The effects of gamification on environmental knowledge and behaviors

Thomas van Drumpt
Mid Sweden University
Ecotechnology Department
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MID SWEDEN UNIVERSITY
Ecotechnology and Sustainable Building Engineering

Examiner: Anders Jonsson, anders.jonsson@miun.se
Supervisor: Gireesh Nair, gireesh.nair@miun.se
Author: Thomas van Drumpt, thva1100@student.miun.se
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Abstract:

The world is faced with many different environmental challenges. These challenges will need to be addressed with a variety of different tools. The way people behave has a significant impact on environmental contributions and as such influencing behavior towards better environmental decision making is something that should be addressed.

Gamification is the introduction of elements of play in situations which are normally not considered play. Gamification has been shown to change the way people interact with their environments. The environmental field is ripe for testing how gamification can be used to increase environmentally beneficial behavior.

Two case studies were conducted at MIUN campus in Östersund. One study focused on creating a fun and interesting method to increase environmental learning. The other study attempted to change the way students recycled on campus.

The learning study produced results which were slightly better for the gamified information in terms of knowledge acquisition compared to students who read a pamphlet (66% for the game and 56% for the pamphlet). More importantly 98% students considered the game to be interesting and were more willing to participate in it.

The recycling study showed that environmental behavior could be affected by a gamified environment. The test week showed a 41% increase in recycling over the previous 2 weeks.

A properly designed game environment has the potential to change the way people behave in a beneficial way for the environment. It is important that the game mechanics match the stated goals or this could lead to failed implementation.
1.0 Introduction and scope

The world we live in today is faced with many environmental problems. We have major international problems like global climate change as well as smaller local problems like smog over large cities. Almost every action we take in some way affects the environment. Whether we go to the grocery store and purchase a paper or plastic bag to carry our groceries home or even simply if we purchase locally grown fruits and vegetables we are making environmental decisions. All of these problems are not all solvable by simply taking one action. Even if we invent a cheap emissions free energy source that can supply all the world’s energy needs we still need to address other problems like loss of ecosystems and ocean acidification. The point is the problems we face are incredibly large and one change will not fix all of them.

In order to even begin to address the problems we have, society will need to change many things at the same time. It is here that this paper begins its discussion. Behavior makes up a large portion of possible environmental changes. How we use our energy at home and what devices we decide to purchase significantly impacts our individual contribution to environmental problems. How then can people be directed into making the ‘right’ choices? Psychologists have studied the reasons we behave the way we do for many years. There are many strategies that have been invented and used to influence the actions of people. This paper will look at one such method called gamification and how it can be used to affect the way people learn about the environment as well as how they act affecting the environment.

A literature review will be conducted as well as 2 case studies. One case study will be to see if environmental learning can be made fun and interesting while the other will be to see if recycling rates can be improved at one location at MIUN Östersund. The learning study will not be concerned with changing any environmental behavior and will instead be focused solely on finding if environmental learning can be made more effective and interesting. The recycling study on the other hand will be limited to recycling rates. The study will not consider if the recycling was sorted properly.

2.0 Literature Review

Huesemann (2001) concludes that technology will never solve all of our environmental problems by itself. It is impossible to make a technology with no environmental cost and any created solution to a problem will unavoidably cause problems somewhere else (Huesemann, 2001). The problems that society faces then
need to be addressed in ways other than just seeking to advance technology with environmental focuses.

A look at individual behavior then can be instructive in how to deal with environmental problems. For instance if a person switches to a vehicle that is 10% more fuel efficient but increases their driving by 10% we see that there is no actual overall gain caused by switching vehicles. This rebound effect was found to overstate environmental benefits by about 20% for vehicle usage and 7% for reduced electricity usage if not considered (Murray, 2012). Dietz et al. (2009) ran a study to measure the approximate impact of household behavioral change in the United States. They measured strict behavioral differences like driving in a more energy efficient manner as well as the adoption of low or no cost technologies that were more energy efficient and came to the conclusion that simply changing behaviors can result in a 20% reduction in energy usage by US homes. In Europe and Asia similar strategies were estimated to result in a 50% lesser change due to there already being a culture of lesser energy consumption (Dietz et al., 2009). Their results make a compelling case for examining behavioral change, but which methods can be used to make such a change occur?

People’s feelings about the norms in society has been shown to have an effect on behavior. Rimal and Real (2003) studied alcohol consumption in U.S. college students. They found that student’s perception of injunctive (what others approve or disapprove of) and descriptive (what others actually do) norms in conjunction with their group identity can explain up to 53% of the variance in actual drinking behavior (Rimal and Real, 2003). In an earlier study in 1990 Cialdini et al. studied how norms affected behavior in regards to littering. They found through several case studies that both descriptive and injunctive norms played a role in behavior (Cialdini et al., 1990).

A common method of trying to get people to change their behavior is by increasing their knowledge of the effects and ways to mitigate the environmental damage of their actions. In 1981 Scott Geller ran workshops designed to educate people on energy and water consumption as well as effective methods of reducing this consumption. Geller’s respondents to his questionnaire after the workshop showed an increased awareness of the energy crisis as well as knowledge in how to personally change behavior for better results and a commitment to do so going forward (Geller, 1981).

This reporting seems to indicate that these workshops were effective tools in increasing knowledge as well as an indication that behaviors would change as well. However, after followup visits to these participants it became clear that behavior has not actually had significant changes (Geller, 1981). A conclusion that could be gained from this information then is that simply giving people information is not enough to drive behavioral change. Generally speaking, studies have shown that handing out
information can lead to a change in knowledge there is low correlation with actual behavioral change (Stern, 2011, and Abrahamse et al., 2005.).

Geller et al. ran another study on water consumption in 1983. After a baseline was taken they would apply techniques such as installation of water saving devices as well as giving feedback on individual water usage for those that were not given devices to install. Participants were divided into three groups, educational, behavioral, and engineering. The educational group was given a pamphlet describing ways to reduce water consumption. The behavioral group was given daily and weekly feedback regarding their water consumption so that they were aware of changes both on a short term as well as a more long term scale. The engineering group was given devices to install that would reduce water consumption mechanically (for instance a toilet dam that will reduce water usage per flush). This study showed that while there were some positive results generally the numbers were lower than expected across all groups, even those who had received devices that would reduce consumption just by their installation, indicating that people who received these devices changed their behavior in a negative way once they were installed (Geller et al., 1983).

Giving direct feedback on how actions relate to results has also been studied as a method of influencing behavior. Corrina Fischer (2008) compared results of studies on electricity usage when exposed to feedback. Studies showed a range of savings from 1.1% - 20% with an average of 5 - 12%. More importantly, she evaluated which types of feedback worked best. Best-case situations included feedback that was presented in a computerized fashion that allowed users to select different feedback appropriate to them, feedback that was in some way interactive, feedback that was detailed more than simply an aggregate, and feedback that was provided very frequently (Fischer, 2008).

The way situations are presented can change the behavior of respondents. Freedman and Fraser (1966) ran an influential study showing that after agreeing to a small request, people were significantly more likely to agree to a second larger request a few days later than if they had not initially agreed to the small request. Study participants were 35% more likely to agree to the second larger request after initially agreeing to a minor related request than if they were asked initially for the large request. The reason for this was posited in the paper as ‘He may become, in his own eyes, the kind of person who does this sort of thing, who agrees to requests made by strangers, who takes action on things he believes in, who cooperates with good causes” (Freedman and Fraser, 1966). The implication being here that simply getting someone to participate in behaviors can get them to see themselves as someone who does these things and thus is more likely to continue to do them in the future.

When recycling was being introduced in the United States few communities had mandatory recycling. There were voluntary curbside initiatives and initially getting
people to participate without large costs being involved. In 1995 Werner et al. set out to find out which methods of securing participation were the most effective relative to their cost. All community members received flyers informing them of their recycling program. Some of them were then called on the telephone to discuss the program and a final group were asked to make a written commitment to participate in the recycling program. Along with measuring response rates to the recycling they also measured attitudes towards the recycling program with a questionnaire. It should also be noted that they attempted to distance the questionnaire from the project in general by masking it as a university project on recycling so that it was not seen as an extension of the town project. The results of project showed that overall 40% of community members participated in curb side pickup at least once and 24% participated more than once across the 5 month test period. Signature commitment was significantly higher in terms of participation with 63% participating at least once and 48% participating more than once. Interestingly there is reason to believe that the results of the questionnaire show that those who had committed to recycling via signature showed higher favorability toward the recycling firm as well as toward recycling in general. The researchers drew the conclusion then that there could be a change in attitudes as a result of self persuasion given a longer time frame (Werner et al., 1995).

As can be seen there is often a gap between knowledge and action that can be seen in many different scenarios not just in regards to environmental action. In Bangladesh a study on hand washing found that 95% of respondents reported an understanding that washing of hands with soap prior to eating food was hygienically beneficial but only 22% actually did so (Rabbi and Dey, 2013). Kollmus and Agyeman also studied how attitudes towards actions affected behavior. They found that there are areas in which attitudes directly correlate with behavior. To find these correlations attitudes need to be measured that are directly related to that action. For instance attitudes towards climate change do not correlate towards driving behaviors since these attitudes are not related to the behavior being measured, for instance drivers do not consider climate change strongly whilst driving rather their most pertinent attitudes here would be the desire to get home quickly thus despite their feelings for climate change, their behavior may not follow during all actions that relate (Kollmus and Agyeman, 2002). More focused measurements will lead to higher correlation between behavior and attitude but often will lose instructive information since the attitudes that correlate to specific actions are so narrow, they will not paint an overall picture that could help in understanding the behavior (Kollmus and Agyeman, 2002).

Blake (1999) proposed that the gap between environmental knowledge and behavior stemmed from one of three types of barriers, individual barriers, responsibility barriers, and practical barriers. Individual barriers consist of things that are specific to
individuals, such as lack of interest or laziness. Responsibility barriers can stem from a feeling that individual action is irrelevant to the problem as well as a lack of trust in the institution suggesting which actions should be taken, such as the government. Finally, practical barriers are often the result of a lack of a particular resource, for instance time or money, to engage in a particular behavior (Blake, 1999).

Identifying the barrier to the behavior is very important to developing the correct strategy to overcome these barriers. In some examples memory is a barrier that affects whether or not action is actually taken. For instance, if people are in general in favor of the behavior already simply reminding them with a prompt for action can be sufficient for a large change in behavior. In a study by Austin et. al. (1993), they received a 54% increase in desired behavior simply by prompting people to take action in a non obtrusive way (Austin et al., 1993).

Social cues have also been used to change behavior. A study on dorm shower water usage measured the behavioral change of turning off the water while applying soap. Initially a sign was put up asking users to turn off their water which led to only a 6% adoption rate. Later planted modelers were introduced into the shower who did not interact with the participants but simply did the requested behavior. In this scenario 49% of those showering turned off the water to apply soap, this increased to 67% when two modelers were put into the shower (Aronson and O’Leary, 1983). Additionally community based social marketing has been shown to change behaviors on a larger scale in a study done by Doug McKenzie-Mohr (2000). Water usage during summer months was shown to be reduced by about 54% in those who were selected for a community social marketing compared to an increase of 15% by those who received only an information campaign (McKenzie-Mohr, 2000).

Financial benefits have been considered extensively with regards to environmental behaviors. However, they have not been shown to be incredibly effective due to the fact that there are several economically beneficial technologies that have low adoption rates despite their favorable economics (Stern et al., 2010). Abrahamse et al. in 2005 alternatively did a comparative study on the effects of financial rewards on behavior change. Their study found that rewards did make a difference in environmental behavior though the actions measured were generally short-lived (Abrahamse et al., 2005). This can mean that financial rewards are better used for one time actions such as the purchase of energy efficient technology rather than being used for repetitive behavioral change.

Learning is a different category than behavioral change. Learning is a complex process that is different in many people. One main factor determining learning success is motivation Yeung et al. (2011) found that motivation comes from six motivation variables; self-efficacy, mastery goal orientation, engagement, avoidance coping, and
effort withdrawal. Students who had a higher degree of motivation tended to perform better though as students grew older motivation tended to decrease (Yeung et al., 2011). Fun can also play an important part in learning. Fun “can have a positive effect on the learning process by inviting intrinsic motivation, suspending one’s social inhibitions, reducting stress, and creating a state of relaxed alterness” (Bisson and Luckner, 1996). This state has been shown to make learners more receptive to instruction as well increasing intrinsic motivation for learning (Bisson and Luckner, 1996).

Self efficacy is the belief that one can achieve the goals set out as well as organize the course of action necessary to do so. Students who display high levels of self efficacy tend to perform deep learning strategies (Cheung and Lal, 2013). Interest is the level of enthusiasm about a subject inherent to the user. Interest can be situational where a certain situation interests a subject to a larger or smaller degree than others thus this is almost a personal quality. Interest is an important part of motivation and can be either intrinsic or extrinsically brought upon (Ryan and Deci, 2000). Mastery goal orientation is the tendency to develop new abilities by setting goals primarily to improve rather than to show success. Mastery goal orientation has shown to have a positive correlation with learning (Yeung and McInerney, 2005). Engagement is the desire to stay involved with tasks related to learning. Engagement can be a seen to reduce boredom, increase commitment, and be malleable, that is able to be used to facilitate a variety of learning related behaviors once it is achieved (Fredricks et al., 2004). Not all aspects of motivation have positive correlation with learning success. Avoidance coping is the act of giving up because the material is too hard or too boring while effort withdrawal is simply not putting forth full effort in relation to academic work. These maladaptive behaviors for learning are significant contributors to lack of academic success (Lau et al., 2008).

2.1 The Case for Gamification

In order to make long lasting environmental change, behavioral changes by individuals will need to be implemented in a variety of fields. It is with this in mind that gamification is discussed here. Gamification is the addition of play like elements into areas that are not traditionally viewed as play. The addition of game like elements into everyday life settings has the potential to change the way people behave in many ways.

The addition of game elements can come online or in a real life situation. An article by Kelly Liyakasa for CM magazine in 2012 expects that by 2013 “half of all enterprises will include gamification as part of their social business initiatives” (Liyakasa, 2012). This can be seen today with many companies utilizing

Cansu Akarsu created a soap stand in 2010 that will encourage children to play with it in order to teach proper hygiene at a young age. The soap shish places soap along a rack in the shape of an abacus. Children then draw monsters or characters they hate to place along the rack and are told that these represent germs. A song is incorporated with the usage of the rack teaching the children the proper amounts of soap to use (Akarsu, 2010).

Nike has developed a band that is worn and generates a score based on the physical activities performed during the day. It calculates total steps as well as calories expended and then tabulates this into a score that users can see on an LED display. Users can set goals on the band for activity levels creating a customized difficulty (Stack, 2012). It is important to note that this kind of gamification will not motivate someone to start exercising, rather it is used to bolster the motivation and to reinforce the goals of those who are already interested in the desired activity (McCoy, 2012).

Volkswagen’s the Fun Theory award in has shown several creative ideas for gamification of everyday activities (Schultz, 2010 and Bates, 2009). The speed camera lottery was tested in Sweden in where rather than penalize those who exceeded the speed limit, drivers who were photographed going under the speed limit were entered into a drawing for cash prizes taken from a pool of the ticketed speeders. Over the course of the pilot program the street showed a decline in speed of 22% (Shultz, 2010). Another entry for the fun theory awards was the piano stairs. Developed with the idea of encouraging people to use the regular stairs as opposed to the escalators, the piano stairs played different musical notes depending on which stair was stepped on. Also tested in Sweden, the Piano Stairs saw an increase of 66% in foot traffic compared to prior to the installation of the gamified environment (Bates, 2009).

Gamification is not just used by companies to achieve a desired result, Patricia Hewitt did a study on classroom learning and the affect that games had on students in 1997. She had students in a classroom environment play different games relating to environmental education and measured learning rates as well as changes in classroom behavior. She found that 4 of the 6 games played showed a statistically significant changes in student performance while at the same time generating a more positive classroom environment that was more focused on learning than just making a good grade on tests and that games need to be targeted to the needs of the students and to focus not only on facts (Hewitt, 1997).

The increasing adoption of smart phones (Smith, 2013) has opened up the ability to create games in a variety of situations that previously would have required significant investment to produce a gamified environment. Using the phone as a tool it
is much simpler to add a game element to pretty much any situation. The Queensland University of Technology has attempted to gamify their orientation activities (Fitz-Walter et al., 2011). 26 first year students that each had a smart phone were selected to participate in the first test program. The application was added to their phone, which contained an events list and tasks to complete. Completing each of the 20 tasks gave the users a badge and an achievement. Tasks could be any number of things, like checking into events, adding friends, or finding a location on campus. Not all achievements were listed directly many actually required students to figure out their meaning before completing them. When students completed the orientation they were given a survey to measure the effect of the pilot program. Overall the pilot program was received quite well (Fitz-Walter et al., 2011).

Though the data for this use of gamification is positive, there are some interesting points that suggest that not all of the features implemented in the game were as useful as reported. Achievements were given for each of the first 3 events that users checked into and although seventy-three percent of participants reported the checkin feature to be useful 82% of participants checked into three or less events, the upper limit for the last achievement. The quiz question achievements could also be improved. Students taking quizzes were allowed to keep retaking the quiz until they got the right answer. This led to students not actually attempting to find the answer but just using trial and error until the application gave them an achievement (Fitz-Walter et al., 2011). Finally, 77% of participants reported that friend list feature was useful but 68 percent only added 1 or less friends through the application (Fitz-Walter et al., 2011). These shortcomings show that while overall the game was designed in such a way that would be useful for new students the system included mechanics that were not designed properly.

UbiAsk is a mobile crowdsourcing platform that attempts to quickly translate signs or symbols in one or another language to the user’s native tongue. Users were asked to take pictures of the sign or symbol that needed translating. The picture is then uploaded for review by several bilingual native speakers. The key differentiating piece with this game is that the whole process is done without payment for service. Other applications offer the same service but, they all rely on paid experts to assist in the translation (Liu et al., 2011).

The goal for this application was to generate a quick accurate reply as to the meaning of the query. In order to increase these characteristics, a game layer was added to the application. Users were given points for quickness of reply and first responses to questions asked. No consideration was given to the accuracy of the translation due to this being a closed game where only knowledgeable persons could comment. The points were then allocated based on the location of the question asked and the user with
the most points in each location was given the title of ‘local expert’ for this location. The aim of the game then being to conquer the most territories and display local knowledge across many different regions. Results from the test period indicate that this kind of application has the potential to be successful. Half of all requests were answered inside of ten minutes while three quarters were answered within 30 minutes (Liu et al., 2011). An average of 4.2 answers per question was recorded as the rate of response. These results were achieved in a situation where the experts were not payed for their services despite achieving similar levels of service to other paid platforms (Liu et al., 2011).

Mobile phone technology has allowed gamification of other areas as well, including personal health. The Playful Bottle is an augmented drinking mug developed by Chiu et al. (2009) that works to help people drink a healthy amount of water per day. A regular drinking mug is fitted with an electronic measurement system that calculates how much a person is drinking and when, which is then relayed to a mobile phone application that displays the results, and stores them for long term monitoring (Chiu et al., 2009).

Two game layers were created for the application. The first was an individual centered game which displayed the users hydration level as an individual tree. The tree would change its apparent health through five different stages or levels depending upon how closely the user’s water intake matched the ideal amount. The second game was similar in mechanic to the first but also included a social aspect. Friends from the surrounding area were also displayed as a forest which could then be used to compare hydration levels. Both games included reminders sent to the users when their ‘trees’ would start to wither. However, the social game allowed users to send reminders to others by first performing their own water drinking action to earn credit then spending this credit by tapping on another user’s icon in the forest. Doing this action would display a notification on the receiving user’s tree. Once the receiver drinks water the social interaction is complete and the tree advances one level back towards full health (Chiu et al., 2009).

16 university staffers were selected in a test of the Playful Bottle to compare the effects of the game layers with baseline behavior. 3 weeks of drinking behavior were tracked using the Playful Bottle but without any game layer activated to establish a baseline. The users were then separated into 3 groups: a control where no reminders were sent for the duration of the study, a group using the individual tree game with system reminders, and a group in the forest game containing both social and system reminders for hydration. The study then measured total drinking amounts as well as drinking interval for all users for the next four weeks (Chiu et al., 2009).

Figure 1 shows the changes on average of each of the different game environments in relation to the control group. Table 1 shows the response time of the
different available events. The response is measured as how long it took the receiver to take a drink after being notified via one of the available mechanisms, either a social reminder in the forest game or the standard system reminders in both the forest and tree game. This shows that users responded much faster to social reminders than to the standard system notifications (Chiu et al. 2009). This study shows how gamified environments can easily add social pressures to their games and how the effectiveness of these games can increase with simple changes to the mechanics. With just a simple tweak in the mechanics they changed drinking response times by about 7 minutes.

![Daily Water Intake Through the Experiment Days](image)

**Figure 1**
(Chiu et al., 2009)
Education is a field in which gamification has showed some promise. Old Dominion University has launched a small investigation led by Landers (2010) into the value of social media in online education. In 2010 about 600 students were given the option of signing up for an online social network integrated with the education. Of the 600 possible 400 set up profiles to use the program. From these students 4500 posts were made in relation to course discussion and 500 status updates were posted during the summer term. In regards to game mechanics for the system, only one technique was used. A certification center was created where optional non graded quizzes were offered from any course in the department. Quizzes were created randomly from a question pool created by subject and were 10 questions in length. Students were allowed to take as many quizzes as they wanted but were limited to taking 1 quiz from 1 course every 4 days. Points were earned by completing the quizzes correctly and once the student reached a certain level of points they received a badge which would be displayed in the social network next to their name (Landers, 2010).

The system was deemed to be a success by the educators creating the system. 28 percent of students chose to participate in the voluntary non-graded quizzes while 4 percent of students signed up to become student mentors and 5 percent signed up to be mentored. The school even reported a positive correlation between social network use and GPA. Students also self reported that the system was rewarding in a social aspect and allowed them a working space that otherwise was lacking in most classes (Landers, 2010).

<table>
<thead>
<tr>
<th></th>
<th>Forest Game social reminders</th>
<th>Forest Game system reminders</th>
<th>Tree Game system reminders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of events</td>
<td>50</td>
<td>451</td>
<td>496</td>
</tr>
<tr>
<td>Responded events</td>
<td>48 (96%)</td>
<td>440 (98%)</td>
<td>448 (98%)</td>
</tr>
<tr>
<td>Censored events</td>
<td>2 (4%)</td>
<td>11 (2%)</td>
<td>8 (2%)</td>
</tr>
</tbody>
</table>

Response Time to Different Reminders

Table 1

(Chiu et al., 2009)
Libraries are also taking gamification seriously. Some libraries are running games like Bibliobouts, which is designed to increase students' abilities in finding information. These games challenge students to find information using the tools available in the library (Danforth, 2011). Bibliobouts was a social game implemented online that taught students these research skills without making lessons out of the material and instead had them complete a research project while at the same time playing a game (School of Information University of Michigan, 2012).

The environmental field has also produced a few examples of gamifying regular activities. Liu et al. (2011) also studied EcoIsland which is an online game designed to work to reduce individual and family carbon dioxide emissions. The goal of the game was to provide feedback on what the everyday activities that a family does has on the global climate change. Each member of the family is entered into a game world as an avatar and then sets a target for carbon dioxide emissions. Targets can be set in relation to nation averages in any way that the user chooses. The family avatars are then displayed on an island surrounded by seawater. Users manually enter daily activities and these are then used to estimate carbon dioxide emissions. As the users exceed their set targets the seawater around the island is seen to be rising. The game will then display useful techniques or activities for reducing emissions to give some feedback on how to meet their target. After indicating that they have completed these activities the seawater recedes accordingly. Users can also view other families that live in the surrounding areas. Players are rewarded with a virtual currency for completing environmentally friendly activities. This can then be used on a virtual marketplace to decorate their island or to purchase emission ‘rights’ on other islands (Liu et al. 2011).

The EcoIsland test did not produce significant changes in behavior. While seventeen out of twenty users reported they were more conscious of environmental issues after the experiment than before there was no correlation between this and the readings from the electricity meter and reported activities (Liu et al. 2011). It is important to note here that the EcoIsland test can be instructive despite being a failure in terms of actively affecting people’s behavior. This paper will return to EcoIsland later when discussing game mechanics.

Recyclebank is a company that rewards people who report taking small environmental actions with coupons. They had previously published ways in which people can take specific actions in certain rooms in their house to help ‘green’ the world. With this background they wanted to create ways in which people would engage more with the information, generate more new users to the site than they had before, and to encourage their users to take individual green actions. In order to do this they set up an online game environment called the Green Your Home Challenge (ROI Research Inc., 2011).
A game layer was added to their current website where instead of just being presented with the information users would be given 1 room at a time and would then be presented with various interactive media such as quizzes, polls, and interactive flash tools. Users then earned points for completing these tasks as well as points for the amount of referrals they generated and finally points for the points earned by their referrals. A leader board was maintained and prizes were given at different point levels as well as to those that were highest on the leader board. Different rooms were also unlocked after certain periods of time encouraging users to visit the site frequently. To measure the effectiveness of the game environment Recyclebank worked with Google Analytics to track website usage and ROI Research to track correlation with real life activity changes (ROI Research Inc., 2011).

The Green Your Home Challenge was a large success across all three goals measured. Recyclebank saw a 71% increase in unique visitors compared to previous months before the game layer was added. Not only were there new visitors to the site but there was also an increase in new members to the site. Finally, the reward for referring a friend produced an 821% jump in referred users. Furthermore, it showed that 62% of all visitors attempted to get others to participate in the challenge (ROI Research Inc., 2011).

Engagement in the site also showed a change in behavior. Before the game layer was added the average visitor to the site spent 6 minutes on the site. After the game was implemented users spent an average of 18 minutes on the site. It was also determined that 25 percent of all users visited the site 3 or more times. Finally, after the last room was opened 63 percent of the people entering this room had previously visited 3 or more of the other rooms available (there were 5 in total). Users also reported that they were pleased with the game environment. 62 percent were very/extremely satisfied with the challenge while 86 percent stated they would be very/extremely likely to participate in similar games in the future (ROI Research Inc., 2011). This shows how significantly the way information is presented can change the way people interact with it. Users spend significantly longer in the site with the game layer as well as returned multiple times to continue to receive new information.

To measure the main goal of this challenge, educating and changing personal behavior in a green way, ROI Research deployed a pre and post survey and measured the differences. Table 2 shows some of the changes in behavior that users reported. 97% of visitors surveyed reported that the challenge helped them increase their knowledge of ways they can help the environment. There was also a correlation between how many points users earned and their reported knowledge increase (ROI Research Inc., 2011). It is important to mention here that ROI Research did not actually measure any concrete changes, they only measured a self reporting of results. As reported in Geller’s studies
self reporting changes does not necessarily mean that actual behavioral changes are taking place. Furthermore, none of the game mechanics really focus on changing behavior. The game layer rewards knowledge acquisition as well as giving bonuses for increasing traffic to the site.

<table>
<thead>
<tr>
<th>What green actions do you take</th>
<th>Pre</th>
<th>Post</th>
<th>%+</th>
</tr>
</thead>
<tbody>
<tr>
<td>I turn off the lights</td>
<td>18%</td>
<td>26%</td>
<td>44%</td>
</tr>
<tr>
<td>I use CFL/Eco bulbs</td>
<td>28%</td>
<td>38%</td>
<td>36%</td>
</tr>
<tr>
<td>I conserve water/energy</td>
<td>34%</td>
<td>45%</td>
<td>32%</td>
</tr>
<tr>
<td>I buy local produce</td>
<td>0%</td>
<td>14%</td>
<td>---</td>
</tr>
<tr>
<td>I wash clothes in cold water</td>
<td>0%</td>
<td>7%</td>
<td>---</td>
</tr>
</tbody>
</table>

Pre/Post Game Results

Table 2
(ROI Research Inc., 2011)

All of the previously discussed systems were either launched with gamified environments or had the game layer added onto an existing system. It is also interesting to see how behavior changes after having a game layer removed in relation to the baseline of a gamified environment. Thom et al. (2011) did exactly this with Enterprise SNS. A large IT company with a global workforce of about four hundred thousand deployed a social networking system called Enterprise SNS. In this deployment they started with a game layer that gave users points for using the system. Users earned posts by posting pictures and comments, answering questions, or contributing to a list. These points were then displayed on a leader board in a bee themed system. There were also four different levels that users could reach by obtaining a set number of points. This would be displayed on their profile along with badges that could be earned by performing certain actions. Half the site users were given the point and badge system while the other half had only the regular social network deployed. After six months all users were given access to the game layer but after ten months the game layer was removed for the entire system. Metrics were taken at each of these stages to see the effect of the game layer on network activity (Thom et al., 2011).

The data shows a higher rate of usage in the gamified environment, though there is no difference between the likelihood of new users posting for the first time in the environment the gamified environment showed much higher levels of activity by the users who chose to adopt the system in this environment. It is also interesting to note
that when compared to the non gamified environment the game layer section shows much higher rates of activity at the beginning of the game but this trends to a lower level after a few weeks, however this level is still higher than the non game environment (Thom et al., 2011).

The main part of this study concerns what happened after the removal of the game environment. With the planned removal of the network the researchers measured the level of activity in the two weeks before removal and in the two weeks immediately following the removal of the game layer. There were large drop offs in activities across all categories. Qualitatively the researchers theorize that some of this drop off is from small non contributing comments like greetings that were mostly added just to score points in the game. Overall, however, such a large change in activity cannot have resulted simply from the removal of these kinds of communication and suggests rather that the point system did influence usage of the social network in a positive way (Thom et al., 2011).

2.2 Game Mechanics

Game mechanics are the constructs within which a game is played. In a board game they are the rules while in an online environment they may be the way a user interacts with the game environment (Priebatsch, 2010).

Seth Priebatsch a gamification entrepreneur and Tom Chatfield a game theorist have presented a list of eight game mechanics that drive people to continue playing games. Table 3 lists these dynamics and supplies an example of how this mechanism is used. The appointment dynamic is a reminder or set specific time in which actions need to be performed. Games like Farmville keep people coming back every few hours in order to perform actions like watering their crops. If players fail to keep the appointment there will be some kind of in game penalty. This kind of dynamic is can also be something like a daily bonus for playing. Games like World of Tanks give players experience for doing well in battle, but on the first win of the day they receive a multiplier to this experience. Players here receive no penalty if they miss their appointment but they do forfeit their bonus. Influence and status is something games can confer via leader boards or badges; anything that shows how one user compares to another. Applications like 4Square provide badges to show users that have achieved certain set tasks. The badges display on their profile which is viewable by all of their friends who also use the application. This kind of mechanic is also is what was used by Ubiask. Players were rewarded for their contribution by ‘conquering’ territories and being the best local expert. Progression is the stepwise movement showing gain in skill, knowledge, experience, or any other measurement that can be shown increasing up to
another level or until completion of a task. Websites like LinkedIn include progression mechanics in their account setup by introducing a progression bar to show how far along in the process a user is. Really any game that has a leveling or experience meter use this mechanic. Communal discovery is the act of a large group of individuals working together to solve problems or find something together. Websites like Digg have evolved solely using this mechanic. In Digg users work together recommending the webs most interesting stories for other users to read (Priebatsch, 2010). Games providing multiple long and short term aims keep people engaged by providing long term goals and short term actions that will help people reach the overarching goal. World of Warcraft has this as a main feature of their gameplay. Players advance levels by killing virtual monsters with the main objective to reach level fifty. Rather than just allow players to kill monsters on their own up until they reach level fifty the game provides many small quests that gain the character experience which helps them reach the main goal. While the long term goal is always the same, reach level 50, the smaller quests give something attainable in the short term while trying achieve the ultimate

<table>
<thead>
<tr>
<th>Game Dynamic</th>
<th>Example of usage in a Game</th>
</tr>
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<tbody>
<tr>
<td>Appointment Dynamic</td>
<td>Farmville: watering crops</td>
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<tr>
<td>Influence and Status</td>
<td>4Square: badges</td>
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<tr>
<td>Progression</td>
<td>Linked In: profile completeness bar</td>
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<tr>
<td>Communal Discovery</td>
<td>Digg: Communal finding of best web stories</td>
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<tr>
<td>Multiple Long and Short Term Goals</td>
<td>World of Warcraft: Questing system</td>
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<tr>
<td>Reward all effort</td>
<td>Experience points in game for attempting any mission</td>
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<tr>
<td>Rapid frequent and clear feedback</td>
<td>Death of in game character or gaining experience for successful actions</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>McDonalds Monopoly game</td>
</tr>
</tbody>
</table>

Game Dynamics and Examples of the Their Use

Table 3
endgame goal. Without these smaller sub missions the game would be more frustrating. Rewarding all effort is an important part of gaming. Games tend to reward almost all positive actions in the form of experience, however, successful actions are usually rewarded at a greater rate. This gives users the feeling that they are constantly progressing and challenges them to attempt previously untested routes to solve problems. The rewarding of any attempts is also important because it encourages gamers to try and find different ways of getting the solution. The security of a reward of some experience allows gamers to take risks in their attempts to find an optimal path to their goal. Finally games that have uncertainty either in reward schedules or progression tend to be more interesting and engaging than those that provide a mechanical one action equals one reward mechanic. The McDonalds Monopoly game is an example of uncertainty in a gamified environment. Once a year McDonalds runs a promotion on their products where consumers are given Monopoly pieces on all of their purchases. Collecting these pieces and completing a set give a reward from cash prizes to free fries. What is interesting with the game is that the reward of finding one of the prize winning pieces is much more exciting to a person than simply getting a reward after performing a specified action (Chatfield, 2010).

Games can be used as a way to bring people together on issues that otherwise might be ignored. Jane McGonigal (2010) has created alternate reality games that seek to solve pressing world issues. Her ‘World Without Oil’ created a weekly updating simulation of a global oil crisis in which oil was rather quickly removed from the economy and encouraged people to blog about how they ‘reacted’ to this alternate reality. People worked together in telling a story across the country of how people are adapting to the lack of cheap oil. One of her other games Superstruct was a more broad environmentally themed game. This game like World Without Oil was an alternate reality game in which a supercomputer calculates that humans have only twenty three years remaining until they go extinct if they continue living the same way as the have in the past. The computer identifies five different areas that need to be improved or human life will cease to exist. These areas are energy, health, hunger, security, and the security of the social safety net. Players in the game are then tasked with working together to find ways in which to solve problems in these sectors (McGonigal, 2010). Each of these games use the communal discovery game mechanism to bring people together and put them in an engrossing environment in order to solve large problems. These games are not intended to change behavior but to put diverse peoples’ creativity into fixing world issues or at least considering how their actions affect a broader group than just themselves.

It should be noted here that the vast majority of papers on gamification were games that were held online or used some form of phone to augment the world that
users participated in. Gamification can be used in either capacity but most literature has focused on online games. This is not information that is then useless while looking to create an offline gamified environment, the game mechanics are still the same. Feelings of communal exploration or status are still motivators for players regardless of the medium at which they are delivered, what differs then is simply the resources used to convey them.

Games like the Speed Camera Lottery use feedback by taking pictures of those who are driving at the correct speed as well as uncertainty because of the randomness of the reward provided. The Piano stairs on the other hand reward anyone taking the stairs by playing tones as they walk. They also use communal discovery in a way since people can work together to create music by walking on stairs in a certain pattern. Game mechanics translate through the medium and rather than be limited by it, they simply are controlled by what the game designer is trying to implement.

3.0 Reviewing Game Mechanics

Games succeed or fail depending upon how well they mix the game dynamics in relation to their goals. UbiAsk created their game layer using solely influence and status as a reward for participation. This was moderately successful for them but many people were not influenced by the game mechanics. Looking at these games particularly those who greatly succeed and those who fail can give us a better understanding of how these mechanics influence behavior.

The Old Dominion University program’s gamified environment was a moderate success. This system succeeded in their goal: to get students to use the online quizzes. While this is interesting by itself it can be worth it to discuss what could have been done better. The social game could easily have been worked to provide some incentive to become a mentor or to reward taking advantage of these groups. Since this was deemed a positive reaction a gamified solution could have been applied to increase just such activity. Furthermore, progression could easily have been added into the game environment with the inclusion of rewards or status from the completion of a certain number of quizzes. Status as well could be implemented with certificates or badges for completing certain quizzes above a specific threshold. While in general this game environment was deemed a success, with a bit more ambition this project may have been able to make an even larger impact.

The Queensland University of technology orientation game succeeded in some of their goals, but showed some weakness in execution. Perhaps there could have been more achievements that were not exactly specified what the condition was for obtaining them. Since students were not attempting to actually find the answers and instead using
trial and error (Fitz-Walker et al., 2011), the question sections could instead have been
tweaked to give students declining points for each guess, with a minimum number of
points needed to complete the achievement.

The Playful Bottle is one of the game systems that seemed to really change
people’s behavior. Users presented with either of the two game environments drank
more water per day as well as more regularly than those who were not given the game
environment. It can also be seen that the forest game environment was more successful
than the tree game (Chiu et al., 2009). Similarly, both of these games provide players
with an appointment dynamic by providing system reminders based upon drinking
levels. Both games also confer status on the player by giving them a tree that is healthy
when well hydrated and withered when not receiving enough water. The main
difference between the two games is the social operation. In the tree game users only
worry about their own tree. The forest game, however, adds an additional social
element. Not only is their tree now visible to others giving a boost to the status of
having a well watered tree, but they also add the ability to interact with others through
their caregiving mechanism. As the results also show users were much quicker to
respond to the social alerts given to them than they were to the standard system alert.
Finally, it is also important to note that this game also gives quick and automated
feedback with no input necessary from the user. Because the game measures the
amount that is drank from the cup, the user receives feedback from their actions as they
happen and the game is tied directly to actions taken by participants rather than to self
reporting.

On the available measures the Green Your Home Challenge also matched each of
their stated goals. Users were more engaged with the website, there was a significant
gain in new users, and users reported that they changed their behavior (ROI Research
Inc., 2011). The Challenge mixed several different game dynamics pertinent to their
goals. Users were given points for completing tasks and referring friends, these points
were not only used to grant access to rewards but were also a part of increasing status
through the community leader board as well as rewarding all action. By opening the
rooms one at a time throughout a specified schedule the challenge also added an
appointment dynamic to a relatively static game. Each room was divided into different
levels. There would be certain questions asked or quizzes to take but the user did not
know this before ‘entering’ this room. This added a level of uncertainty to how the
information was presented allowing users some degree of excitement to the experience
of playing the game. After being asked for by users in the forums the challenge also
added a section to the game for user generated content (ROI Research Inc., 2011). This
added to an already deep game by giving a sense of communal discovery to its
participants. Finally, feedback was given in a few ways. Players would receive points for
participating in the tasks of each room giving them points which could be redeemed on coupons that the site provided this feedback was quite clear and quick. However, there was no measuring mechanism for users at home behavior. Instead the challenge relied on a pre and post test to see how users reported changing their behavior. While the results of the test showed that users say they changed their actual behavior, there can be a discrepancy between reporting and actual behavior as seen in the EcoIsland example.

The EcoIsland game is an example where the addition of a game layer failed to significantly change the behavior of the people playing it. Players reported changing their behavior but the addition of a meter showed that they actually made no large changes in how they used electricity. The researchers theorize that this was because it was a small sample size and that the test period fell at an inconvenient time due to the large family holidays in Japan at the time (Liu et al., 2011). More likely the game failed because it did not adopt the correct mechanics for its stated goal. The game did a good job in creating a social atmosphere where players could compare themselves to their neighbors and decorate their islands with rewards from doing environmentally friendly activities. Where the game fails however is providing quick and clear feedback. Players are supposed to self report when they do any activity into the EcoIsland interface. This would be any activity that would release green house gases, so anytime the user did anything involving electricity, heating, or transportation using fossil fuels, they would have to enter this into the game. Feedback is simply not provided for any actual actions that the users take. So while users reported that they had changed their behaviors, according to the meters measuring electricity usage this was not the actual case. This game does many things correctly. They made a social game that caters to users desire for status as well as give information to help the users take better action. They also make available information on how to set goals for environmental impact, however they fail because their mechanics are not related directly to their goals. To make a better game the system would have to automatically calculate how people are affecting the environment and display that on the game screen. This would show the users exactly what they are doing that is effecting the environment and allow them adjust their behavior accordingly, rather than thinking they are making a difference and not actually doing so. The game could also use some sort of progress system showing users approaching their stated goals in an effort to motivate them to continue using the application. While there may be some merit in the test period falling over a holiday that caused people to not adopt environmentally friendly behaviors, this should not have effected the users to such a degree that there was no change measured. After all, to solve environmental problems people need to change their behavior in general and not just on days that are convenient for them.
It seems a recurring theme when discussing game mechanics how feedback is or is not implemented correctly in the game. It has been shown the quick clear feedback that is customizable has the potential to change behavior (Fischer, 2008). When it comes to games it can almost be said that the entire game is constructed to give feedback. Games give points or experience for correct actions which is a feedback to the player showing which actions are more desirable than others. It is important then that the feedback that the game is representing is related to the goal of the game. EcoIsland gave players feedback, but here it was feedback related to selecting less environmentally impactful behaviors on their self reporting screen that were rewarded the highest. This then can lead to EcoIsland being a good game for increasing awareness of environmental behaviors but, because the game was not directly linked to actual happenings, the game failed at providing feedback that was useful to actually changing behavior. The PlayfulBottle on the other hand related all of its game mechanics to measurements taken by the bottle. This ensures that the game is giving feedback related to its actual goal; getting people to drink water in a more healthy manner. Games excel at giving feedback to their users in fun and engaging ways, however, for the game to be successful the game must relate its feedback to the goal.

4.0 Methods and Materials

Two case studies were run on MIUN campus in Östersund. Study 1 was a test on how gamification can affect learning about environmental facts that affect daily life. Study 2 was a study on how gamification can affect environmental behavior, namely recycling.

4.1 Study 1: Gamified Information

In study 1, a 2 page pamphlet (see appendix 1 for pamphlet) was created that ranked environmental behavior. The information contained within was drawn from several life cycle assessments and the goal being not just to show which is better but to give the reader some idea as to how much better one activity was relative to another. For example a person would have to use their cotton shopping bag 131 times before it would ‘break even’ with getting a new plastic bag every time whilst shopping (Edwards and Fry, 2011). A 6 question questionnaire (see appendix 2) was created to measure familiarity with the material. The questions used in this study were created to measure awareness of the relative impacts of environmental actions, for instance how much energy is saved by recycling aluminum vs mining new ore. A few qualitative questions
were included as well as the 6 material based questions to measure students’ attitudes towards the information supplied as well as to verify that the study was not oversampling one particular group of students. Students in the G building (a large common area not specific to one type of student) were randomly approached and asked in Swedish if they could help with a master’s thesis. They were also notified that all the material would be presented in English, and if needed, clarification would be provided. 117 students accepted and were then divided into 3 groups; 34 students were given the baseline questionnaire, 38 students were given the pamphlet and questionnaire, and 45 students played the game and were given the questionnaire. The groups were intended to be of a similar size if possible but due to time constraints and the patterns with which student’s accepted the groups ended up being of slightly different sizes.

Randomization was done in case there was some hidden bias. If all of the baseline group were taken at the same time and there happened to be a high concentration of nursing majors at the hall at this time, this could skew the results of the study if this group had a different baseline knowledge than others. Randomizing the allocation of the groups then would theoretically spread out any hidden biases evenly thereby making a more unified test group (Schulz and Grimes, 2002). Also, randomizing the selection of students would eliminate any unconscious selection bias (Schulz and Grimes, 2002).

The first group was simply given the questionnaire to test baseline knowledge of the material. The second group was given the pamphlet to read followed by the same questionnaire. The third group was asked to play a trivia style game covering the same material as the pamphlet. Players would be asked a question regarding the relative effect of some environmental activity and given a few choices. Players would be able to select a choice and if their answers were correct they would get 2 points. If they were incorrect they were given a second opportunity to guess from the remaining choices. If they got the second chance correct they were given 1 point whilst if they got it wrong they were given 0 points. If a player was sure they knew the correct answer they could choose to forfeit their second chance opportunity and would receive 4 points if they were correct but 0 points if they were incorrect. After each question a short explanation would be given as to the correct answer. Players who successfully beat the average score would be rewarded given either coffee, candy, or a danish from a nearby coffee stand. The initial average was set by 3 ecotechnology bachelor’s students so that students participating in the study would have a goal to compare against initially and then changed after each player finished. Finally, the players of the game were given the same questionnaire and results were compared.
4.2 Study 2: Gamified Recycling

Study 2’s goal was to see if gamification could be used to change actual behavior related to recycling. First the site of the project was determined. The common room of the P building at campus Östersund was selected because it was a relatively high traffic area with recycling bins nearby. It was also deemed superior to other spots because the bins were in a rather awkward location and not readily apparent with the room design.

The study was then broken down into three weeks. The first week was a simple baseline week where the recycling bins were changed daily and weighed on a scale accurate to the nearest gram. The second week introduced a sign over the recycling bins pointing out their location and any recycling was emptied and weighed. The third week a gamified environment was added to the common room and the recycling was weighed as usual. It should be noted here that while this study was done during three consecutive weeks, a few days were not counted due to holidays which led to extreme low traffic on campus. Each study week was given 5 normal weekdays so that the data would be equal. Weekend days were also counted but there was no usage of the recycling bins on these days so they were discarded.

The gamified environment consisted of mostly visual clues. Colorful construction paper was cut to resemble dinosaur footprints and laminated then taped to the floor starting at the entrance. The footprints then led off towards a table where a poorly handwritten note was left. The footprints led around the room stopping off at various tables where other notes were left. On the notes were hints as to what was in the recycling bins. Things like “Did you know that MIUN’s dinosaurs like burnable recycling?” or “Dirty paper is the best!” were included on the notes. Finally, the footprints led into the burnable bin. This bin was specifically chosen because it had the second highest average daily usage and was used every day during the baseline period. The compost bin which had the highest daily usage was not selected because this would make it significantly harder to keep the dinosaur in the bin clean. When the bin was opened it would be revealed that a silly looking dinosaur, also made of cut and laminated construction paper, was in the bin and it would thank people for feeding him (see appendix 3 for pictures of experiment).

5.0 Results

5.1 Study 1: Gamified Information
34 students took the baseline questionnaire and scored an average of 23% correct. 38 students read the pamphlet, answered the questionnaire, and received an average of 56% correct. 45 students participated in the game, answered the questionnaire, and received an average score of 66%. Figure 2 shows the distribution of scores for each group.

Across both test groups there was broad agreement that the information was useful with 80 out of 83 students who received either the pamphlet or the game agreeing that the information was useful. 68% (26 out of 38) of those receiving the pamphlet mentioned that the information was presented in an interesting fashion while 98% (44 out of 45 - it should also be noted that the one person who did not agree did not fill out this section of questions located at the back of the questionnaire).

![Distribution of Questionnaire Scores](image)

**Distribution of Questionnaire Scores**

**Figure 2**

5.2 Study 2: Gamified Recycling

The baseline week showed the burnable bin having an average of 91 g of
recycling in it per day. Week 2 which consisted of a sign pointing out the location of the bin showed an average of 50 g per day. Week 3 with the gamified environment showed an average of 172 g per day. Table 4 shows each day’s recycling numbers and table 5 shows the weekly averages per day of each container.

<table>
<thead>
<tr>
<th>Paper Packaging</th>
<th>Hard Plastic</th>
<th>Metal</th>
<th>Containers</th>
<th>Burnable</th>
<th>Compost</th>
<th>Misc</th>
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Daily measurements (g) of recycling during each week
Blue is baseline week, yellow is sign only, and red is gamified environment.

Table 4
Gamification is a strategy that often is used to generate engagement with an object that is otherwise not normally attained. Study one created a trivia game out of environmental facts which allowed people to engage with them in a manner that is not normally possible when they are just presented as facts. Study 2 created an environment around the recycle bins prompting students to explore the area and engage with the bins in a new way. Previously, the bins were simply a location to dispose of waste, but in the gamified environment they were the focal point of exploration.

The increase in engagement created by gamification can be a motivating factor. Each study presented in this paper dealt with this in different ways. Study 1 motivated people bringing a competitive element to learning whilst rewarding participants as a result of their scores. Study 2 created uncertainty motivating participants to explore the area around them. Alternatively, sites like the Green Your Home Challenge created engagement by bringing their facts into an interactive environment.

Gamification is not a magical wand that can cure all ills instantly. There are games that are successes and games that are failures. Most of the reasons games succeed or fail are due to their mechanics. Games like EcoIsland contained no feedback related to their desired goals, this caused them to fail. On the other hand Green Your Home Challenge had mechanics that drove users to the site, fostered communal discovery, and increased engagement within each room which created a massively successful

<table>
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Daily averages (g/day) of each recycling by week

Table 5

6.0 Discussion
experience for the company. It is important again here to distinguish that they did not include any feedback related to actual behaviors. This means that while the goals that they started with were met, they may not have had as much of an effect as they may have hoped on actual behavior. Games like the Playful Bottle on the other hand directly tied all of their mechanics to actual behaviors and were shown to have a strong effect on the way people actually behaved.

6.1 Study 1 Gamified Information

This study was done with the intent of examining how information is presented affects the ability to understand and later recall the information. In this game rather than just present the facts and ask people to learn them, the information was presented with a goal of engaging people in the pursuit of a reward while still imparting practical environmental knowledge. In terms of mechanics the game was designed to have multiple aims such as reaching the reward level or past that to the high overall score. Players were advised that the minimum score for receiving a reward was the average point total at the moment and were also informed of overall high score so far. This would give players the ability to shoot for higher goals if they had already surpassed the average as well, by giving them multiple long and short term goals (see table 3). The way the game was scored (2 points for a correct first guess, 1 point for a correct 2nd guess, or 4 points for a correct first guess with no option of a second guess) meant that in the 9 question game the average was almost always in reach until the final few questions keeping even lower performing players interested in the game.

The game provides directly clear feedback (table 3) almost instantaneously. Players are notified of their scores at the end of each question as well as being reminded about the average score and the overall top score also giving a sense of progression (table 3). Anecdotally, players were very concerned about their scores and often agonized over choices, especially towards the end of the game. The game also used the high score as a means of status as players were encouraged to try to reach this point.

As can be seen both of the test groups did better on the questionnaire than the baseline, showing that there was an increase in understanding of the material after either reading about the information or playing a game revolving around the material. The game performed slightly better than the pamphlet in correct questions answered on the questionnaire, 66% vs 56% respectively. This can possibly be attributed to other things other than specifically the gamification of the material. Players in the game spent the majority of the game time comparing certain environmental situations while the pamphlet group were reading comparisons but also longer explanations of the problems. This could lead to the game group paying attention more to the actual
numbers than the pamphlet group. It is important to note that the game group was also given context after the questions explaining how comparisons ended up the way they did, but the questions in the game were all related to quantitative relative impact. Alternatively, the questionnaire was quite difficult. The answers were all numbers and some of them were quite similar which may have made recalling the exact number difficult even though I attempted to make as large of a spread as possible ie: a) about the same b) 20% c) 50% d) 95% instead of a) about the same b)5% c)10% d)15%.

The most interesting result here aside from the similarity in final questionnaire scores, is the almost universal agreement that the information was informative (96%) and the disagreement that the information was presented interestingly (68% thought the information was presented interestingly for the pamphlet group and 98% for the game group). Almost all of the game group participants stated that they really enjoyed playing the game or that they wished more information was given in a similar way. In fact many of those in the game group who beat the average score declined their prize (a coffee or candy from the coffee island) and instead thanked me for letting them play. Also anecdotally, it was significantly easier to get people to play the game than it was to get people willing to read the pamphlet. Students who were asked to read the pamphlet were often very concerned about the length of time needed to read the pamphlet and were generally less willing to participate in this part of the study despite the length of time being relatively similar for the game and pamphlet (about 10-15 min each). Those asked to play a game followed by answering a questionnaire were much more likely to accept without asking further questions and were often eager to see if they could win. Though anecdotal, this provides strong evidence that this kind of method for delivering information can be used to increase environmental learning. Simply giving out pamphlets can be effective in increasing learning as well, but when people enjoy the process of learning it can be easier in getting them to participate in the activities needed to start the learning process.

With more technical skill a better game could have been created that would make use of more game mechanics. The game tried to give some status (table 3) to players by keeping track of the high score. Since the game was done anonymously though, this was not as effective as it could have been. Had the game mentioned the name of the high score holder this would confer some status to that person and give a reward rather than just the knowledge that they had the high score for a period of time. If the game were integrated into some form of teaching environment the high scores of the game could have been compared across classes or even across years. Alternatively, if this game were held online, flair or badges could have been used for the class’ network generating status. Also, there was little uncertainty in the game. The game used progression (table 3) though questions with the final score simply being added up.
While this provides good progression, if the game were longer it would be difficult to keep players interested throughout the entire game because they could easily see if they were going to make the average score before the game was close to being completed possibly leading to frustration or disinterest. Again, if this game were held online, perhaps some creative ways could be added to strengthen this mechanic. The game could be divided up into sections ie: energy, transportation, etc and the players could be either given flairs and badges if they score exceptionally high in each section, adding both surprise and status to the game and also bringing uncertainty (table 3) to the goals of the game. Finally, in an online environment it wouldn’t be hard to bring together a communal discovery element. There could be sections of the game where players/students work together to solve the answers or even expanding the game by creating new questions for the future.

6.2 Discussion: Study 2 Gamified Recycling

Study 1 essentially took information and changed the format of it to become simply a game. Study 2 on the other hand, is more about designing an environment that takes advantage of elements of play in order to get participants to behave in a certain way. The game environment created in the P building relies mostly on uncertainty and on communal discovery (table 3) to drive the intended effects. As soon as student’s opened the door to the building they were confronted with something interesting. There were footprints on the ground leading into the common area. These footprints lead around to the different tables where notes were placed. The notes on the tables contained phrases giving hints as to what they might find and where and were written in a style to create a character. The notes were written in basic Swedish with poor spelling and grammar which would make sense after finding out that a dinosaur had written them. The goal of these prompts and decorations was to create a desire in the person to figure out what was happening. Ideally, they would follow the footsteps around looking at the notes being slightly confused until they led up to the bins. Finally, when the correct bin was opened it was revealed that there was a dinosaur thanking people for feeding him. While the mechanics of this ‘game’ were not expressly communal, they certainly facilitated communal activity. Several people were seen to open the bin laugh and then return to their friends and point out the funny dinosaur in the bin. Feedback on the other hand, was provided when someone opened the bin and were greeted with a positive message along with something funny and unexpected as a reward for ‘discovering’ the recycle bin. The use of injunctive norms can also reinforce this behavior in the future.
This three week study showed some significant changes during the gamified environment with averages moving from 91 g/day during the baseline week, 50g/day during the simple signage week, and 172g/day during the gamified environment week.

Surprisingly, the second week, which had a sign put up indicating the location of the recycling bins, had a drop in average recycling. This could have happened because of the timing of the study. In the middle of the month was Valborg, one of Sweden’s larger springtime holidays. The study did plan for this by discarding several days when there were no or significantly less classes at the university. However, it is possible that some students extended their vacations and did not return to university despite classes being in session, leading to lower traffic in general in the vicinity of the bins. Though, looking at not just the burnable bins, this drop is not observed across all the other bins. Paper packaging and glass had higher numbers that week while hard plastic stayed exactly the same. It should be noted also that while glass had a higher average that week than normal it really was only one day that had some heavy glass objects in the recycling. The drop in usage of the glass containers during the final week of measurement is probably related simply to the fact that these bins were rarely used. The glass bin was only used twice throughout the entire study period, it just happened that the second week that there was one day in which a heavy glass jar was deposited. The average usage then looks like it drops during the third week however, it is just likely that this type of recyclable is not used very much in this location.

It can also be interesting to note that while this study did not measure rates of correct recycling, in the last week there seemed to be higher incidences of improper sorting in the burnable bin. This could be because more students who did not normally use the recycling were drawn to the burnable bin because of the way the environment was set up.

This case study effectively combined the game mechanics needed to overcome the barriers to behavior for this location. As discussed the location of the bin is rather out of the way so the introduction of exploration in a communal discovery situation lead to the desired behavior of using the bin. The addition of the poorly hand written notes were prompts but also part of building a character. Instead of a normal note on the table the addition of something different added a layer of uncertainty as to their purpose. They were clearly not normal and were designed to get people to question why. Finally, the reward for desired action was the funny dinosaur in the bin.

In general this game achieved its goals. However, the study would have benefitted from a longer study period which would allow not only longer periods for each level (baseline, sign, and gamified environment) but would also allow for an additional level of a return to baseline status which would check to see if the gamified environment had produced any lasting effects.
7.0 Conclusion

These experiments show how gamification can be used in a variety of different circumstances to affect environmental behavior and learning. Gamification is a way of providing feedback to users when they are tied to the right goals. Green Your Home challenge provided great links between their game mechanics and their goals of increasing engagement with the site, generating new users, and general knowledge but missed the mark in their overall goal of changing actual behavior since their game layer had no actual feedback tied to actual events. In the studies done at MIUN, feedback was provided instantly whenever participants completed an action correctly, either by answering a question correctly or by interacting with the recycling bins.

It is important to tie game mechanics to the correct goals. Simply getting people to continue to play the game by adding things like progression do not help if the game is targeting the important actions. This was seen with the EcoIsland game. They tied their mechanics to reporting and linked none of their on game attributes to actual actions and the game failed accordingly. Alternatively, the recycling game focused on people interacting with the bins and the quiz gave points and awards for successfully answering questions. Simply adding a game layer to a situation will not fix environmental problems. Rather, one must identify the barriers that people have in order to develop a proper game for the situation. The trivia game was created in order to make learning about the environment more fun and interesting to the average person, it should be noted that there was no effort made to actually change the way people behave here, rather this game was designed only to give accurate information so that if participants wanted to behave in an environmentally friendly way in the future they would have the knowledge to do so. Respondents to the qualitative questions provided clearly indicate that the game was well received and that such a presentation is more interesting than simply writing a pamphlet out containing the same information. The recycling game focused most of its attention on directing people to the bin. As stated before the bins were found in a not so obvious location so while many people may have wanted to recycle, they may not have known that there was a nearby station for them to do so. The success of these games comes from the mechanics being tied to the goals set at the beginning. The trivia game was made fun and interesting while the recycling game engendered a desire for exploration.

Gamification can be a cheap and fun way to approach some of the environmental problems we have. The introduction of games will not solve every problem at once, but separately they can affect the way people behave in a variety of situations. Games have been shown here that they can be used to get people to take advantage of recycling or to
increase interest in learning. There is no reason that they cannot be applied to other situations, like water or energy usage. To address these problems games would need to be supplied that provided accurate and quick feedback as well as other game mechanics to keep users interested in the game. They obviously will have different barriers than were found here at MIUN campus, but with some creativity they could also be overcome.
Appendix 1 Pamphlet used during Study 1

Ranking Your Environmental Choices

We live in a world where we are increasingly educated on how our choices affect our environment. We are told about how recycling is important and sorting our waste can make a positive impact on a global scale. Public transportation is discussed not only as a method of moving people from place to place but also in terms of its relative benefits environmentally. What we often miss are questions of relativity. How much better is it to use public transport as opposed to an individual car for your daily commute? Is drinking bottled water really that bad for the environment? This short paper will attempt to give some perspective on environmental choices we make every day in an effort to not just show that one thing is better than another but also where there are significant differences and where the alternatives are not as far apart as intuition might dictate.

Mass transit is something that most major cities invest heavily in not just to ease traffic, but also as a means of generating a positive environmental impact. In an aggregated study Mikhail Chester looked at the relative performance of public transport in New York City, San Francisco, and Chicago compared to auto transport. In these cities about 10% of all miles travelled by passengers was by mass transit, while 99% of the total miles travelled by vehicle was personal auto transport. As a whole he concluded that using mass transit was effectively ~2-3x better than using personal autos from an energy and green house gas perspective. He also concluded that it was more important to focus on increasing usage of mass transit than to invest in increasing their relative efficiency because the amount of energy needed to transport additional people is marginal compared to the benefit gained (Chester, 2008).

In our homes there are many things that play a large role in affecting the environment. We heat our homes and use electricity, which causes green house gases to be released during its production. Lighting in fact is responsible on average about 10% of all the electricity that is used in homes (US Department of Energy, 2012). Clearly this is an area that can be targeted for energy reduction. Recently there have been an increase in the numbers of energy efficient light bulbs entering the market, but how do they compare. Incandescent bulbs are very easy to produce but use significantly more energy to provide light than halogen, compact fluorescent (CFL) or LED lights. 99% of the energy used over a lifespan of an incandescent bulb is in the use phase with only 1% used in manufacturing. Compared to that, LEDs and CFL bulbs have about 4% of their energy used in the manufacturing process. To actually compare the different bulbs it is
important to realize that they have different lifespans. A functional unit can be set by comparing all the methods the longest lasting bulb, which would be the LED. This way all the bulbs can be compared by asking how much energy (and how many bulbs) will be needed to provide the same amount of light as one LED bulb. Using this method of comparison it can be seen that using incandescent bulbs would require 22 bulbs and ~4x the energy compared to LED. 27 halogen bulbs would need to be used though they would require ~3.25x the energy. 3 CFL bulbs would need to be used but will end up using only marginally more energy than an LED (Navigant Consulting Inc., 2012).

There are other opportunities in our homes that are not just direct energy savings for the owner, but still provide an environmental benefit. Recycling at home can provide environmental benefits that are incredibly large. There are many different kinds of recycling. In Sweden it is common to separate metals, colored glass, plain glass, compost, paper packaging, newspaper, plastics, and burnable materials. Each of these has different efficiencies but in particular metal recycling can be very effective. Aluminum especially is a metal that is effectively recycled. It require almost 95% less energy to recycle aluminum than it does to extract new aluminum in the same amounts. Paper on the other hand can also be quite effectively recycled. Recycling paper saves roughly 40% of the energy and 50% of the water compared to creating new paper (Kazmeyer).

So far the examples discussed show mostly intuitive things. Recycling is quite good and so is mass transit. Using energy efficient bulbs does save quite a bit of energy and so on. However, when shopping we can be faced with a decision that isn’t as clear-cut. After paying for the groceries we need to decide which method of carrying the groceries home we will use. Traditionally there are one use plastic or paper bags available for use at the boutique but more recently there has arisen a set of multiple use bags designed to be used several times. Because these multiple use bags are heavier and use more material, they all have significantly higher initial environmental cost. This can be offset however, since they are designed to be used multiple times. The problem comes here when we see how often they need to be used to break even with simply purchasing a new high-density polyethylene (HDPE) every time you shop. In terms of global warming potential plastic bags are 3x better than paper, 11x better than polypropylene (PP), and 131x better than cotton. This means that to ‘break even’ a cotton bag will need to be used 131 times before it will be beneficial to the environment for you to have made this purchase. The problem here is also that consumers tend to use their reusable bags on average 51 times before discontinuing their use. It is also important to mention here that if the regular plastic bag is reused again after the first use this will effectively increase the amount of times a bag designed to be reused will have to be used to break even (Edwards and Fry, 2011).
Finally, something as simple as water can be something that is taken for granted. It is common knowledge that bottled water is more harmful to the environment than regular tap water. The question is how significant is the difference. In terms of global warming potential tap water is on average ~20-100x better than bottled water. The main causes are the long transport distances for the bottles compared to the simple delivery methods of tap water (Franklin Associates, 2009).

Environmental problems are all around and most actions have some effect on the environment. It is therefore important to realize which how the actions we take compare to others in order to make the best possible decisions.
Appendix 2
Questionnaire for study 1

Ranking Your Environmental Choices Questions

1. How much better in terms of green house gases is tap water compared to bottled water
   a. 1-10 times better
   b. 20-100 times better
   c. 200-1000 times better
   d. 2000-10000 times better

2. How much more energy efficient is it to recycle aluminum as compared to mining new ore?
   a. 25% more efficient
   b. 40% more efficient
   c. 60% more efficient
   d. 95% more efficient

3. As an aggregate how much better in terms of green house gasses is taking mass transit compared to an individual automobile?
   a. they are about the same
   b. 2-3 times better
   c. 5-10 times better
   d. 20-30 times better

4. In terms of lifecycle energy used, how much better are LED bulbs compared to Compact Fluorescent bulbs?
   a. they are about the same
   b. 2-3 times better
   c. 5-10 times better
   d. 20-30 times better

5. Compared to creating new paper, how much energy does recycling paper save?
   a. 10%
   b. 25%
   c. 40%
   d. 60%

6. If you bought a new cotton bag to take shopping, how many times would you need to use this bag to ‘break even’ as compared to purchasing a new plastic bag each time you shopped?
   a. between 10-20 times
   b. between 40-50 times
   c. between 80-110 times
   d. between 120-140 times
What is your area of study?

Was the information in the material informative?

Was the material presented in an interesting fashion?

Do you have any general comments?
Appendix 3
Pictures of Study 2

Recycling bin is out of the way on the left

Sign placed during week 2
Footprints leading into common room

Poorly handwritten note left on table.
The text on the notes left around on each table included “Did you know that Miun’s dinosaurs like burnable recycling?”, “MMM thin plastic, but no hard plastic!”, “Dirty
paper is the best!”,”No metall!”, “Even old snus packets are good”, and “More food please!”. The notes were all written in the same style, with poor handwriting and generally basic Swedish.

Dopey dinosaur thanking people for food
References


