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PROMOTING PRO-ENVIRONMENTAL BEHAVIOUR THROUGH AUGMENTED REALITY AND PERSUASIVE INFORMATIONAL POWER: A PILOT STUDY

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Abstract: This pilot study examined the idea that use of a mobile technology can have positive consequences for both individual users and, indirectly, society. The augmented reality (AR) application used here is defined as a persuasive technology because it is intended to modify users' attitudes or behaviours. The application was designed for personal use although it can generate indirect benefits for users' communities as well as for users themselves. The application was tested on a small sample in a controlled setting in order to observe how it was used and to evaluate its efficacy as a source of information and tool for persuasion. The results showed that opinions of the AR device were generally positive; moreover, participants admitted that it improved their awareness of environmental issues. The strengths of this research are that it shows how the use of persuasive technologies can have collective benefits and demonstrates their informational power.

Key words: persuasive technology; pro-environmental behaviour; augmented reality.

Theoretical framework: Real and computer mediated persuasion

There are many definitions of persuasion in social psychology. In their review Roloff and Miller (1980) attempted to offer a clear definition of the expression 'to be persuaded'. The first generally accepted important distinction concerns coercion; persuasion can be indirectly coercive or coercion may be anticipated by persuasive communication. The second assumption they highlight is that persuasion is often built on symbolic negotiation. Some earlier scholars (Woolbert, 1917; Rowell, 1932) argued that there is a distinction between persuasive communication and oriented conviction communication, and identified the former with the emotions and irrational thoughts of the receiver, and the latter with rational and logical aspects of reasoning. More recent studies have confirmed that persuasive communication is based on both types of reasoning—logical, and irrational or emotional—which can follow different processing paths or converge in a unimodal process (Kruglanski, Thompson, & Spiegel, 1999).

For Nilsen (1974) the goal of persuasion is to elicit beliefs or actions in other people, which gives the term an entirely negative connotation, as the assumption is that persuaders

care only about their own interests. More recently Cavazza (2005, p. 131) suggested the following definition of persuasion: "the communication process in which a source presents arguments and facts, reasoning and conclusions directed to induce a change in the receiver"; in other words, it is a process that culminates in an effective and measurable change in an attitude, behaviour or belief in the receiver, or the target of the persuasive communication.

In 1981 Petty, Cacioppo and Goldman tested the hypothesis that personal motivation is an important determinant of attitudinal change. They manipulated the level of personal involvement and the subjective relevance of persuasive arguments and the results confirmed their hypothesis.

The concept of persuasive technology works particularly well with the concept of indirect pressure exerted by an active source of influence; this indirect pressure takes the form of messages that evoke the advantages and disadvantages of a specific action (Mucchi Faina, 1996) and can be contrasted with varying levels of direct pressure on a target to behave in a certain way.

According to Fogg (1997), persuasion should not be construed as manipulation, but as an act or communication aimed at encouraging a change in attitude or behaviour. A technology can be considered persuasive when it is designed with a persuasive intent and in this sense the eventual effect should be considered planned rather than adventitious.

The social relevance of environmental issue

Environmental protection is a subject of great social interest at the macro-social level. In 1987 the World Commission on Environment and Development (WCED) included the concept of sustainable development in its list of topics of interest, thus bringing it to public attention. Then the Earth Summit held in 2002 in Johannesburg recognised that there are ecological, economic and socio-cultural dimensions to sustainable development.

Every year there is an International Climate Conference involving about 160 nations, who share initiatives aimed at protecting the planet and substantially slowing down the anthropogenic deterioration. This led to the 2015 Paris Agreement on measures to minimise climate change.

From a sociological point of view, there are different ways of addressing environmental issues. For example Kohl (2008) declared that environmental sustainability can only be brought about through social participation and interdisciplinary communication, as environmental problems are not confined to one sector and cannot be addressed or resolved by a single type of competence or by a single country. Järvelä (2008) extended this line of argument, suggesting that society should develop in accordance with the principles of social sustainability (Järvelä, 2008).

The concepts of environmental care and sustainable lifestyles can be dealt with at three levels of social intervention: the macro, meso and micro. The macro-level involves joint initiatives by several countries in different parts of the world, but says little about the changes individuals should make to their daily lives and behaviours to protect the planet. There have been numerous studies in social and environmental psychology highlighting this discrepancy between declared attitudes and the behaviour of individuals (Tversky, 1969). Often individuals interpret their behaviour as being pointless or of little importance given the size

or gravity of the issue and so think their efforts will have little impact on the environment (Maréchal, 2010). In addition to the impact of action awareness, other factors that determine the formation of new behaviours are individuals' perceptions of the control they exert over the action to be performed (Ajzen, 1991) and the perceived ease of incorporating a new behaviour into their routine, turning it into a habit (Ajzen, Brown, & Carvajal, 2004).

Stern defined behaviours that have a positive impact on the environment (pro-environmental behaviours) as behaviours performed with the intention of changing the environment in a positive way, but also highlighted a frequent problem in this area: there is often a mismatch between good intentions towards the environment and their actual impact on the environment (Stern, 2000). There has also been an increase in concern about the state of the environment, but this is increasingly associated with poor knowledge (Gifford, 2007).

Augmented Reality

Augmented reality (AR) is the real time coming together of virtual objects in three dimensions with the actual surrounding environment; in more technical terms it is the evolution of virtual environments (VEs) in which a user can interact in a completely artificial way with virtual elements in 3D. What makes AR novel and different from conventional VEs is that the interaction occurs in the real environment: virtual objects are superimposed on real ones and integrated into the context of the real environment (Azuma, 1997).

The relevance of this technology is that the integration of digital elements into a real-world context can provide the user with useful inputs during interaction with the environment. These digital elements are useful for carrying out specific activities or tasks and can also represent additional information content.

In 1997 Azuma defined AR as a technology characterised by three elements: the integration of the virtual and real, interactivity and representations in three dimensions (Azuma, 1997). Subsequently Craig extended and expanded this description by adding other elements to the definition of AR (Craig, 2013):

- The real or physical world is expanded by the presence of digital information superimposed on the information already present.
- The information is displayed in conjunction with the user's perception of the real world.
- The digital information content that is present depends on the location and on the user's perspective on the real world.
- The experience provided by the AR is interactive on several levels: the user can change the digital information, create new information or change his or her perspective and interact with the same information from a different point of view.

AR applications work by determining the real world position and orientation of the rendering device (its *pose*) with respect to the surrounding location—often referred to as SLAM (simultaneous localisation and mapping). Determining pose within an environmental context often involves a combination of sensor-based (use of accelerometers, gyroscope, etc.) and vision-based (use of camera, depth sensors and artificial intelligence to recognise and locate either visual fiducial markers or map and learn objects and the surrounding area) techniques. Some ARs also exploit Bluetooth markers, wi-fi signal triangulation and global position satellite (GPS) data to locate the rendering device in a context.

Figure 1. Example of recognition-based AR: a Topps baseball figurine. [Source: New York Times]

A fiducial marker-based approach offers a robust means of superimposing information and virtual objects on top of real objects, but the visual markers (logos, Quick Response Codes, etc.) have to be placed beforehand, which maybe an undesirable visual intrusion within a domestic setting.

The object- or area-learning approach is less robust but requires no prior interference with the real location. In our pilot studies we used area learning facilitated by devices supporting Google's 'Project Tango' application interface (API). Below are examples of AR with and without a fiducial marker (Figures 1 and 2).

Several researchers have already shown an interest in AR in various socially relevant contexts, for example the development of applications to support learning. It has been argued that a learning environment can be improved through students collaborating and sharing real space augmented with information and digital elements (Price & Rogers, 2004). In particular, environments enriched with technologies that use AR may inspire increasing numbers of students, whereas more traditional technologies such as the computer or tablet actually reduce users' opportunities to interact with others and with the environment (Price & Rogers, 2004). Other researchers have examined the merits of AR as a method of

Figure 2. Example of superimposition AR for medical-educational use. [Source: AugmentWorks]

supporting the sort of experiential learning that can occur as a result of a direct experience in reality (Huang, Chen, & Chou, 2016).

It is believed that in tourism AR could take the form of an online VE, in which tourists could learn about new places and obtain a better tourist experience through the provision of additional information on specific sites (Jung, Chung, & Leue, 2015). Some tourism AR applications have already been developed, for example Historical Oslo offers users a real-time comparison of the places tourists visit, with historical reconstructions of the same places in AR, and additional content, which adds to the tourist experience (Chen, 2014).

Recent work by Craig (2013) has described developments in AR in fields as diverse as medicine, advertising, arts and entertainment.

With regard to the use of AR in relation to environmental issues and sustainable lifestyles, a recent strand of research concerns ways of increasing people's awareness of and affection for the natural environment. Other scholars have evaluated the power of a VR game to improve recycling habits and reduce pollution (Carmen Juan, Furiò, Alem, Ashworth, & Cano, 2011). In all these cases an important aspect of the applications has been that they are fun to use. They were tested on samples of children and students, which may have created

a sort of technology acceptance bias. The literature contains further studies addressing the relationship between environmental protection and technology, especially mobile and pervasive technologies; for example Martos and colleagues (2016) suggested that mobile devices could play a role in keeping the level of pollution in cities under control.

The pilot study

The primary objective of the research planned and conducted in Salford was to develop and test an AR-based application for the Samsung Tango mobile device. The application was intended to stimulate a change in user attitude and behaviour and raise environmental awareness in the home. Thus it was hoped the application would deliver a twofold benefit: individual users would benefit financially from changes to household management, while society at large would benefit indirectly from the individuals' pro-environmental behaviours.

A multidisciplinary research team developed the application for the Tango mobile device and assessed its usability and effectiveness. We attempted to take into account the factors Craig highlighted as being conducive to the successful use of AR (Craig, 2013). Craig stated that the first priority is that the tool is aesthetically and functionally pleasing. For example it should be fun to use and provide timely feedback. The application should be able to perform the function for which it was designed and be simple to use or provide appropriate instructions for users.

It is also important that the application is suitable for conditions in the target use environment. For instance if the device is to be used outdoors it must have a clear display suitable for use in various natural light conditions. Craig also referred to the importance of the application providing additional value simply by virtue of being a technological novelty. Finally it is important that the device on which the application is implemented either shows no errors during use or errors that are predictable and can be eliminated. It should also be possible to update the application.

The pilot study was designed with two main objectives in mind:

1. To evaluate the tool from an educational point of view, specifically how successful it is as a method of conveying meaningful information about pro-environmental behaviours.
2. To observe and assess whether the application developed for Tango promotes pro-environmental behaviours.

Eight volunteers were recruited during university classes. They were given detailed written information about the study and its objectives, and consented in writing to participation.

The experimental part of the study was carried out in the Energy House, at the School of the Built Environment, University of Salford. This was an ideal setting because we were interested in behaviours inside the home. The Energy House is a real, English-style house, the only house in Europe to have been placed in an environmental chamber capable of producing different climatic and atmospheric conditions and the only such house in the world made of bricks. These features make it ideally suited to conducting experimental studies of new energy saving materials, systems and equipment, but also of behavioural

changes associated with the adoption of various energy efficiency measures in the Energy House.

Study design

The participants arrived at the department in which the Energy House is located according to the agreed timetable; they were asked to fill out an anonymous screening questionnaire, used to identify their attitudes to environmental issues and technology and to certain behaviours and habits.

One person at a time was accompanied to the Energy House to use the application implementing the AR; this activity lasted about 15 minutes.

Immediately after their experience in the House participants were interviewed to obtain information about their first impressions of the device, their attitudes and opinions on the topics covered and the type of experience they had just undergone; finally they were asked if they had any suggestions for future improvements to the application or device.

The participants used the device inside the House, observing seven scenarios. Each scenario represented a problem that is frequent in domestic life in Britain. The participants viewed a 3D animation accompanied by informative content shown on the device's display:

1) Flying coins were presented on the windows of the living room in AR, to represent the cost of having single-glazed windows; the following associated information was presented:
   - Single glazing: a single-glazed window does not provide effective insulation and the loss of heat through the glass means that more energy is consumed to maintain the desired temperature.
   - Double glazing: installing double glazing in all the windows in the average three-bedroom home would save about £150 a year on the heating bill and the double-glazed windows should last for 20 years or more.
2) There was an animation on the television screen: the device showed a video depicting pollution from a power plant with the following information:
   - Use of the standby mode on many different home appliances is responsible for approximately 5-10% of electricity consumption in the home. In global terms it is responsible for 1% of global CO_2 emissions.
   - Turning off electrical devices will do more to reduce energy use than anything else. A decrease in electricity consumption means that less power is used, resulting in less pollution from the burning of fossil fuels.
3) In the kitchen of the House there was a washing machine, on which the participants saw a polar bear that was either dancing or sad and depressed, depending on the temperature selected:
   - Setting the temperature to 30°C instead of 60°C corresponds to an energy saving of more than 60%; the energy saved from a reduction of only 3°C in the average wash temperature in European homes is equivalent to eliminating the emissions produced by around 700,000 cars.
   - Even a 10°C increase in wash temperature increases the environmental impact of doing laundry, because the most energy-consuming aspect of the process is heating the water.

4) Moving to the second floor of the House revealed a large carbon footprint on the stairs, intended to represent the environmental impact of CO_2 emissions and their relationship to choice of room temperature:
   - Increased use of non-renewable energy makes the planet warmer, the CO_2 emissions contribute to the greenhouse effect and increase a person's carbon footprint.
   - The ideal room temperature for the domestic home is 20°C; turning the thermostat down at least one degree in winter (and up in summer) for 8 hours a day can radically reduce one's carbon footprint and save at least 5-15% per year on energy bills.
5) In the bedroom an AR mountain of waste was placed on the bed and information was provided comparing light-emitting diode (LED) light bulbs and traditional incandescent bulbs:
   - Although LED bulbs are more expensive to buy, in the long term they save energy and money and reduce pollution. The lifespan of an LED bulb is about 50,000 hours.
   - The first incandescent light bulb was invented in 1879, and although extraordinary improvements have been made since, they remain extremely inefficient; their lifespan is about 1,200 hours and so they need to be changed fairly frequently and there are strict rules about disposal.
6) Inside the bathroom the theme was water conservation, and the digital element added was a wilted flower.
   - Having a shower takes between 5 and 12 minutes, and uses up to 60 litres. Reducing excessive use of water can help wildlife in our rivers and oceans.
   - Taking a bath can use up to 100 litres. Given that the UK has less water available per person than most other European countries it is important to be aware of how much water is used during various tasks.
7) The last scenario appeared near the ceiling at the top of the stairs and showed animated people shivering with the cold or feeling comfortable.
   - Insulation means more comfort and lower CO_2 emissions; if everyone in the UK installed 270mm of loft insulation the country would save over £500 million a year in energy consumption.
   - Heat rises, so without loft insulation a home will lose up to 25% of its heat, as a result the inhabitants will be colder and spend more on gas or electricity to achieve a comfortable room temperature. On average loft insulation remains effective for 40 years.

Results

We subjected the data obtained from the first screening questionnaire and from the individual interviews to a qualitative analysis. There are many different points that are worth noting.

The first point to emphasis is that there were cultural differences in awareness of environmental issues. Not all the participating students were of British nationality and those of other nationalities were used to different climate and household issues; some were fairly indifferent to the information provided. Clearly it is crucial to coordinate the different levels of intervention: as different countries have the same shared intentions and action plans for reducing environmental problems, it is inevitable that successful interventions will vary from

country to country and that socio-cultural research on this topic should be closely linked to the native culture.

In some cases there was a discrepancy between attitudes towards technology declared in the initial questionnaire and impressions recorded at the end of the experiment, with initially negative or sceptical attitudes towards technology becoming positive on the merits of using AR to increase individuals' awareness of environmental issues and stimulating a change in behaviour.

The analysis of the interview data revealed a general enthusiasm for the AR experience. Only one participant had previously used a similar technology, so novelty definitely played a key role in participants' impressions. All respondents recognised the informational power of the application and considered the mode of transmission to render the information useful, easier to remember and more immersive, compared with information transmitted via more traditional methods such as scientific texts or television. Participants also appreciated the wealth of facts and objective data. These contained information that most people do not know and may not be interested in learning about, because—according to our sample—people tend to view environmental issues as a global concern rather than as directly related to personal everyday life. Many of our participants reported that as a result of using the VR application they had learned that there are simple actions that can be performed in the home that will have a positive effect on the external environment. Although the experience and the instrument were generally appreciated, participants were also asked to express any doubts about the use of such a tool in daily life and to suggest changes or improvements for the future. Some expressed doubts about the convenience of the tool: they found holding the tablet and moving it to frame the digital elements on the screen uncomfortable and noted that sometimes they had little time to learn the new information; others suggested that allowing users to explore the information conveyed by the device in more detail would make the application more effective. When asked about everyday use in their own home participants suggested that it would be useful to have a similar application available on smartphones. One participant said that the tool and the application were still too simple to be implemented outside a research context, but in this context it is important to note that the majority of participants were postgraduate computer science students and therefore had a moderately good knowledge of technology.

Some participants noted that the application had some persuasive characteristics. For example the information was detailed and specific, and with the right balance of information to be assimilated would make it easier for users to pay attention to key environmental concerns. This latter feature, together with the peculiarities of AR, which makes it particularly engaging, mean that the tool is also suitable for children and would be a valuable teaching aid.

It was clear even to the participants themselves that many people are not fully aware of environmental concerns, in particular the issue of pollution. Much of the information provided was new to participants, with many not knowing the difference between single- and double-glazing or the difference in energy consumed by electronic devices in stand-by mode and when switched off. The most common pro-environment behaviour amongst our sample was recycling, but turning off all the lights in the house and paying attention to water consumption were also cited. The main motivation given for such behaviours was to save

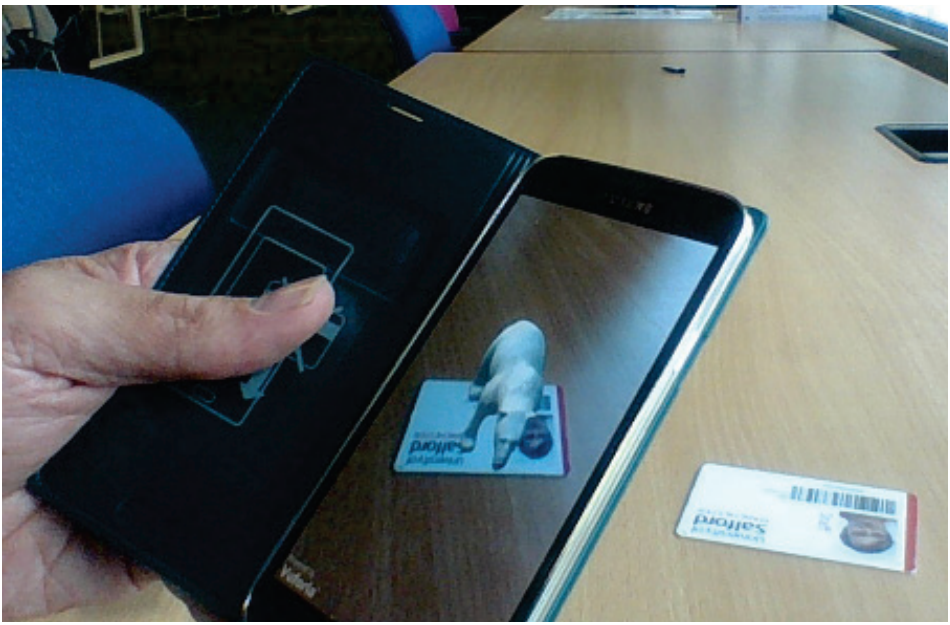

Figure 3. Example visualization of the application, which shows the polar bear in AR. [Source: Ian Drumm, Salford University]

money, but some also mentioned the importance of their actions for the environment and for caring for the planet we share.

Finally the scenario with the polar bear was the one liked best (see Figure 3): it was considered to combine a very vivid and appropriate image with useful information.

Only one participant mentioned the risks of becoming dependent on technology, which is unfortunately already high amongst the younger generation because of daily use in the home.

The results from this small, non-representative sample showed that students make two linked assumptions about environmental issues and the benefits that the use of technology can provide. They admitted that they—and probably the majority of people—had a fairly detached view of environmental issues, which they still saw as a global concern that was distant from their daily lives. They also found the application had real advantages as it stimulated awareness of environmental issues in a pleasant way and they thought it might be useful in stimulating and supporting some of the behaviours necessary to protect the environment.

Conclusions

The environment was chosen as the topic of investigation because of certain theoretical considerations: although the benefits to society from the personal use of an application can be identified in pro-social behaviours, charitable actions or socio-cultural activities for

integration, it was considered preferable to select a theme that was not overly sensitive in a psychosocial sense, that way we could exclude some purely individual variables, such as altruistic personality traits, ability to empathise, discomfort or personal well-being. The information presented in this environmental module was based on objective, universally recognised, shared data. Although at the country level there are cultural differences as well as differences dictated by the climate and social conditions, there are, nevertheless, global initiatives underway to promote pro-environmental behaviours and attitudes at the individual and community level.

The future development of this pilot project will include updating the application on the basis of the results obtained in these early tests, which were aimed at assessing the application and implementation device from a technical and theoretical point of view. The updates will make the application informationally richer, enabling users to find out more about a particular issue and to insert links to data sources to provide greater credibility. According to a recent study (Fantinelli & Cortini, 2018) informational power is a positive predictor of the use of AR applications. The extant literature also suggests that use is predicted by the fun factor, but in this case we can go further in our analysis to better assess the user's perception: does the application retain its persuasive power even if usage probability is mainly affected by the perceived fun? Do people who use the application because it is fun to use still derive information and motivation from doing so?

Another variable that influences pro-environmental behaviour is sense of belonging; Lalli (1992) demonstrated that people who identified with the place where they live were more sensitive to environmental issues than those who felt no sense of belonging.

This pilot study is original because it considers perceptions of the individual and the collective benefits of persuasive technologies. The decision to carry out a pilot study was determined by two factors: the use of AR as technology and the fact that there are no previous studies using this technology to implement persuasive principles in order to simulate a shift to a more sustainable lifestyle. These two factors led the research team to carry out this pilot study. We now intend to replicate the study using a large sample to obtain the first comprehensive evaluation of the method and the technology.

Persuasive technologies are typically designed so as to respect ethical parameters, but they may have consequences that pose a threat to communities and so there should be further social and psychological investigation into their use. For example, it would be useful to assess users' perceptions of the utility of the application or their endorsement of the underlying altruistic principle. Finally according to the Fogg model (2003) persuasive technologies may become socially, psychologically or technically obsolete, especially if advances in the field of human-computer interfaces and usability continue. Hence another challenge for the future concerns the updating of the design of persuasive technologies.

References

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behavior and Human Decisions Processes*, *50,* 179-211.

Ajzen, I., Brown, T. C., & Carvajal, F. (2004). Explaining the discrepancy between intentions and actions: The case of hypothetical bias in contingent valuation. *Personality and Social Psychology Bullettin*, *30*(9), 1108-1121.

Azuma, R. T. (1997). A survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments, 6*(4), 355-385.

Carmen Juan, M., Furiò, D., Alem, L., Ashworth, P., & Cano, J. (2011). *ARGreenet and BasicGreenet: Two mobile games for learning how to recycle*. Paper presented at the 19th International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision, Plzen, Czech Republic.

Cavazza, N. (2005). *Psicologia degli atteggiamenti e delle opinioni*. Bologna: il Mulino.

Chen, W. (2014). *Historical Oslo on a Handheld Device – A Mobile Augmented Reality Application*. Paper presented at the 18th Annual Conference Knowledge-Based and Intelligent Information & Engineering Systems, KES-2014, Gdynia, Poland.

Craig, A. B. (2013). *Understanding Augmented Reality: Concepts and applications*. Waltham: Morgan Kaufmann.

Fantinelli, S., & Cortini, M. (2018). Informational power and perceived collective benefit affecting the users' preference for a mobile technology: Evidences from a Survey Study. *Frontiers in Psychology, Human-Media Interaction section, 9*(2018), 898.

Fogg, B. J. (1997). Captology: The study of computers as persuasive technologies. Conference on Human Factor in Computing Systems, *Special Interest Group on Computer Human Interaction*, New York.

Fogg, B. J. (2003). *Persuasive technology. Using computers to change what we think and do.* San Francisco: Morgan Kaufmann.

Gifford, R. (2007). *Environmental psychology: Principles and practice* (4th ed.). Canada: Optimal Books.

Huang, T., Chen, C., & Chou Y. (2016). Animating eco-education: To see, feel, and discover in an augmented reality-based experiential learning environment. *Computers & Education, 96*, 72-82.

Järvelä, M. (2008). Social and cultural sustainability. In J. Kohl (Ed.), *Dialogues on sustainable path for the future - Ethics, Welfare and Responsibility* (pp.46-65). Turku: Finland Futures Research Centre.

Jung, T., Chung, M., & Leue, N. C. (2015). The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park. *Tourism Management, 49*, 75-86.

Kohl, J. (2008). Dialogues on sustainable paths for the future: Summary. In J. Kohl (Ed.), *Dialogues on sustainable path for the future - Ethics, Welfare and Responsibility* (pp.8-14). Turku: Finland Futures Research Centre.

Kruglanski, A. W., Thompson, E. P., & Spiegel, S. (1999). Separate or equal? Bimodal notions of persuasion and a single-process «unimodel». In S. Chaiken &Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 293-313). New York: Guilford.

Lalli, M. (1992). Urban-related identity: Theory, measurement, and empirical findings, *Journal of Environmental Psychology, 12*, 285-303.

Maréchal, K. (2010). Not irrational but habitual: The importance of "behavioural lock-in" in energy consumption. *Ecological Economics*, *69*(5), 1104-1114.

Martos, A., Pacheco-Torres, R., Ordóñez, J., & Jadraque-Gago, E. (2016). Towards successful environmental performance of sustainable cities: Intervening sectors. A review. *Renewable and Sustainable Energy Reviews, 57*, 479-495.

Mucchi Faina, A. (1996). *L'influenza sociale*. Bologna: il Mulino.

Nilsen, T. R. (1974). *Ethics of speech communication* (2nd ed.). Indianapolis: Bobbs-Merill.

Price, S., & Rogers, Y. (2004). Let's get physical: The learning benefits of interacting in digitally augmented physical spaces. *Computers & Education, 43*, 137-151.

Roloff, M. E., & Miller, G. R. (1980). Persuasion: New directions in theory and research. *SAGE Reviews of Communication Research*, *8*, 12.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues*, 56(3), 407-424.
Tversky, A. (1969). Intransitivity of preferences. *Psychological Review*, *76*, 31-48.

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