issue is the continuous funding and maintenance of these games. When selling a product, it’s important to present the measurable impact. According to a talk in the *Games for Change Festival* in New York, (“If you can measure something, you can rationalize it, you can optimize it, you can sell it. If you are in the no profit industrial complex you can get more funding if you demonstrate a measurable impact.”)<sup>19</sup> The reality proved this point, after browsing the App Store on iPhone, it turned out that most of the environmental educational games were launched between 2015 and 2018, with very few still providing updated versions. Aside from the fact that these not-for-profit games are hard to sell, the talk from *Games for Change Festival* also mentioned a dilemma while designing these games, (“If you can measure it, then it’s not the change I want to see. The problem is that by focusing on measurable goals we narrow our action. We favor individual change, versus systemic and long-term change.”)<sup>20</sup> Since we live under a shared environment: the air, water and resources, long-term change would be preferred from climate change educational games. Although individual change is also worth noticing, it does not play a significant role in remediating the overall situation of climate change. If this is the case, it would be essential to evaluate the trade-off when deciding what’s the goal of the game.

The last issue is the lack of attractivity and popularity – no one purchases the game even if it’s free. Comparing to common educational games one may encounter in the App Store, the

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<sup>18</sup> Garrett W. Richards and Michael Long, “Video Games and Learning about Climate Change,” Nighthawks Open Institutional Repository, <https://digitalcommons.northgeorgia.edu/jces/vol13/iss3/9/>.

<sup>19</sup> Paolo, “Making Games in a Fucked Up World – G4C 2014”, Molleindustria, <https://www.molleindustria.org/blog/making-games-in-a-fucked-up-world-games-for-change-2014/>.

<sup>20</sup> Paolo, “Making Games in a Fucked Up World – G4C 2014”, Molleindustria, <https://www.molleindustria.org/blog/making-games-in-a-fucked-up-world-games-for-change-2014/>.

climate change related games usually embrace an “old-fashion” game design and interface, which also come with much lower App rating, less comments and variety. There were very few with modern looking and smoother experience, but the focus was not educational: they were more like racing games between polar bears rather than helping the users understand why polar bear is escaping.

## Games explored

I investigated several games from web, PC and App stores. The climate changes educational games that already exist either focus on the read/write and visual aspect or do not fully utilize the kinetic aspect. For example, the NASA Kids website did an excellent job creating a children-friendly background. However, the content was wordy (Figure 2) and was a "copy and paste" product from the general website.<sup>21</sup>

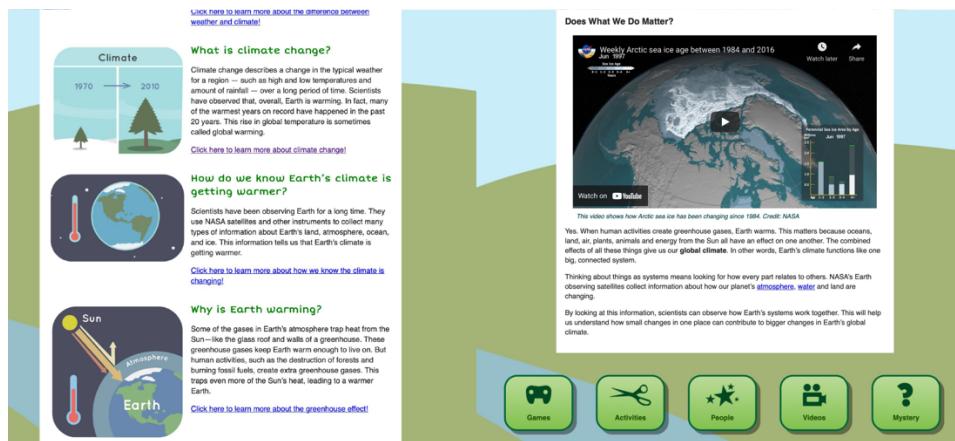


Figure 2: Impact of Climate Change (change in sea ice area) by NASA ClimateKids

Another example is from the American Museum of Natural History. Figure 3 shows a checklist and a small quiz published on the website to educate children about climate change. Regardless of the rich color, the content is still heavily text based. Although it does involve

<sup>21</sup> “ClimateKids.” NASA. NASA. Accessed September 14, 2021. <https://climatekids.nasa.gov/heat-islands/>.

kinetic learning through a quiz-style form, it is more about giving the knowledge rather than helping children understand them.<sup>22</sup>

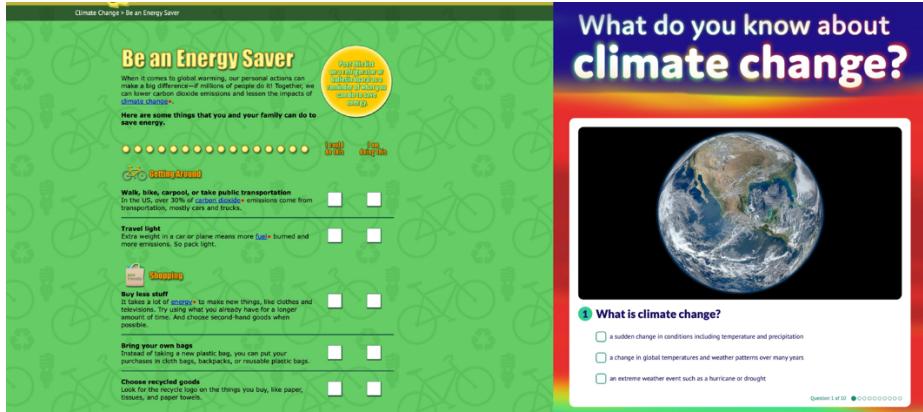


Figure 3: Climate Change quizzes from American Museum of Natural History

### Hardships during game exploration:

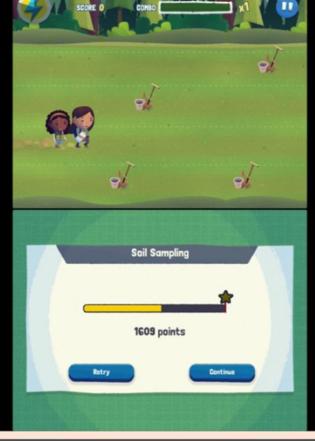
Just as the climate change games on the internet did not do a good job at targeting the children, the climate change education related applications in App Store and on computers also seem immature. I was trying to scrape all the climate change related game from Apple Store, which would allow me to run codes to analyze the rating, gather general information such as publication date and download times. However, due to technical and budget limitations, I was not able to finish that process.

Table 1 shows a list of games downloaded from App Store and Steam, the pros and cons of these games are listed. Each game was experienced for around an hour, and the evaluation was given based on my experiences. While all these games have their own strength, they can be improved or upgraded to more comprehensive versions by integrating more knowledge into the game itself or changing the content and operations so they best fit elementary school

<sup>22</sup> “Be an Energy Saver: AMNH.” American Museum of Natural History. Accessed September 15, 2021. <https://www.amnh.org/explore/ology/climate-change/be-an-energy-saver2>.

students. Another finding is the lack of updated versions: none of these games were updated after the release date. This reflects that the lack of sustaining supports and feedback for climate change educational games.

*Table 1: Educational games evaluation*

Game Name	Game Interface	Pros	Cons	Target learner type
Plasticity Game (PC Steam 2019)		Appealing graphics	No instructions	Visual
		Thoughtful theme	Only walk left or right	Kinetic
			Only available on PC	
Save an Elephant (App Store 2014)		Self-explainable theme	Violent way to win: either the elephant die or the elephant hit the driver	Read
		Easy to play with	Knowledge is not merged into the game	Visual
Save the Park (App Store 2016)		Easy to operate	So hard to win (gain a star)	Read
		Easy to understand	Too simple to get bored	Visual
		Task based	Outside resources may be overwhelming for children	
		Different difficulties	Opponent only walk straight	
		Information-driven		
		Partner with National Park Service		
		Accessible to real-life experience		

## Interview and Survey

### Interview

Christoffer Holmgård -- a game developer, teacher, and game/artificial intelligence researcher -- noted a small immersive game can cost millions of dollars to make and years to design, produce and launch.<sup>23</sup> One of his games costed \$3 million and took 10 years to make. Holmgård also pointed out that the advertising of games is another major source of spending, the cost per click (CPC) can cost from \$0.5 to \$5 based on the websites and “you cannot guarantee users will download your game after they see the ads.” Holmgård provided his insights of climate change educational game:

1. Developers need to be clear why they want to build a game.
2. Developers must be aware how much an actual game can potentially cost to make.
3. For learning games, developers should identify the purpose of the game, is the game for skill training, message communication or something else?
4. Climate change topic can be interesting, sensitive, or boring depending on the user.
5. If one does not have enough budget, try making something out of developed games (i.e., immersive story-telling game within Minecraft).
6. Cooperating with big educational website could be a potential solution, but climate change can be a relatively sensitive topic since it tends to make less profit.

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<sup>23</sup> “Christoffer Holmgård – CEO – Modl.ai | LinkedIn,” accessed May 6, 2022, <https://dk.linkedin.com/in/holmgard>.

## Survey

I sent out a survey about the experiences with climate change educational games. The survey was sent to parents or teachers of children in primary school. There were 14 respondents in total, with 7 of them completed the survey. There were 5 parents, 1 teacher and 1 parent and teacher. According to the responses, the age of children ranges from 4 to 10 years old, with an average of 6 years old. Since the sample size was very small, the results below may not be generalizable.

For the question asking about the effectiveness of children's learning method, visual and auditory ranked first, followed by kinesthetic, which is different from the VARK model presented. Out of the seven participants, only 4 of them indicated their children play educational video games, and they all found the game(s) as an effective for learning. Some games recommended are *MLP Chinese, Level Learning, Zearn, Get Epic, Khan Kids, ABC mouse and DragonBox*, but none of these are related to climate change. However, all the four respondents showed interest in having climate change educational games and are all willing to pay for the games. For the question asking about elements to consider when choosing educational game, two of the parents/teachers considered school and teacher recommendations. The other two considered usefulness and effectiveness. For the three respondents whose children do not play educational games, two of them stated it's the way of their parental education that they don't want their kids to have early access to video games. The other participant wrote 'test', which did not explicitly explain what he/she meant.

## Conclusion

### Current issues

From previous papers and studies, it's clear that the current market is not supportive of environmental educational games. Although the design approach of educational games is the same as video games, the user experience and interface design are the main obstacles when incorporating climate change elements into the game design regime. One major reason is the lack of practice and experience with designing a game that embraces both the ultimate experiences of video games and the ability to convey accurate information to the right target. The lack of ultimate experience brings less customers and thus less feedback for the games that were designed. As Ike and his colleagues mentioned in their paper, "UX is the game immersion and if the player does not buy into the UX, most likely they would not want to continue the game play." The top issue now is not what content is suitable for primary school children, but how to bring more supporters and hence funding into designing better, more immersive environmental educational games. It's also clear that there's a dilemma in making climate change related games: whether to aim at measurable impact (market competitive) or systematic change (long-term impact). If the trend stays this way, it will be a long time until the climate change educational game industry starts to make changes.

From the interview, we can see that making an immersive and interactive climate change educational game would require a huge amount of capital. It's feasible to upgrade an already existing game or take advantage of already mature platform. Although the survey is not generalizable based on only 7 full responses, we still see the lack of experience with climate change educational games. Based on the responses, it would be also possible to have the game

fit into a curriculum. The potential solutions below give a brief overview of all possible solutions.

### Potential solution

Since elementary school students from different age group can have different cognitive development, all the solutions provided below will have a choice for difficulty levels. If the game is being made, future research can be done to explore the best theme for children from different age groups.

*Table 2: Better educational climate change game solutions*

	<b>Immersive Story-telling Game (Appendix B1)</b>	<b>Collection of Mini Games (Appendix B2)</b>	<b>Launching on already mature website</b>	<b>Design a game-based curriculum</b>	<b>Upgrade a current game</b>
<b>Description</b>	<ul style="list-style-type: none"> <li>- Can played locally or multiplayer online</li> <li>- Complete quest or watch videos at different locations</li> <li>- Can be based on a world map</li> </ul>	<ul style="list-style-type: none"> <li>- Play on tablets, phones</li> <li>- Like Sesame Street</li> <li>- Open for self-developer uploads</li> </ul>	<ul style="list-style-type: none"> <li>- Mini-games on mature website such as Sesame Street</li> <li>- Can launch on different platform</li> </ul>	<ul style="list-style-type: none"> <li>- A climate change educational game-based add-on course</li> <li>- cooperate with school</li> <li>- flexible study time, complete within a given time</li> </ul>	<ul style="list-style-type: none"> <li>- Talk to current game developer such as Plasticity</li> <li>- Find support and resources to upgrade the game</li> </ul>
<b>Pros</b>	<ul style="list-style-type: none"> <li>- Immersive</li> <li>- Interactive</li> <li>- Self-explorable</li> <li>- New and competitive</li> </ul>	<ul style="list-style-type: none"> <li>- Easy to maintain</li> <li>- Less effort to make</li> <li>- Control addiction</li> </ul>	<ul style="list-style-type: none"> <li>- Simplest way</li> <li>- Customer resource</li> <li>- Easy to maintain</li> </ul>	<ul style="list-style-type: none"> <li>- Stable customer</li> <li>- Larger impact</li> <li>- Resources to educational expert</li> </ul>	<ul style="list-style-type: none"> <li>- Save time, capital, and effort</li> <li>- Not from draft</li> <li>- Collaborative ideas</li> </ul>
<b>Cons</b>	<ul style="list-style-type: none"> <li>- Expensive to make</li> <li>- Time costly</li> <li>- Labor costly</li> <li>- Can be addicted</li> </ul>	<ul style="list-style-type: none"> <li>- Less immersive</li> <li>- Less competitive in current market</li> <li>- Limited innovation</li> <li>- Lack customers</li> </ul>	<ul style="list-style-type: none"> <li>- Less credit to developer</li> <li>- Smaller impact</li> <li>- Need to persuade the main website developer</li> </ul>	<ul style="list-style-type: none"> <li>- Need experts to design</li> <li>- Long time for evaluation and launching</li> <li>- Less-entertaining</li> </ul>	<ul style="list-style-type: none"> <li>- Not your own game</li> <li>- Limitation in changing</li> <li>- Can be hard to save an already-dead game</li> </ul>

## Appendices

### Appendix A: An overview of the studies into the effectiveness of educational use of computer games

Author(s)	Year	Genre	N	Subject	Results
Levin	(1981)	Action	-	Math	Computer games are motivating, engaging and ultimately successful in teaching children the planned math concepts. Computer games may be especially suitable for teaching different ways of approaching math that caters for individual differences.
Dowey	(1987)	Puzzle	203	Dental health	Children learn best from a combination of teaching and computer games but although they learn about dental hygiene this does not transfer into change of everyday practice.
McMullen	(1987)	-	37	Science	The drill-and-practice computer game was not found to have any effect on the learning, neither short-term nor long-term. However the students playing the computer game indicated that they thought they had learned more.
Jolicoeur & Berger	(1998a; 1998b)			Fractions Spelling	You learn from computer games, but educational software is more effective.
Wiebe & Martin	(1994)	Adventure	109	Geography	They find that there is no difference in learning geography facts and attitudes between computer games and teaching activities not on a computer.
Sedighian and Sedighian	(1996)	Strategy	200	Math	The learning outcome is critically affected by teachers' integration of computer games and traditional teaching, but computer games prove highly effective.
Betz	(1995)	Strategy	24	Engineer	Finds that computer games increase motivation and learning
Thomas et al.	(1997)	Adventure	211	Sex education	Students learn from playing the computer game both on specific knowledge items and in self-efficacy.
Brown et al.	(1997)	Action	59	Diabetes	The study finds that children can learn about diabetes from computer games changing everyday habits.
Klawe	(1998)	Adventure	200	Math	Computer games are effective in teaching students about math.
Adams	(1998)	Strategy	46	Urban geography	Computer games increase motivation and teach students about the role of urban planners (affective learning)
Noble et al.	2000	Action	101	Drug education	Students taught by the computer games, found the experience motivating and wanted to play the computer game again.
Turnin et al.	(2000)	-	2000	Eating habits	Computer games can teach students about eating habits and lead to significant change in everyday habits.
Feng & Caleo	(2000)	-	47	Spelling and math	Children that played computer games learned better than peers not using computer games, mostly in spelling.
Becker	(2001)	Action	-	Program.	The study testifies to the increased motivation in connection with computer games. Games are found to be more effective and motivating than traditional teaching
Lieberman	(2001)	Action		Asthma, diabetes,	A review of a number of research projects that support that you can learn from computer games.
Rosas et al.	(2003)	Action	1274	Reading and maths	Computer games increase motivation, and there is a transfer of competence in technology from using the computer game.
McFarlane et al.	2002	-	-	All subjects	The study finds that teachers in general are sceptical towards the learning of content with computer games. However the learning of general skills was appreciated.
Gander	(2002)	Strategy	29	Program.	The study finds that computer games are effective for especially teaching specific knowledge.
Squire et al.	(2004)	Simulation	96	Physics	Students using the simulation game performed better compared to the control group.

**Appendix B1 Immersive Storytelling Game**

## Appendix B2 Climate Change Mini-Games



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