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SERIOUS GAMING AS A MEANS TO CHANGE ADOLESCENTS' ATTITUDES TOWARDS SAVING ENERGY; PRELIMINARY RESULTS FROM THE ENERCITIES CASE

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Introduction

Reduction of energy consumption, and thus CO_2 emissions, has become the focal point of energy and environmental policies worldwide. The 1997 Kyoto Protocol and The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) have spurned the European Union (EU) to substantially curtail emissions (20% below 1990 levels by 2020). The "Peak Oil" phenomenon will further influence nations' energy household for the coming decade. In this light it is interesting to see new developments in the field of e.g. electric and hybrid vehicles that consume no or limited fossil fuels.

The substantial efforts that are required to reduce energy consumption and migrate towards sustainable energy sources have widespread repercussions, however, for industry and transportation as well as for the household. In fact, some have argued that focusing on household appliances and domestic lighting constitutes a cost-effective way to achieve energy savings [5]. Organic LEDs for lighting applications, for instance, constitutes an eye-catching technological development enabling low energy lighting. Although current and future technology (e.g. double-paned windows, insulation technology, and organic LED (Light-Emitting Diode) for lighting applications) may reduce energy consumption by an estimated 30 % [5], we cannot afford to overlook the role of consumer behaviour and psychology (cf. [10]). Indeed, influencing consumers to change their behaviour may substantially add to modern technology's energy-saving potential. In fact, some researchers suggest that focused attempts to do so may result in an energy reduction of at least 10 % ([6]; cf. [2]).

Educating the Net Generation teenagers about energy saving

A considerable part of the energy consumers of tomorrow are today's secondary school students. Policymakers therefore increasingly focus on adolescents to stimulate awareness of sustainability and energy saving. Media channels and institutes, e.g. schools, offer excellent possibilities to stimulate youngsters to do so. Nevertheless, non-interactive media channels and traditional education programmes to some extent seem to mismatch with the information-processing styles, communication and social routines of today's young people. Often called the Net Generation or Digital Natives [11], they have literally grown up in a world in which computers, (mobile) internet, social networks, cell phones and video games are pervasive [4]. For example, Robert & Foehr [15] report that based on a study in the US in 2004, 15- to 18-years olds played computer games for approximately half an hour per day. It may be expected that these days this figure will be substantial higher due higher penetrations of (free) online games via e.g. online social networks and special interests community sites. Typically, this particular age group is proficient at multitasking, prefers visual information over textual, is cross-media oriented, and is highly active on social network sites. In order to be successful, strategies aiming to educate young people about energy conservation should be designed accordingly.

Educational or serious games are often regarded as effective learning tools [3] due to their engaging character and are used in various contexts (e.g. [8]). Serious games go beyond what is labelled as "edutainment games" or "elearning games" which are primarily learning tools with additional elements to give it some gaming and/or entertainment characteristics. Serious games, on the other hand, are more strongly focused on the fun and enjoyment of the gaming experience while the learning elements are not fully obvious or centrally positioned in the game. Serious games can be categorised using four dimensions [14]: the primary educational content (e.g. health oriented, energy oriented), the primary learning principle (e.g. practicing skills, knowledge gain through exploration, cognitive problem solving), the targeted age group, and platform used (e.g. PC-based with variants such as online and offline games; console-based games played on Nintendo Wii, Sony Playstation etc.).

The actual effectiveness of serious games as a means to influence attitudes and behaviour of teenagers has not been established unequivocally. As indicated by Graesser et al. [9], available reviews and meta-analyses over the last few years have not provided overwhelming support that serious games enhance learning of content, strategies, or skills. In the current project, we will therefore test the effectiveness of the serious game EnerCities, developed to positively influence energy-related household behaviours. As our target group, adolescents, typically lives in with their parents, many energy-related behaviours that occur in the household are not theirs, and therefore are unlikely to be influenced by the playing the game. Hence, with our approach we do not focus on learning effects in terms of actual behaviour, but on a change in behavioural attitudes instead.

EnerCities: a serious game about energy

EnerCities [12] is a European project that rolls out a serious game in which players are challenged to build a sustainable city. It runs online (www.EnerCities.eu) and on Facebook (http://apps.facebook.com/enercities) and is currently available in six EU languages. The browser-based 3D technology of EnerCities is the Unity3D plugin. This 3D technology leads to 3D perspectives, smooth scrolling and zooming and animated graphics. In this way EnerCities appears to the teenagers - in comparison with browser-based Flash games - as a modern browser game with attractive / nice graphics. The game and related educational materials are freely available for schools and individuals across Europe. Large-scale usage of the game on schools started as from September 2010; in parallel, individuals are invited to sign up and play the game. Game players and control group members are asked to fill in questionnaires, the results of which will used to ascertain the game's effectiveness in changing energy-related attitudes and several household energy-related behaviours.

Although data proving EnerCities' effectiveness in terms of learning and behaviour change has only recently become available, elearning professionals and teachers had early on already indicated the EnerCities game as valuable. It was awarded the title of "Best Learning Game 2010" by the European platform "ENGAGE Quality Awards"; this platform "recognise[s] excellent contributions from teachers, educational practitioners, game developers and producers to the quality of game-based learning". The award for Best Learning Game focuses on "digital games for teaching and learning that stand up to methodological, didactical and technical standards". In addition, the Dutch game industry awarded EnerCities with the title "Best Online Game 2010". This suggests that EnerCities is not only a learning tool but also has attractive gaming elements making EnerCities fun and enjoyable.

Figure 1 Screen shots taken during various stages in the EnerCities game

The game starts with a small village and a small piece of land to build on. A drag-and-drop interface lets players build structures (e.g. residential and industrial areas, renewable / non-renewable energy sources, green zones) to expand the city. The gamer needs to balance *People*, *Planet* and *Profit* while supplying the growing city with sufficient electricity, implementing energy conservation and CO_2 emission measures and minimizing fossil fuel use. Each player's decision influences the scores for people, planet and profit. When done well, players receive more potential city space to expand their city and to utilise extra available game options (see fig 1). The game allows players to execute several strategies and see the results of their actions on the long term. The duration of the game is approximately 15-45 minutes, depending on the player's strategies. Playing the game on Facebook

gives players additional functionalities to share scores and experiences with Facebook friends. In this way, involving the player's social network could lead to intensified competitions among youngsters to break the EnerCities high scores.

Procedure

To test the intervention effectiveness of the game on several energy-related attitudes, a between-participants design was adopted. Thus, measurements of attitudes of the experimental and control group were compared. Questionnaires were composed in six European languages (Dutch, English, German, Greek, Slovenian, and Spanish), and placed on www.EnergyQuestionnaire.eu.

Looking at the every day life setting of youngsters, several specific energy-related variables form the core of the analysis. The questions asked dealt with respondents' attitudes towards saving energy at home, turning off lights when leaving an unoccupied room, switching off the TV instead of using standby, and taking shorter showers. Initially, lowering living room thermostat was also incorporated, but this item was dropped later on, as this specific energy-related behaviour is not relevant in warm southern European countries as Spain and Greece. Each attitude measure consisted of three items, requiring respondents to rate on 7-point scales how good vs. bad, pleasant vs. unpleasant, and useful vs. not useful they thought each of these behaviours was. These three items were subsequently averaged to form one attitude measure for each specific behaviour (Cronbach's Alphas .77, .81, .79, and .78, respectively).

Results

Description of sample and preparation of the dataset

Towards the end of May 2011, data had been collected from more than 800 respondents from various European countries. However, some respondents (both from the experimental and control group) had stopped answering questions well before reaching the end of the questionnaire. In addition, some respondents had filled out parts of the questionnaire with invalid data (e.g., scoring each single item the same), and a few had filled it out multiple times. After omitting these, 653 cases remained, 325 related to the experimental group and 328 being part of the control group.

The sample used for our analyses comprised 36 % females and 64 % males. The average age was 16.40 years (SD = 3.21).

Effects of exposure to EnerCities

The analysis reported below served to show whether any change in attitudes towards energy-consuming household behaviours had taken place.

To reduce the risk of an inflated Type 1 error, a multivariate ANOVA was conducted. The dependent variable list consists of four attitude constructs, indicating participants' stance towards *1) Saving energy at home*, *2) Switching off lights in unoccupied rooms*, 3) *Turning off TVs rather than using standby functions*, and 4) *Taking shorter showers*. This analysis yielded a significant multivariate effect, $F(4, 648) = 2.76$, $p < .03$; Wilks' Lambda = .98. Subsequent inspection of the univariate effects yielded significant effects, indicating that playing EnerCities increased participants' attitudes towards saving energy at home, turning off TVs rather than using standby functions, and taking shorter showers. In contrast, only attitudes towards switching off lights in unoccupied rooms showed no significant effect. Means, standard deviations, and significance levels are displayed in table 1.

Table 1 Means and standard deviations of attitudes towards energy-related behaviours for the experimental and control group, and significance of their differences (7-points scale; higher scores indicate more positive awareness)

	Experimental Group*		Control Group*		Significance**	
	M	*SD*	*M*	*SD*	*F (1, 651)*	*p*
Attitude towards saving energy at home	6.19	1.16	5.96	1.30	5.59	.018
Attitude towards switching off lights in unoccupied rooms	6.31	1.11	6.18	1.11	2.06	Ns.
Attitude towards turning off TV instead of using standby	5.95	1.28	5.73	1.44	4.44	.036
Attitude towards taking shorter showers	4.82	1.71	4.41	1.82	8.90	.003

* Experimental Group N = 325; Control Group N = 328; data gathering period: February 2011 – May 2011

** Ns. = not significant

Conclusion

In sum, it appears that playing the EnerCities game has resulted in higher attitudes towards saving energy at home in general, as well as towards performing specific energy-related household behaviours, i.e., attitudes towards turning off the TV after use instead of using the standby function, and taking shorter showers showed a pronounced, significant difference between the experimental and control group.

These results beg the question why these specific behavioural attitudes were affected, whereas attitudes towards switching off lights were not. This lack of effect regarding switching off lights is especially surprising in light of both the ease with which this particular behaviour can be adopted, and the discussion about and eventual phasing out of the inefficient incandescent light bulbs for general lighting purposes in the European Union. Regarding the latter, one would expect light regulation to have become increasingly salient as a means to reduce household energy. On the other hand, this increased salience may also have led to highly positive light-switching attitudes in the first place; emphasis in popular media on conventional light bulbs as highly inefficient may well have highlighted light regulation behaviour as an easy-to-perform and worthwhile way to reduce household energy consumption. Possibly, the resulting high a-priory attitude may have left little room for a further increase by means of our experimental manipulation. Some evidence for this contention may be found in the average attitude ratings being highest for light regulation, both in the experimental and control condition.

Also surprising is the finding that of all four attitude measures, the attitude towards taking shorter showers shows the most pronounced effect of the experimental manipulation. Many people would probably associate taking showers with comfort and relaxation, while comfort is less strongly associated with switching off TVs or light in unoccupied rooms. Nevertheless, our findings suggest that people are especially willing to sacrifice some of this comfort for the benefit of saving energy.

The mean scores on the attitude ratings were rather on the high end of the scale. Overall, it seems that saving energy in the household is something that our target group, tomorrow's energy consumers, takes quite to heart. It also appears that these attitudes are not etched in stone, and that serious gaming may well be a successful means to influence them even further.

This study suggests that interaction with a serious game about sustainability and energy affects attitudes towards energy-related behaviours. Interestingly, however, the game and the behaviour mismatch in the level of specificity. The EnerCities game required its players to adopt a global stance and build and expand a city, thereby continually choosing between construction and city-planning options each with their own specific consequences for comfort, revenues, energy consumption and CO_2 emission. The questionnaire, on the other hand, focuses on a more microscopic level of behaviour, namely energy-related behaviours in the household. In light of this difference in scope, it is intriguing to find that the game nevertheless seems to have affected attitudes. Apparently, members of our target group experienced very little difficulty in connecting the one with the other. This finding has significant consequences for the design of serious games. It suggests that game designers have greater latitude in their efforts to design a game with the object to change public opinion in that one does not necessarily need to focus on the specific behaviour to be changed but could choose behaviour that are dissimilar but nevertheless related.

When focusing on changing actual behaviour rather than attitudes, other factors should be taken into account as well, such as the mitigating effects of the nature of the behaviour under consideration. The degree to which behaviour is repetitive, for instance, is of major importance. Many studies have suggested that simple behaviour that occur in the household, such as light regulation and waste recycling, tend to become habitual when they are frequently performed (e.g. [13], [1]). In essence, this means that these behaviours are instigated and performed in a more or less automatic fashion, and hence are difficult to control by consciously forming intentions [7]. As such, strategies aiming to influence behaviours by creating awareness or increasing relevant knowledge among the target group may be less successful if these behaviours are habitual.

Strictly speaking, we have to be careful in attributing the effects found purely to the game. The game, after all, was often not played in isolation, but rather in the presence of fellow students or as a part of classroom learning activities with guidance of inspired teachers. It is, in principle, possible that these factors external to the game itself have contributed to its apparent success. Future research, we feel, should target the beneficial effects of this social aspect of online serious gaming.

The positive effects of exposure to EnerCities reported here, suggests that serious gaming has the potential to change public opinion. The specific aspects of serious games that bring about these changes therefore warrant further scientific scrutiny and testing. Hopefully, this will enable scientists and games designers to use these specific parameters, so as to design serious games with far greater effectiveness while at the same time being fun to play.

References

1. AARTS, H., DIJKSTERHUIS, A. (2000). *The automatic activation of goal-directed behaviour: the case of travel habit*. Journal of Environmental Psychology, 20 (pp. 75-82)
2. ABRAHAMSE, W., STEG, L., VLEK, C., ROTHENGATTER, T. (2005). *A review of intervention studies aimed at household energy conservation*. Journal of Environmental Psychology, 25 (pp. 273-291)
3. ANNETTA, L. (2008). *Video games in education: Why they should be used and how they are being used*. Theory Into Practice, 47(3) (pp. 229-239)
4. BENNETT, S., MATON, K., KERVIN, L. (2008). *The 'digital natives' debate: A critical review of the evidence*. British journal of educational technology, 39(5) (pp. 775-786)
5. BERTOLDI, P., RICCI, A., DE ALMEIDA, A. (2000). *Energy Efficiency in Household Appliances and Lighting*. Berlin: Springer-Verlag
6. DARBY, S. (2000). *Making it obvious: Designing feedback into energy consumption*. In Bertoldi, P., Ricci, A., De Almeida, A. (Eds.), Energy Efficiency in Household Appliances and Lighting. Berlin: Springer-Verlag (pp. 685-696)
7. De VRIES, P., AARTS, H., MIDDEN, C. (2011). C*hanging simple energy-related consumer behaviors: How the enactment of intentions is thwarted by acting and non-acting habits*. Environment and Behavior (in press) xx(x) (pp. xx-xx) Paper available at: http://eab.sagepub.com/content/early/2011/01/12/0013916510369630.full.pdf
8. GUSTAFSSON, A., KATZEFF, C., BÅNG, M. (2009). *Evaluation of a pervasive game for domestic energy engagement among teenagers*. Computers in Entertainment, 7(4)
9. GRAESSER, A., CHIPMAN, P., LEEMING, F., BIEDENBACH, S. (2009). *Deep learning and emotion in serious games.* Serious games: mechanisms and effects (pp. 83-102)
10. HERRING, H. (2006). *Energy efficiency - a critical view*. Energy, 31 (pp. 10-20)
11. JONES, C., RAMANAU, R., CROSS, S., HEALING, G. (2010). *Net generation or Digital Natives: Is there a distinct new generation entering university?* Computers and Education, 54(3) (pp. 722-732)
12. KNOL, E., DE VRIES, P.W. (2010). *EnerCities: Educational game about energy.* Proceedings CESB10 Central Europe towards Sustainable Building
13. OUELLETTE, J.A., WOOD, W. (1998). *Habit and intention in everyday life: The multiple processes by which past behavior predicts future behaviour*. Psychological Bulletin, 124 (pp. 54-74)
14. RATAN, R., RITTERFELD, U. (2009). *Clarifying serious games.* Serious games: mechanisms and effects (pp. 10-24)
15. ROBERTS, D.F., FOEHR, U.G. (2008). *Trends in media use.* The future of children, 18/1 (pp. 11-37)
16. WRAY-LAKE, L., FLANAGAN, C., OSGOOD, D.W. (2010). *Examining trends in adolescent environmental attitudes, beliefs, and behaviors across three decades*. Environment and Behavior, 42(1) (pp. 61-85)