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Analysing The Pedagogical Affordances of A Carbon Calculator Application (Adva) and Its Role In Environmental Education

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Abstract

The effects of global warming are palpable and Singapore has begun the pursuit of carbon neutrality as a goal. Accordingly, the country's Ministry of Education has launched the Eco Stewardship Programme in a bid to foster sustainable practices among students. Meanwhile, there has been a proliferation of lifestyle applications on smart phones, including those that are environmentally inclined. This paper explores the pedagogical potential of Adva, which is a carbon calculator application. It foregrounds how Adva can be integrated into the geography curriculum/classroom to augment teaching/learning experiences and ultimately, to incite transformative, pro-environmentalist action.

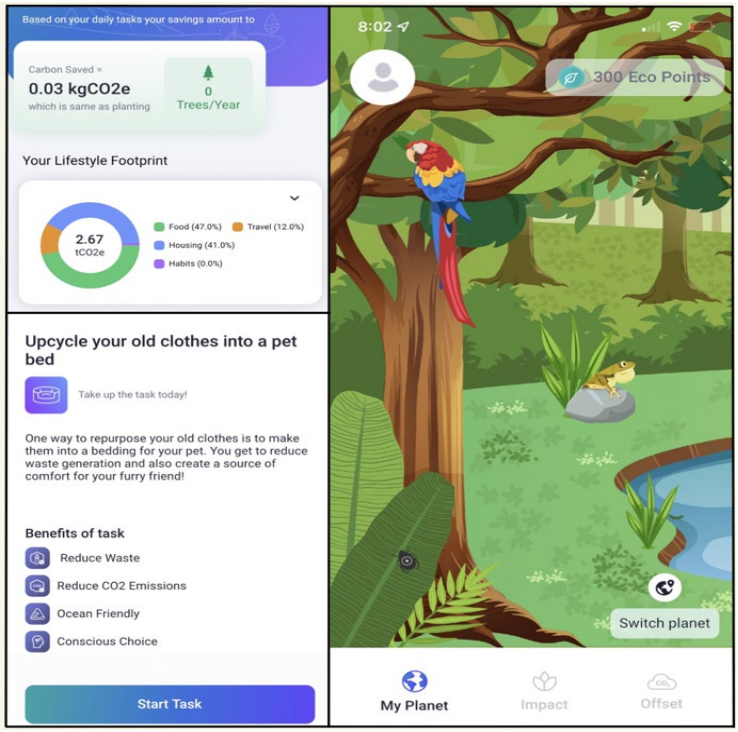
Introduction: Climate change and Adva

Many countries over the world are experiencing the devastating effects of climate change (United Nations, 2022). The Intergovernmental Panel on Climate Change (IPCC) was therefore inaugurated to provide policy makers with scientific data on the phenomenon and advisories on combating climate change. It has highlighted the urgent need for countries to scale up mitigation and adaptation strategies to slow down and cope with global warming respectively. Likewise, Singapore is not immune to the repercussions of climate change. According to the National Climate Change Secretariat (NCCS, 2022a), as a small island state located near the equator, Singapore is vulnerable to rising sea levels as well as heat stress and variable rainfall. Simultaneously, Singapore's carbon footprint per capita was ranked the 27th highest globally (NCSS, 2021). Its large carbon footprint stems from its heavy reliance on imported goods (NCSS, 2022b) and lifestyle choices that consume a lot of energy (e.g. extensive use of air-conditioning). Consequently, the state has put in place the Singapore Green Plan 2030 which is aligned to the UN's 2030 Sustainable Development Agenda and is working towards zero carbon emissions in the near future (Singapore Green Plan, 2022). Consonant with the Singapore Green Plan 2030, the Ministry of Education (MOE) has embarked on an Eco Stewardship Programme in 2021 to strengthen environmental education while promoting environmentalist causes/practices (e.g. reducing food waste and energy consumption, MOE, 2021a). In particular, the geography curriculum (in secondary schools and junior colleges) has been organised around the concept of sustainability.

In this digital age, young people are spending more time on their devices. A

survey by The Straits Times estimated that in 2020, almost 100% of Singaporeans above 15 years old use a smartphone (Müller, 2021; Teng, 2021). As such, scholars like Drigas and Angelidakis (2017) have sought to capitalise on electronic devices and smart phone applications for teaching/learning. This paper argues that as a carbon calculator application, Adva can play an integral role in fostering eco-pedagogies that contribute to education for sustainability.

Figure 1: Screen shots of Adva's features. Top left: A carbon calculator function. Bottom left: Example of a task recommended by Adva. Right: "My Planet" feature.



According to its website, Adva is an educational application designed to raise environmental awareness and to incite individual action for transformative social change (Adva, 2022). It serves primarily as a calculator of the user's carbon footprint based on their lifestyle choices. Additionally, Adva incentivises environmentally friendly tasks/activities by awarding the user discounts or cash back on sustainably sourced and produced items, as well as Starbucks vouchers. Moreover, it is also able to recommend customised tasks/activities based on the user's overall lifestyle proclivities and to inform users on how their actions have been beneficial to the environment (Figure 1). Users can also select a preferred carbon reduction path to embark on, as well as imagine their own virtual sustainable 'planet'.

The main objective of this paper is to evaluate the effectiveness of a Carbon Calculator application in promoting environmental consciousness and sustainable lifestyles, as well as how this application can be (better) incorporated into teaching/learning experiences. Its research questions are as follows:

How does the use of a carbon calculator (in the form of a smart phone application) influence one's pro-environmentalist behaviour (or not)?

How can smart phone applications (such as the carbon calculator) contribute to environmental education?

The rest of this paper is organised into three big parts. The first section begins with a literature review of the (dis)advantages of smart phone applications designed for learning and to promote lifestyle changes in their users. The second section attends to the pedagogical and technological affordances of Adva, especially with respect to its potential to promote pro-environmental action. This paper ends with some recommendations on integrating the use of this application in Geography classrooms.

Literature review: Lifestyle applications as educational tools

Lifestyle applications on smart devices have seen an increase in popularity (Ceci, 2021). Scholars have sought to understand the this phenomenon by analysing consumer motivations and behavioural changes precipitated by these smart phone applications. While much of the existing literature is based on health and fitness lifestyle applications, some key ideas gleaned from this body of work remain applicable to understanding how a carbon calculator application can inculcate pro-environmental habits .

'Uses and gratifications theory' is commonly used as a framework to explain consumer motivations in the use of these applications, including user retention (Stafford & Stafford, 1996). It asserts that individuals deploy technological media to gratify specific needs/wants (Hiniker et al., 2016). The theory also states that user interactivity (i.e. the extent to which users can manipulate what goes on in the application, Williams et al., 1988) is crucial to the application's take up rate (Papacharissi & Rubin, 2000; Charney & Greenberg, 2001). Relatedly, Venkatesh (2000) highlights some tenets of user-friendly applications that will minimise 'computer anxiety' (i.e. the apprehension from unfamiliarity or being digitally illiterate) and maximise 'computer playfulness' (i.e. spontaneous interaction with the program; Hackbarth et al., 2003). Computer anxiety is generally higher when one is confronted with a new digital system (Hackbarth et al., 2003). Accordingly, a good design of the user interface, ease of use, utility/functionality and permanent access (i.e. no subscription fees) are crucial factors in ensuring user retention (Legris et al., 2003; Schepers and Wetzels, 2007; Kim & Lee, 2018; Mehra et al., 2021).

Lifestyle changes entail a reconfigureuration of one's "coordinated sets of activities" (Michie et al., 2015: 1). The facilitation of these changes via lifestyle applications are usually premised on behavioural techniques such as setting achievable goals, outlining clear instructions positive change, and consistent self-monitoring (sometimes via automated feedback on the user's performance, Zhao et al., 2016; Coorey et al., 2018; Mckay et al., 2018). Another common method involves providing (monetary and non-monetary) incentives as a means of extrinsic motivation (Wanders et al., 2014; Gneezy et al., 2011). There are of course shortcomings to these application features derived from behaviourist principles. Some are unable to verify their users' (falsified) results/progress (Mckay et al. 2018). Moreover, while the mobilisation of monetary incentives overwhelms the cultivation of other sources of intrinsic motivation and is unlikely to sustain a practice once the incentives are being withdrawn (Gneezy et al., 2011).

Scholars have examined the role that smart phone applications can play in the educational sphere. They have mostly

shown that these visually appealing applications have brought their users much enjoyment (Ozdamli & Cavus, 2011; Powell & Wimmer, 2016; Lu et al., 2017) which heightened their intrinsic motivation to learn (Schmitz et al., 2012; Hsu & Ching, 2013; Hwang & Wu, 2014) (Murray, 2011; Jeno et al., 2017). The extent of their positive impact on academic grades, however, remains debatable (Shen et al., 2008; Jeno et al., 2017; Pechenkina et al., 2017).

Additionally, the interactive component of such applications aids in the development of one's conceptual understanding. Students arguably retain 25% of what they listen, 45% of what they can observe and 70% of what they can put into practice (Hansen (1990). There is therefore a common consensus among scholars that 'learning by doing' and 'learning through play' are effective pedagogical strategies (Roberts, 2002; Zosh et al., 2017). Both pedagogies coincide with social constructivist theories of how interaction with other subjects and objects can enable the co-construction of knowledge (Roussou, 2004; Ozan et al., 2011; Blake, 2015). Learning by doing involves action/practice while learning through play hinges on playful/stimulating activities (Bruce & Bloch, 2012; Hirsh-Pasek et al. 2015). Moreover, since social interaction is a major component in collaborative learning, some applications have inserted a "social media" element (Karabatzaki, 2018). More recently, newer applications that are equipped with virtual augmented reality and geospatial technology are better able to foster experiential and authentic learning (Herrington et al., 2012; Herrington et al., 2014; Zurita & Baloian 2012).

Mobile applications allow for a productive blend of formal and informal learning, while enabling informal learning to be extended beyond the space-time of the classroom (Khaddage et al. 2016). As such, research has demonstrated that smart phone applications are well positioned to motivate informal learning (i.e. learning outside of institutional/curriculum structures) and relatedly, to present users with situated learning experiences (i.e. learning within an authentic, real-world context, Naismith et al. 2004). Educational scholars have noted that informal learning tends to be a form of authentic learning that is frequently self-directed and curiosity driven (Paris & Hapgood, 2002; Sefton-Green 2004).

Analysing the pedagogical and technological affordances of ADVA

The two key pedagogical affordances of Adva, particularly targeted at energising pro-environmental action are its (a) interactive nature as well as its (b) multi-functionality. First, Adva is a highly interactive application capable of offering its users with immediate responses/feedback—which enhances its 'computer playfulness' (Hackbarth, 2003) and in turn, its user appeal in general. A pertinent aspect of Adva's interactivity is its incorporation of behavioural change techniques in order to motivate sustainable practices with a low carbon footprint. Some of these techniques reflected on the application include clear goal setting (i.e. a stipulated 'ideal' of not more than two tons of carbon dioxide emissions per person per year) and app assisted regular self-monitoring one's progress (see Michie et al. 2015). Adva's key feature lies in calculating and charting the changes to one's carbon footprint over time, alongside lifestyle adjustments (see Figure 2 and Figure 4).

Figure 2: A screenshot of how one's actual carbon footprint (and its break down) is compared against one's ideal carbon footprint of 2tCO_2 per annum on Adva

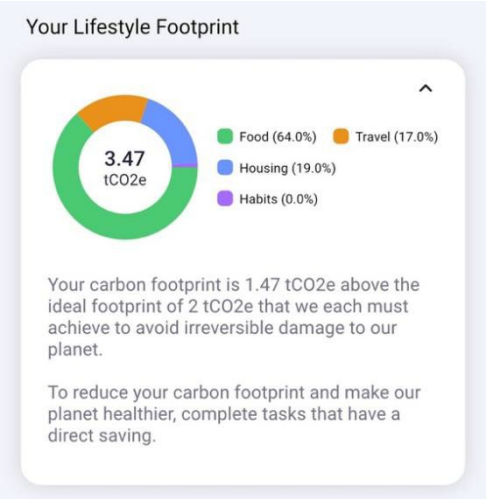
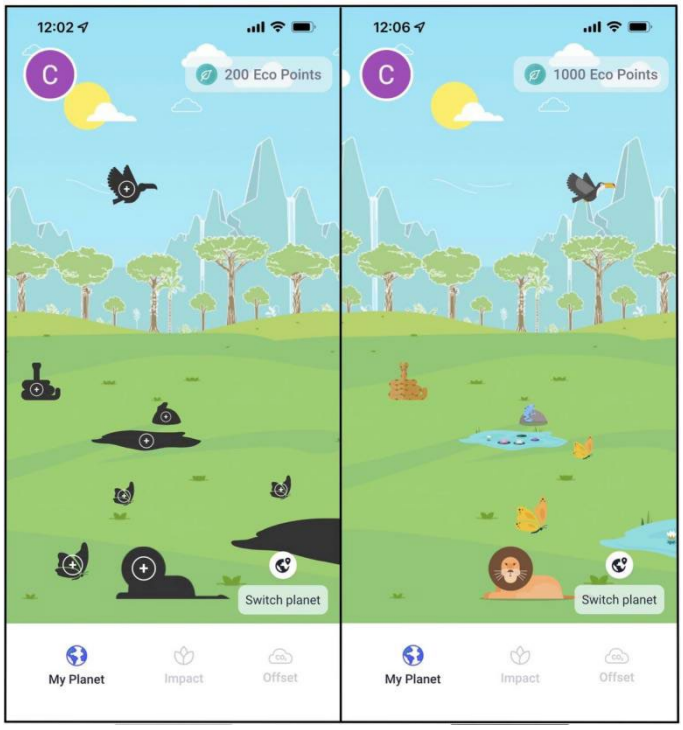


Figure 3: A screenshot of Adva's "My Planet" feature, before and after completing specified tasks (left, with unfilled silhouettes) (right, with filled and animated silhouettes)



Second, multiple functions are built into Adva to facilitate the convenient enactment of sustainable practices. The application has a task manager that curates a personalised list of recommended eco-friendly 'things to do' (see Figure 4). This may also imply switching to more sustainably sourced products, and Adva provides a seamless transition to an e-commerce page where users can select their options and purchase them directly (see Figure 5). Moreover, for users that are more financially established and/or not quite comfortable at making immediate or drastic changes to their middle-class lifestyles, Adva presents them with a range of sustainability related projects across the globe that they can fund to offset their carbon emissions (see Figure 6). Carbon offsetting refers to a method of transferring carbon credits, whereby a reduction in carbon emissions or an increase in carbon storage (via e.g. afforestation) elsewhere so as to compensate for carbon emissions somewhere. The purchaser or funder of the offset is able to claim the reduction in carbon emissions as their own.

Figure 4: Screen shots illustrating the environmental and economic benefits of specific sustainable practices/tasks

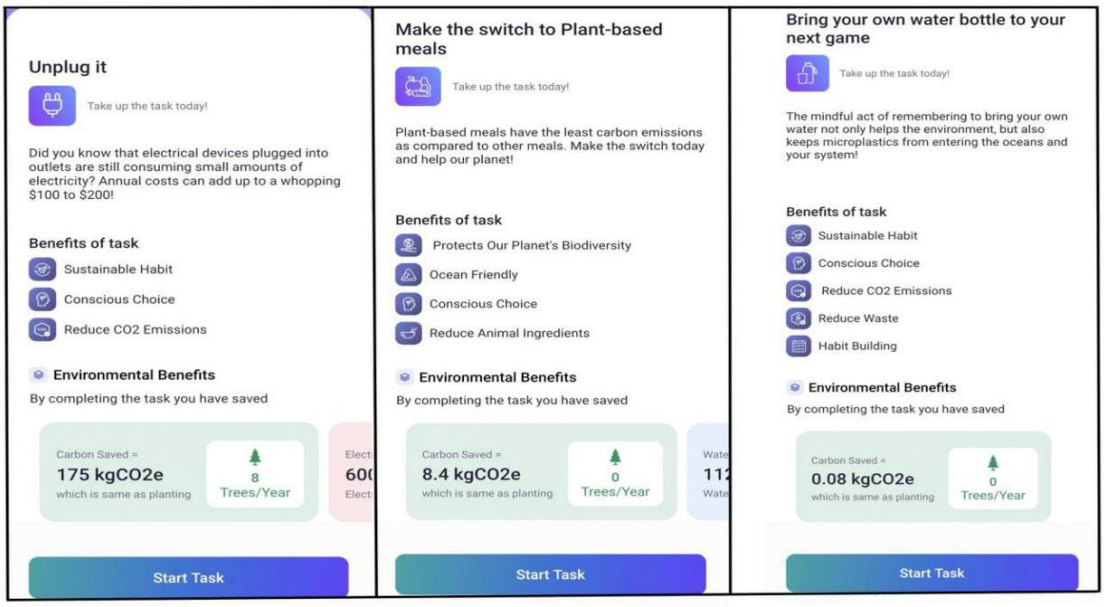


Figure 5: Screenshot of options for sustainably sourced pet food with links to partner websites for more eco-friendly products

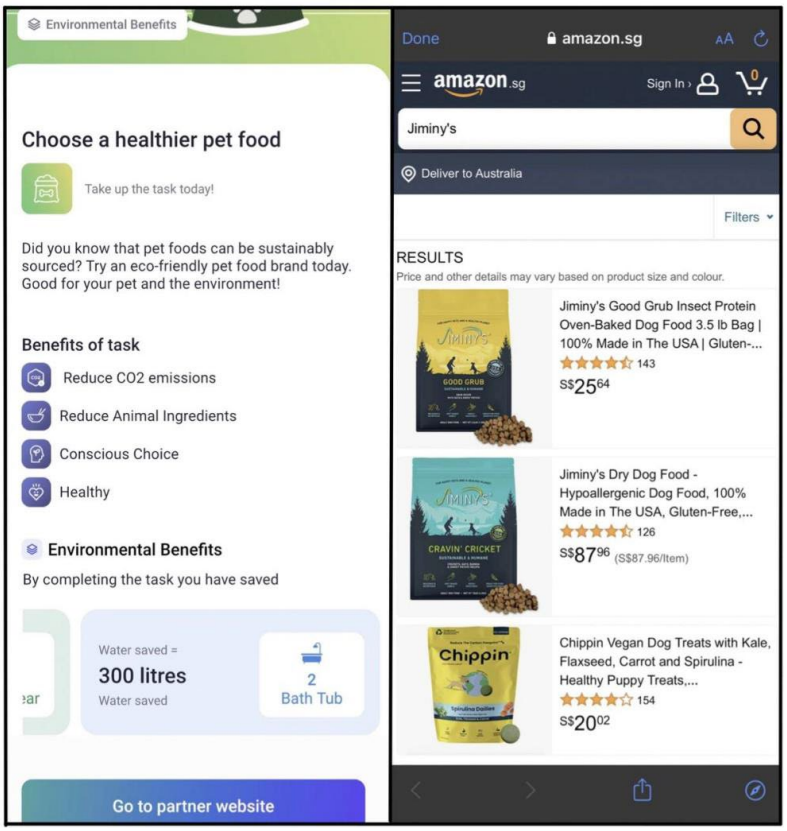
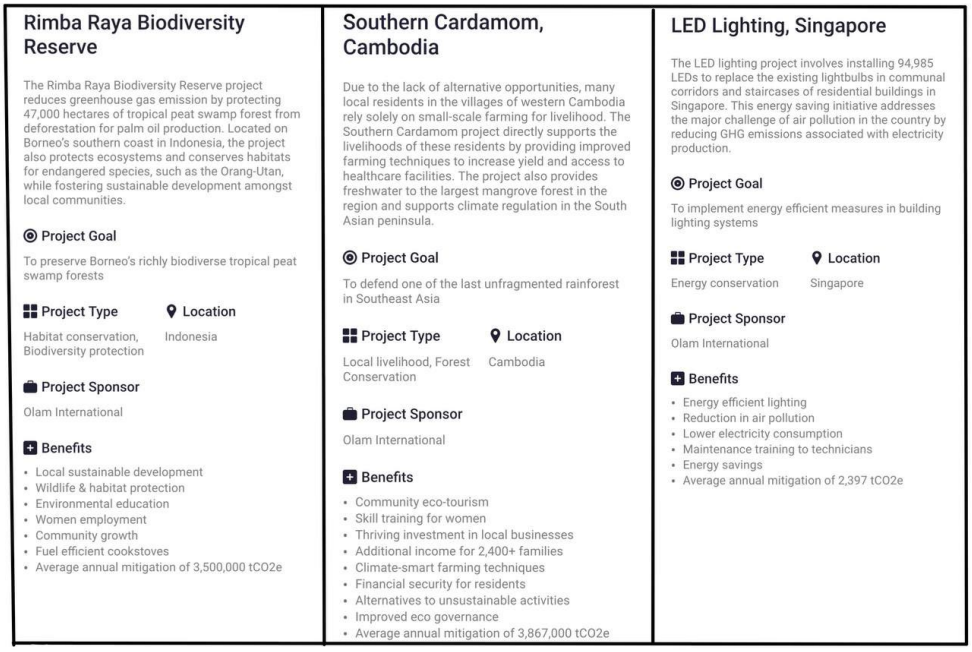


Figure 6: A screenshot of some carbon offsetting projects that users can support via their donations



Additionally, Adva has presented three main technological affordances. First, Adva is free for download making it highly accessible to students, with potential for user retention. Second, Adva is relatively user friendly with three main pages for easy navigation (see Figure 1) thereby reducing computer anxiety and hopefully invoking more computer/digital playfulness. Moreover, it offers users with a highly personalised experience (e.g. curated suggested tasks based on their lifestyles). It has been reported that an application's high customisability improves intrinsic motivation to use the application (Ozdamli & Cavus, 2011; Schmitz et al., 2012; Kim & Lee, 2018). Third, Adva facilitates (informal) learning across space and time, outside a rigidly designed curriculum (Sefton-Green, 2004).

Nevertheless, Adva is not without its limitations. While the application is conceived with the aim of cultivating climate/environmentally friendly habits, it is not able to compel them into being. For instance, there is no means of enforcing or verifying the completion of the tasks, and instilling extrinsic motivation in the form of (consumerist) incentives is certainly unsustainable. Additionally, the way "My Planet" feature is represented visually may confuse users about the ramifications of their actions. The animal silhouettes on "My Planet" page gets filled up when users complete certain tasks and may seem as though they are helping to sustain the biodiversity of a place. Other conceptual limitations include presenting the 'ideal' carbon footprint that one should work towards as a given, leaving capitalist/consumerist practices uninterrogated and being overly reliant on individual efforts at reducing carbon emissions. Such conceptual limitations can be used as a fodder for generating critical discussions, especially in the Advanced level geography classroom.

Recommendations for integrating Adva into the geography classroom

This section offers some suggestions on how Adva can be integrated into lesson plans and classroom activities across ordinary and advanced levels (with respect to the Singapore-Cambridge General Certificate of Education). Introducing such an application is well aligned to the desired outcomes of the geography syllabus (MOE, 2021b: 4) which seeks "to equip students with the knowledge and understanding of approaches that enhance the sustainability of our world and our way of life at various scales."

More specifically, secondary school geography educators covering the 2236 (full geography) and 2272 (combined humanities with elective geography) syllabus can incorporate the Adva application when they are addressing the learning objectives of "how human activities lead to enhanced greenhouse effect" and "describe the responses to climate change" (SEAB, 2022). They can begin with a short CNA Insider (2019) video explaining why Singapore is heating up faster than the rest of the world and to spark curiosity on the predicted consequences of climate change confronting Singapore in 2100. A possible inquiry question to pose to the class could be: "What can be done to reduce Singapore's carbon footprint and who should be responsible for it?". Even though the syllabi highlight climate change mitigation strategies on an international and national scale, students can complete the lifestyle survey on Adva to better comprehend how individual actions can add up and contribute significantly to the country's carbon footprint. In the same vein, the teacher could demonstrate that Singapore's (narrow) focus on reducing carbon emissions via energy conservation as well as mobilising more energy efficient

technologies can be scaled down and adopted on an individual level too. Meanwhile, peer accountability and an overall eco-centric class/school culture can help to sustain such 'carbon light' lifestyle adjustments.

Junior college geography educators teaching the H1 8813, H2 9751 and H3 9822 Advanced level syllabus can deploy Adva as a spring board to evaluate more complex/contested issues bound up in the politics of carbon emissions on a variety of scales. In addressing the lesson objective on evaluating "the responses to climate change, in particular the use of alternative energy sources", teachers can start off by unpacking who gets to define what a person's or a country's 'ideal' carbon footprint is, as well as how it may be tied to a person's affluence and a country's level of economic development. In other words, the big ideas that Adva is built upon can be scaled up, and teachers can draw attention to the inter-scalar linkages in carbon emissions as well. Essay questions in the A level geography syllabus would regularly require students to assess the relative effectiveness of efforts at reducing carbon emissions and scale can be an important weighing criteria in this regard. Bottom up action on an individual scale, which Adva is encouraging may be too insignificant in the broader scheme of things, even when taken collectively, or may take a long time to gain momentum. It also begs the question of what other national or supra-national organisations or institutions ought to be responsible for taking climate change action. The teacher can also guide the students in critically appraising the 'solutions' or tasks that Adva is dispensing, which reduces the wicked problem of carbon emissions into one that can be simply rectified by making more informed choices at the checkout counter, or paying for carbon offsets. These 'solutions' conveniently discount much needed reforms to capitalist/consumerist/developmentalist systems which are arguably the root cause of environmental destruction.

In sum, this paper has demonstrated that the smart phone application Adva is an invaluable pedagogical tool to not just raise climate change consciousness but also to incite climate change action. Concomitantly, even its design constraints can be re-framed to extend discourses on the political dimensions of carbon quantification, reduction and manipulation (e.g. offsets) in the classroom.

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or compel in-person engagement with a community (Zhao et al. 2016).

setting achievable goals and increased self-efficacy (Bailey, 2019)

Young people live in an age of hyper-personalisation whereby media platforms are typically tailored to each individual's preferences for better cognitive absorption (Bright, 2008; Zhu et al., 2014; Acker, 2017).

functions that facilitate play and provide scaffolds via automated feedback.