A Climate Change Educational Creator

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Abstract

Casual creators offer an enjoyable and readily accessible creative experience by enabling a safe and easy exploration of a creative space. This explorative and intrinsically motivating process lends itself to education applications, giving rise to a new category of casual creators, which we call *Educational Creators*. We illustrate this concept through EarthMood, an educational creator for deepening students' understanding of Climate Change. We demonstrate EarthMood through historical data, showing the deterioration of the planet, as well as on recent data, illustrating an improvement in climate due to COVID-19. The remotely-accessible nature of educational creators makes them applicable to both traditional and remote learning settings.

Introduction

Recently, there is a growing discussion on "why, and for whom, do we create CC systems?" (Cheatley, Moncur, and Pease 2019). A wide spectrum of Computational Creativity systems offer value in a variety of ways. For example, an autonomous system may provide value through its artifacts. On the other hand, a co-creative system may enable an artist to more efficiently or effectively engage in a creative process.

Casual creators represent a distinct type of creative systems, allowing a user to easily explore a creative space through playful interaction (ex. moving a cursor on the screen, or controlling sliders). Bringing the question from (Cheatley, Moncur, and Pease 2019) to casual creators, we ask: "Why, and for whom, do we make Casual Creators?"

Casual creators are often made for their *autotelic creativity* (Compton and Mateas 2015), which is the inherent and intrinsic satisfaction of a creative activity for its own sake, without necessarily having any extrinsic aims. We propose that the intrinsic satisfaction of engaging with casual creators need not preclude additional utility. In fact, since their inception, casual creators carried additional, albeit perhaps secondary, aims. For instance, PendantMaker, an early illustration of a casual creator (Compton and Mateas 2015), enables the creation of pendants that can be subsequently 3D printed and worn. In addition to utilizing resultant creative artifacts, what other goals may be accomplished through casual creators?

Figure (1) Using EarthMood to explore climate change.

A core concept of casual creators, the enabling of easy and joyful exploration of a creative space, suggests a new application. Leveraging the inherent appeal of engaging in a low-effort creative process, we propose the utilization of casual-creator-like systems for educational aims. We introduce *educational creators* as a new direction for playful creative systems, applicable to both remote and in-person learning.

Educational creators may offer a particularly engaging form of remote learning. They can be made available online and require minimal to no teacher supervision. As with casual creators, engagement with an Educational creator puts the user (or, student) in the driver's seat. Just as a casual creator allows users to take creative ownership, educational creators have the potential to support intrinsic motivation by offering an inherently enjoyable and user-directed interaction.

In this paper, we illustrate the concept of a casual creator by introducing EarthMood, a system that deepens a student's understanding of climate change. Earthmood visualizes climate change through simple, playful visualizations. The user can adjust sliders representing critical elements such as air pollution (AQI) and immediately see the impact of such changes. By offering an inviting and playful interaction, EarthMood is suitable for giving school-aged children

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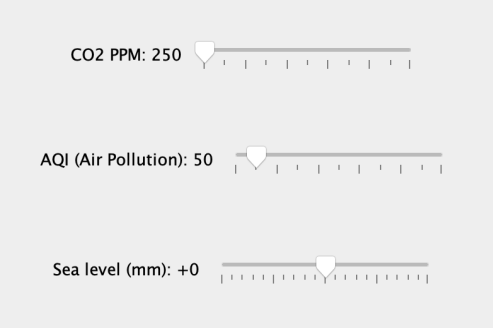


Figure (2) Some of the sliders available to the user to control EarthMood's visualization of climate change. Such controls allow the learner to easily explore the space of creative visualizations corresponding to the Earth's climate condition.

a deeper understanding into the impact of climate change, and as such raise awareness of this critical issue.

This paper illustrates the potential of educational creators through one particular system and application. We believe that educational creators have the potential to support education across a wide array of domains by integrating casual creation into the learning of complex topics.

EarthMood

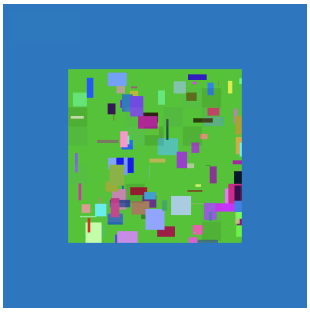
EarthMood is a casual creator that supports the understanding of Climate Change by turning data into an artistic and relatable visual representation. The user engages with the system by controlling how much pollution is released and seeing its impact on the earth in real time, through creative visualization of the data. Using data such as CO2 level in the atmosphere, global temperature, and sea levels, a digital earth is animated to restore empathy to our planet and facilitate a meaningful learning experience. Controlling such conditions through sliders (as depicted in Figure 2) lets the user explore the creative space of visualizations representing various climate conditions, and as such gain an understanding of how human activity impacts the planet.

The visualizations are done entirely through rectangular shapes, resulting in an artistic yet approachable style. Users engage with EarthMood in its animated, live form. See Figure 3 for static illustrations from EarthMood, showing the planet in various stages of pollution.

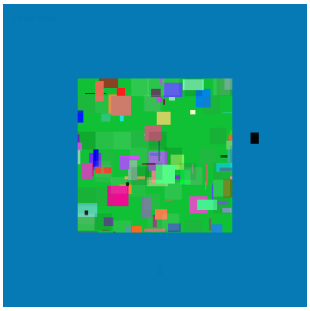
To better understand the visuals, consider, for instance, Figure 3(a). The green zone represents the condition of the earth, while its blue surrounding captures the health of the planet's water bodies. When using EarthMood, the rectangular elements are in a constant state of motion and reflect the user-selected settings, leading to an engaging and responsive experience. The more representative video format, along with two examples, is discussed in the "Video" subsection below.

Data visualization

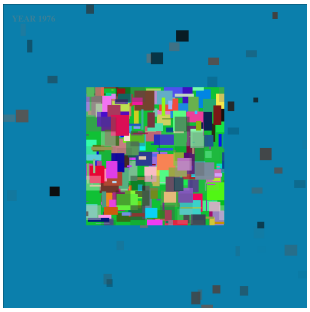
EarthMood uses climate change data such as CO2 ppm, ocean pollution, global temperature, species diversity and



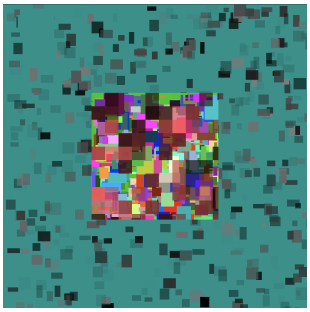
(a) A frame from EarthMood's representation of earth's climate with healthy biodiversity and no visible pollution. The green zone represents the condition of the earth, while its blue surrounding captures the health of the planet's water bodies.



(b) Ocean pollution is introduced into the system as black squares start appearing in the ocean. Rising sea levels cause the landmass to shrink.

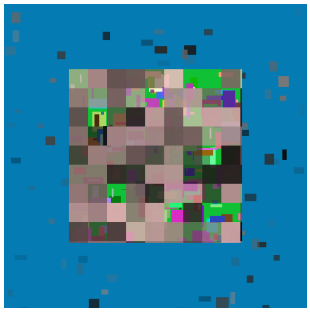


(c) Earth becomes more crowded as population increases. Opaque squares start to obscure the Earth as air becomes more polluted.

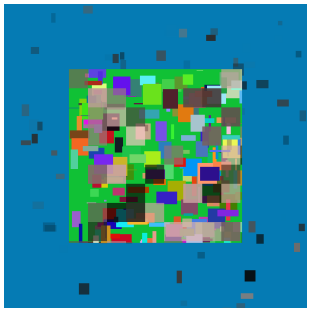


(d) The Earth is barely visible under the dense atmosphere filled with air pollution and the waters are continuing to get polluted.

Figure (3) An illustration of climate deterioration, from healthy (a) to polluted (d). Best viewed in color.



(a) New Delhi, India. Nov, 2019.



(b) New Delhi, India. April, 2020.

Figure (4) An illustration of climate improvement in New Delhi, India, from Nov 2019 (a) to April 2020 (b).

more to visualize the impact of human activity on our planet. Unlike tables and graphs, which fail to evoke emotion, and as such are often ineffective at communicating the devastating impact of climate change, EarthMood aims to create impactful and engaging moving visuals.

The resulting visuals utilize vibrant colors that gradually gets duller as the negative human impact increases. From a series of different simulations shown in Figure 3, we can easily grasp the differences between a polluted Earth versus a clean Earth. These bright visualizations and the radical differences between them aim to elicit emotion in the viewer which turns a "meaningless" statistic into readily relatable images. The student is able to easily manipulate the data through sliders to see the impact of their actions immediately visualized in the artwork.

Features

Below is a list of features used to create EarthMood's moving visualizations:

- *Air Quality Index*: Increases the amount of smoke cloud squares covering the Earth as air quality drops.
- *Endangered Species*: Decreases the brightness of the squares appearing on the Earth as more species become endangered.
- *Carbon Dioxide PPM*: Decreases the opacity of the smoke cloud squares covering the Earth as levels rise.
- *Global Sea Level*: Changes the ratio between the Earth and the ocean, shrinking the Earth as sea levels rise.
- *Global Average Temperature*: Shifts the color of the smoke clouds covering the Earth between blue and red.
- *Ocean Plastic Pollution*: Shifts the color of the ocean from blue to green as ocean pollution grows.
- *Global Population*: Increases the number of squares appearing on Earth as population grows.
- *Earthquakes*: Shakes the screen when an earthquake occurs.

Videos

The interaction with EarthMood is more accurately captured through video than static images. The following video demonstrates EarthMood in action, visualizing climate data from 2000 to 2018:
`https://youtu.be/rbrTKzkyt20`

The data used in the video consists of CO2 levels (National Aeronautics and Space Administration 2019), United States Federal endangered species (Environmental Conservation Online System. U.S. Fish Wildlife Service 2019), sea level (The Commonwealth Scientific and Industrial Research Organisation 2019), global population (The World Bank 2019), SO2 emissions (Ritchie and Roser 2017a), global average temperature (Ritchie and Roser 2017b), and estimated plastics in the ocean (Merran and Mallos 2019).

In addition to visualizing historical data, each parameter of EarthMood can be manually adjusted for the user's experimentation. The following video demonstrates this aspect: `https://youtu.be/UveQMki3_m0`.

Implementation

EarthMood is implemented in Java. It uses a parser to take in data stored in CSV format and generates the images accordingly. The square generation uses a pseudo-random function to determine the position, color, size, and duration of the squares within specified ranges. For the animation, the gpdraw library is used to paint the shapes onto the screen. Multiple threads are implemented to ensure no lag in the animation as the user is changing the parameters. The user control is done with a combination of gpdraw library and Java swing.

Case Study: New Delhi and COVID-19

New Delhi traditionally suffers from air pollution due to high population density. This leads to health risks including heart attacks, asthma, bronchitis and lung cancer (National Geographic 2020). However, during the COVID-19 crisis, the Ministry of Environment reported a significant drop in air pollution in India's capital (Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India 2020).

Poor air quality comes from a multitude of sources such as motor vehicle emissions and coal-based power plants. Due to the stay at home order, many sources of air pollution have been dramatically reduced. This is reflected in the visualizations from EarthMood.

Figure 4 (a) and (b) depict the state of Dehli's climate in November 2019 and April 2020, respectively. A quick

glance at the two figures reveals the substantial climate improvement that took place over this short period of time. In particular, we note the much improved air quality in Figure 4(b), depicted through fewer smoke clouds, revealing the colorful squares beneath.

Discussion

EarthMood aims to represent our planet in a dynamic and relatable way in order to elicit a sense of kinship between the viewer and the earth. Using data collected over the past century, an interactive learning experience is created with the aim of giving a (potentially young) user deeper insight into the significance of climate change.

Letting students instantly grasp the impact of their slider manipulations on the earth's climate through simple visualizations is central to an easy and impactful learning experience (this relates to the *instant feedback* design pattern of casual creators (Compton and Mateas 2015)). A quick glance at the generated images is sufficient to infer the shocking impact of, for example, a small change on the CO2 slider. This self-guided and responsive educational creator aims to offer an engrossing and effective learning experience.

Preliminary analysis suggests that EarthMood evokes feelings in its viewers and deepens their understanding of the impact of human activity on our planet. Further study is needed to evaluate the impact and educational value of EarthMood, particularly in the context of remote learning, and to identify whether this project can have long-term impact on human behavior.

EarthMood's educational value can be extended through, for instance, additional sliders that would allow a student to represent human activity, such as recycling behaviour, the impact of which would be reflected in the visualizations. Furthermore, additional visualization styles can be explored, and complemented with generative music to reflect the state of the planet.

This work initiates the study of educational creators, along with an example of one such system. Additional examples of education creators, as well as a comparison to other educational systems related to Computational Creativity (ex. the educational value of Mixed Initiate Creative Interfaces (Deterding et al. 2017)) are left to future work.

Educational creators can offer impactful learning experiences by combining the inherent appeal of artistic artifacts with the engaging experience arising from participation in a creative process. The artifact may, for example, span visual art, music, poetry or virtual reality experiences. Simple, playful artifacts or more complex ones may be used. We conclude with a summary of the main characteristics of educational creators:

- *Intrinsically motivating:* Based upon the autotelic creativity of casual creators, the joyful experience of creating with an educational creator is likely to give rise to intrinsic motivation.
- *Explorative:* Casual creators support an enjoyable exploration of a creative space. Educational creators place the learners in the driver's seat and are likely to evoke students' curiosity.
- *Learning through play:* The playful experience offered through educational creators makes this a suitable approach for young learners.
- *Remotely accessible:* Educational creators can be made widely accessible through the web, making them easy to incorporate into remote learning curricula.

We believe that educational creators can be valuable across a wide array of disciplines, particularly where students find it challenging to connect with a subject matter through traditional educational approaches.

References

Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India. 2020. National Air Quality Index. https://app.cpcbccr.com/AQI_India/.

Cheatley, L.; Moncur, W.; and Pease, A. 2019. Opportunities for computational creativity in a therapeutic context. In *International Conference on Computational Creativity*.

Compton, K., and Mateas, M. 2015. Casual creators. In *ICCC*, 228–235.

Deterding, S.; Hook, J.; Fiebrink, R.; Gillies, M.; Gow, J.; Akten, M.; Smith, G.; Liapis, A.; and Compton, K. 2017. Mixed-initiative creative interfaces. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 628–635.

Environmental Conservation Online System. U.S. Fish Wildlife Service. 2019. U.S. Federal Endangered and Threatened Species by Calendar Year.

Merran, J., and Mallos, N. 2019. Plastics in the Ocean. https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean.

National Aeronautics and Space Administration. 2019. Carbon Dioxide Concentration. https://climate.nasa.gov/vital-signs/carbon-dioxide.

National Geographic. 2020. Air pollution. https://www.nationalgeographic.org/encyclopedia/air-pollution/.

Ritchie, H., and Roser, M. 2017a. Air Pollution. ttps://ourworldindata.org/air-pollution.

Ritchie, H., and Roser, M. 2017b. CO2 and Greenhouse Gas Emissions. https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions.

The Commonwealth Scientific and Industrial Research Organisation. 2019. Sea Level Data. https://www.cmar.csiro.au/sealevel/sl_data_cmar.html.

The World Bank. 2019. Population, Total. https://data.worldbank.org/indicator/sp.pop.totl.