

Designing a Gamified System using QR Codes via an Android Application for Power Management

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Abstract—The Philippines is currently experiencing an energy crisis. This can be solved by practicing smart energy conservation. However, motivating the people to practice smart energy conservation is a problem itself. To address this problem, the researchers used Gamification. Through the Gamification model, the researchers applied positive reinforcement to students of classes in the 3rd floor of Faura. To accomplish this, the researchers identified a step by step process. The first step is Game Design where the researchers created a theoretical framework of the game. The second step is Game Implementation where the researchers created the actual game. The third step is Game Deployment where the researchers checked for bugs and distributed the game to the participants. The researchers developed a game for the android platform and identified energy conserving tasks represented by QR Codes placed in the classroom. The researchers implemented incentives, competition and feedback in the game to motivate students to practice the identified energy saving tasks. Data gathering was done by requesting the students to answer a short feedback form.

Key-Words: - Smart Energy Conservation, Gamification, QR Codes, Positive Reinforcement, Game Design, Game Implementation, Game Deployment

1 Introduction

The Philippines is currently experiencing an energy crisis. Electricity is being rationed out causing some areas in the Philippines to experience rotating black outs. [1] Meralco believes that there will be an energy shortage on the Summer of 2015 if this keeps up. This can be solved by proper energy conservation. The researchers intend to use Gamification as a solution. Gamification is a newly practiced study that involves applying game elements to real life situations. [2] The aim of Gamification is to motivate a group of people to adjust their behavior on issues that the society is facing. For example, Gamification applied to environment issues will reward participants when doing environment friendly tasks. Simply put, Gamification is a system that applies positive reinforcement to a group of people when they perform tasks that improve the situations Gamification is applied to. Gamification is applied over a set period of time with a variety of tasks to ensure that the tasks turn into habits. For example, Gamification applied to the environment will

motivate people to care more for the environment. The people are rewarded when they do environment friendly tasks defined by the group. For this study, gamification will be applied to Power Management. Positive reinforcement will be applied to the participants of the study when they do power management tasks.

In this study, a game was deployed. The general objective of the study for deploying the game is the application of positive reinforcement on students to encourage them to practice smart energy conversation. This was accomplished through three specific objectives. First, the researchers designed a theoretical framework for the game based on Gamification. Second, the researchers created the actual game based on the theoretical framework. Finally, the researchers tested the game for bugs then distributed the game to participants after testing.

The study was done because the researchers observed through statistics that Filipino households do not practice smart energy conservation. [3] Filipinos commonly use electricity on mostly

unnecessary activities. The most common use of electricity lights, 79% use it on entertainment and 66% use it on space cooling. They need to be motivated to practice energy conservation. The motivation procedure should be effective and not simply giving messages. [4] As shown in Alex Laskey's study, the simple message distribution is not an effective approach. Alex Laskey and his team were only able to successfully encourage households to conserve energy when he encouraged them to compete against each other. Gamification is observed to be an effective alternative in energy conservation. The group has decided to use Gamification to solve the problems in motivating people to practice energy conservation.

2 Problem Formulation

2.1 Power Management

Other researchers attempted to address the power management problem. [5] Roslan Norhayie created an Energy Saving Control System. He created the system because he noticed that students would forget to turn off the lights or aircon when leaving the room. Body heat sensors were placed inside a room. When the sensors do not detect human body heat within the room, the air conditioners and lights will automatically close 10 minutes after the student leaves the room. This study monitors human activity within a room instead of power consumption.

Another study by Han, et. al is a smart home energy system. [6] The system is capable of monitoring the energy consumption of each participating household based on a standard created by the study group called Energy Measurement and Communication Unit. Each participating household has a server that stores data on the energy consumption of each appliance on the household. The data from each household server is then sent to a Remote Energy Management. A website that the group built displays the energy consumption of each participating household and compares them. This is to motivate each household to reduce their energy consumption.

Another study applies Gamification on Power Management. [7] A group of researchers from Delft University of Technology in the Netherlands created an online game called Energy Battle. Energy Battle displayed the household's energy consumption, household ranking based on energy consumption and tips on reducing energy consumption. The group provided a prize of kitchen appliances for the household that ranks 1 at the end of four weeks. At

the end of the study, the households were able to maintain their reduced energy consumption. It was even observed that the energy saving tips became habits.

A mobile application called Joulebug applies Gamification on management. [8] Joulebug displays a list of tasks that the user can do to reduce energy consumption. Once of these tasks is done, the user completes an achievement that he or she can take a picture of and share with friends. The user earns points by completing these tasks and the points are ranked according to who has the highest. The ranked users include only the user and his or her friends.

2.2 Adjusting Behavior

A popular behavior adjustment method in the field of psychology is operant conditioning. [9] B.F Skinner developed the operant conditioning model to modify behavior based on consequences to that behavior. The results in studies showed that behavior that is followed by pleasant consequences tends to be repeated while behavior that is followed by unpleasant consequences tends to not be repeated. A variation of operant conditioning is positive reinforcement. The positive reinforcement model when applied to a subject is to provide that subject with rewards when emitting a desired behavior. This makes the desired behavior occur more often. Another variation is punishment which applies negative stimuli to subjects who emit undesired behavior.

3 Problem Solution

3.1 Game Design

During this phase of the study, the group created a theoretical framework of the game based on Gamification. Gamification bridges the gaming world and the real world. Its aim is to adjust behavior by applying game elements in the form of either positive reinforcement or punishment. Known game elements are incentives, competition and feedback. Incentives refer to rewards given to the player after accomplishing certain tasks. Competition occurs when players are ranked against each other and encouraged to compete for higher ranks. Feedback is a method of showing the player his or her performance in the game. The three game elements are sent to the real world and motivate the people to adjust their behavior.

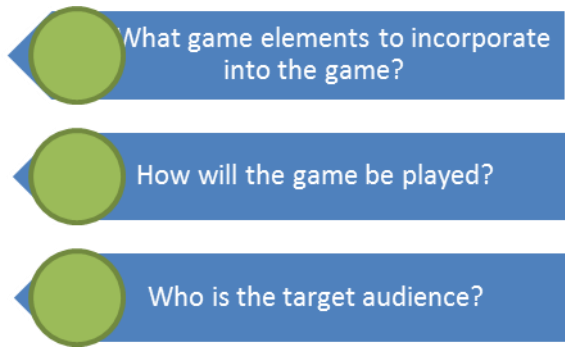


Fig. 1: The Important Questions

The researchers created guide questions as a basis for decisions on the theoretical framework of the game. First is to decide on what device the game can be played on. It starts with if the game will be played on a computer or mobile device then from there the group will need to decide on which platform the game would run on. The next concern would be the gameplay. The game needs to attract the users and avoid the users from losing interest on the game. Included in the gameplay is the formation of the tasks. The tasks need to be instructed to the participants and participants must be rewarded. The researchers need to take notice of the application of the incentives. The researchers need to decide on incentives that will attract users and motivate them. The researchers would then need to apply a system that implements competition on the game. The incentives will act as the feedback for the game.



Fig. 3: QR Code

Fig. 2 shows the intended application of game elements on the study. The game will be played on a mobile application since mobile devices can be brought by users where ever they go. The chosen mobile platform is Android since it is the most popular mobile platform. [10] 61.2% of mobile users were reported to have installed android last June 2013. The researchers are going to use two forms of incentives, one for the game and one for the real world. The game incentives are points that the user earns by playing the game or doing the school tasks. These points are classified according to experience, energy, achievement and special. QR Codes are implemented for users to scan when they finish the tasks. Fig. 3 shows the QR Code design that was created by the group and Monica Sacramento. Once all QR Codes have been scanned, the users can claim their rewards and repeat the process on the same class on a different day. The QR Code is a means to receive bonuses and is not required to play the game. It is advised that players scan it to get more points than their competitors but the game can stand alone even without the QR Codes. The real world incentive is money which the user earns by being part of the top 3 levels. This applies both competition and incentives by using the incentives to spark the competition. Users must compete for the money by gathering more experience points than their competitors. Experience points are converted into a level system where users level up after earning a certain amount of points to give users more goals in the game. Energy points are used as a currency within the game. Achievement and Special points are used for prize exchange.

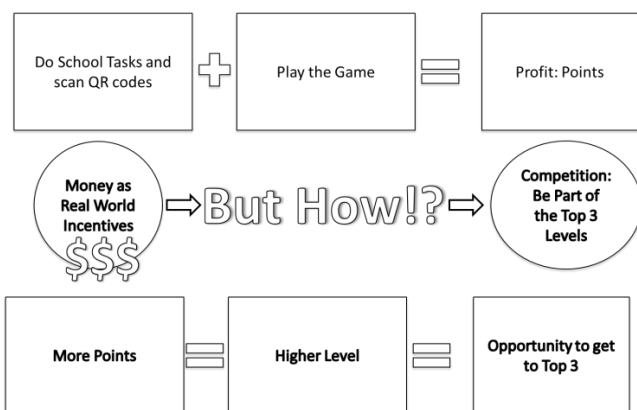


Fig. 2: Game Elements Diagram

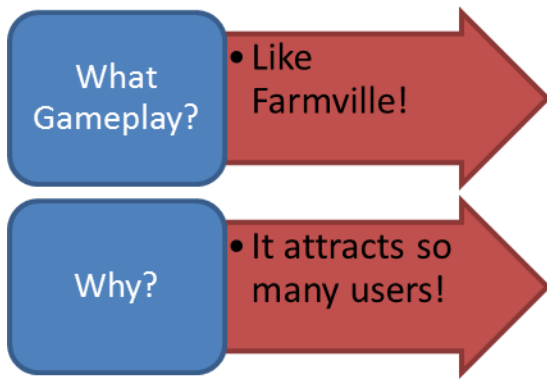


Fig. 4: Gameplay Diagram

Fig. 4 shows the decision on the main game’s gameplay. [11] The researchers found that the Facebook game Farmville is very popular, pulling in millions of users daily. Techniques from Farmville were taken note of and applied to the game plan. A technique used by Farmville to keep users from losing their attention from the game is the application of a decay system for planted crops. The punishment model is applied to users to encourage users to keep their eyes on the game. Another is the profit in the game where harvesting short time crops multiple times tends to give more profit than harvesting a long time crop. The positive reinforcement model is applied to Farmville users here. For this game, the users will be building structures that generate resources. An online database and phone database need to be created to store information. The online database will store the points so users can view it online while the phone database will store game resources for easy access.

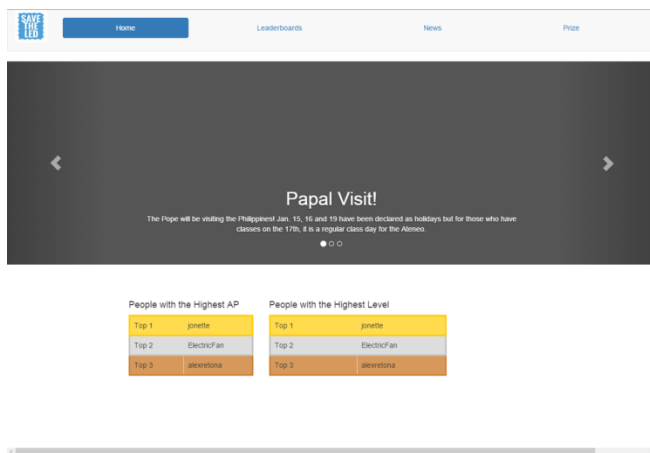


Fig. 5: Website Homepage

Rank	Name	Class	Level	Max EP	EXP	EXP/Point	AP	SP	Rank	Name	Class	Level	Max EP	EXP	EXP/Point	AP	SP
1	jonette	CIE199A	77	1443900	46195	46200	210	109	1	jonette	CIE199A	77	1443900	46195	46200	210	109
2	ElectricFan	CIE199A	46	338280	28775	27600	119	69	2	ElectricFan	CIE199A	46	338280	28775	27600	119	59
3	alexandra	ENGMA101A	16	99000	9425	9000	73	36	3	alexandra	ENGMA101A	16	99000	9425	9000	73	36
4	dyl3	ENGMA101A	15	98000	8825	9000	65	33	4	Genervive	CIE199A	14	205000	8175	8400	70	36
5	Genervive	CIE199A	14	205000	8175	8400	70	36	5	dyl3	ENGMA101A	15	98000	8825	9000	65	33
6	Jaymax	CE21A	6	2021000	3575	3600	56	29	6	Jaymax	CE21A	6	2021000	3575	3600	56	29
7	IvanTan	CE21A	1	21000	25	1000	15	10	7	IvanTan	CE21A	1	21000	25	1000	15	10

Fig. 6: Leaderboards page

The website plans are shown on Figs 5 and 6. The homepage must show the top 3 users in both levels and achievement points and display the three recently uploaded news articles. The leaderboards needs to have 2 tables that sort users according to level and achievement points.

The designed framework was based on the three game elements observed from previous studies. Incentives were provided in the form of game points and real world money. Competition was encouraged through the leaderboards and the prizes. The users were pushed to keep their attention on earning points on the game and made the tasks very important factors for victory. The users must keep on trying to get ahead of the other user to win the prizes. The third is the feedback which is given to the users based on the number of points they earn and their standing on the leaderboards. The researchers decided on the target audience as students in 3rd floor Faura classes. The next step for the group is to implement the game based on the framework.

3.2 Game Implementation

After the text edit has been completed, the paper is ready. In this phase, the group built the game based on the theoretical framework. Games are either built from scratch or with programs that assist the developer in creating games. Games are usually built by a huge game development team. The development team is then divided into smaller teams depending on their task for the game. There is a team that is responsible for creating the art in game, a team for programming the game and a bug testing team. Due to their large numbers and experience, the development team is capable of producing games with amazing art and gameplay. Different versions of the game are also created so that the game can be played on different devices. Mobile games are developed faster than games on high end

consoles. Mobile games tend to have simpler functions and are easier to build.

The researchers used Eclipse IDE and Java platform to develop the android mobile application, SavetheLED. The whole game system shown on Fig. 7 was coded using Java. Several functions were developed and reused across the class files. The Game User Interface and Background was created by manipulating the properties of shapes in Microsoft Powerpoint. The buildings, research and resource icons were created using a combination of the free icons Google released, Adobe Photoshop and Microsoft Powerpoint.

HTML, CSS, Javascript and PHP were used to design the website. The bootstrap css was used to make the website more attractive. The navigation bar, carousel and tables were all programmed with the help of bootstrap. The PHP files are used for the website and mobile application to interact with the online database. The data obtained from the database is converted to JSON Format. The data in JSON Format is accessed through the javascript functions and converted to standard text. The HTML file is prepared to display the text obtained from the javascript functions. A free webhosting site called 000webhost is used to store all the website files and database.

Users can participate in the game by simple means. The researchers implemented a simple registration and log in pop-up window that they must fill up to enter the game. Once the players get in they will be welcomed by free points, starting resources and the game home screen shown on Fig. 8.

The researchers placed goals inside the game for users. These goals are the source of the in game incentives for the users. The main goal of the game is to continue building structures in the available areas in a map. Users can then go to other maps in the game but before they can use the map they must first unlock it. The unlocked map will give the users more areas to be structures on and get more points. Researchers also set challenges to the users known as achievements that provide them with a good number of points when completed.

Users are given in game incentives through the resources and energy points. Resources are obtained through the production pop-up window that computes the amount of resources and energy points you receive through the number of buildings you have. Users are also given free rewards and quest rewards, if they finished the assigned tasks, when they enter the game

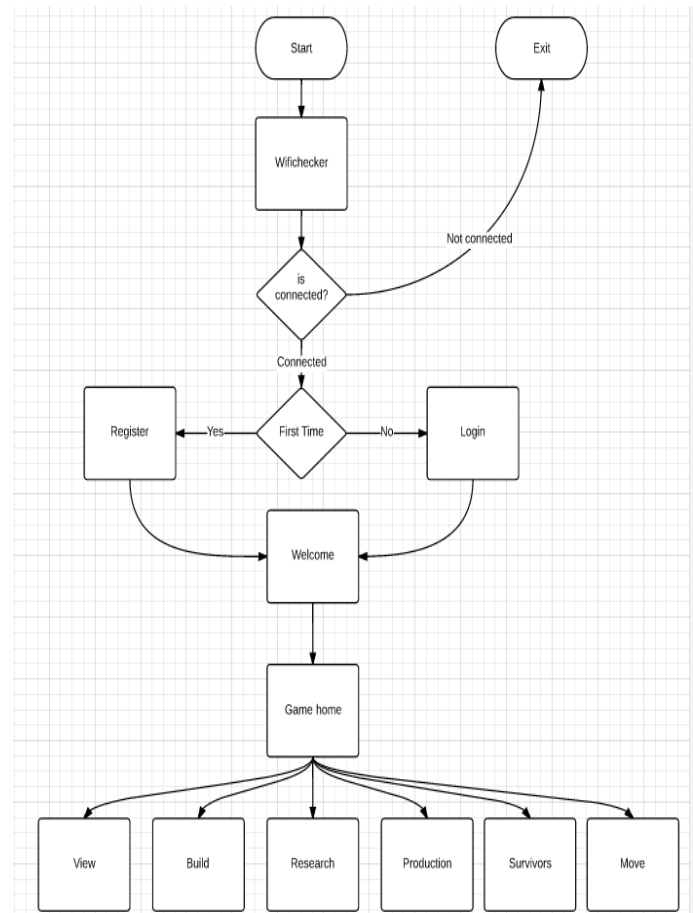


Fig. 7. Game Flowchart



Fig. 8. Gamehome screenshot



Fig. 9 Power Management Tips

The researchers placed power management tips into the game. Whenever users use the Educate function, they are given necessary resources and a power management tip. An example of the power management tip is shown on Fig. 9. The users can also learn from the game. The game also has a special QR Code Scanner that the user needs to use to scan the QR Codes. Once the QR Codes have been scanned, the user can claim his Quest Rewards in the form of points. The QR Code scanner was created using the Zxing library.

The website is shown on Figs 5 and 6. All of the pages have a navigation bar that has links to the other pages and the logo. The homepage contains the top 3 users according to level and achievement points. Three of the recent news is also shown in a carousel. The leaderboards contain two tables where the left table has a list of users ranked according to level while the right table has a list of users ranked according to achievement points. The news page contains a list of all the uploaded articles that the users can view by pressing buttons. The prizes page shows the available images of prizes and how to get them.

The actual application matches the application described in the methodology. The application is programmed to perform the functions it is expected to run when the user runs the function. The final step for the group is to test the application and release copies of the game.

3.3 Game Deployment

The final part of game development is releasing the game. The method of release depends on the operating system or device the game is meant for. Mobile applications are usually distributed through

the android market or google playstore. They can be distributed privately through e-mail or dropbox. Before release, the development team deploys the game to a certain number of people who were hired bug testers or volunteered to be bug testers. They will play the game for a set period of time and the bug tests will report on any bugs found. The game is also tested on phones of different resolutions and android os versions to make sure that the game runs on the all sdk versions from minimum to target. When the game is cleared of bugs, the development team or gaming company launches an advertisement campaign on the game's first release.

Each of the game functions were tested for bugs. The wifi checker was the first to be tested. Each of the functions was run with the wifi adapter disabled. Afterwards, the login and registration functions were checked. Registration was tested by entering an existing and a non-existing username. The login was tested by entering the username and password of a different account and the username and password of the registered account on the phone.

The next function that the researchers tested was the claim rewards function. A tested scenario was before and after the daily reward was claimed. Another scenario was before and after the QR codes were scanned. Using the high starting energy points, all the maps were unlocked and checked if the unlock pop-up windows and map initialize functions work.

The researchers set the resources to high values for the series of tests that followed. The build function was checked by building all of the available buildings with and without the proper resources. The research function is tested by simply opening the pop-up window and checking if the right values based on the applied algorithm are correct. Production was checked if the production rate algorithm worked properly and synchronized well with the claim time set by the user. The achievements pop-up was checked by looking at the details that pop out when pressing each of the achievements. Achievements were also checked if they were accomplished after fulfilling the requirements. Finally, the move function was checked if each of buttons led to the right maps.



Fig. 10. Game Poster

Once the bug testing was accomplished, the researchers looked for participants who have android phones and distributed the application to them privately. The poster in Fig. 10 was used as an advertisement. The application was placed inside dropbox and the link sent to the participants through e-mail. The e-mail came with a link to the application, facebook page for the instructions and the website link for the leaderboards. The researchers advertised the game by visiting classes. The participants were given links to a feedback form that asked if the objectives were fulfilled and to comment on the game.

Preliminary bug testing was successful. The researchers checked the feedback for the gathered data. The data the researchers had so far suggested that the incentives were effective in motivating the students to play the game. A platform for Gamification studies was developed.

4 Conclusion

Based on the gathered data the researchers have, the researchers were able to successfully motivate participants to play the game using the incentives they have provided. The researchers were able to develop a platform for future gamification researchers to use for their study. The game is able to incorporate power management by providing tips and tasks. Future researchers need to develop a thorough design plan for the game before proceeding. It is also recommended that future researchers have a longer test period for longer period of data collection. The researchers would like to suggest that future researchers launch a closed beta phase of their application. Closed beta phase is a pre-deployment phase done by game companies

where they ask players to participate in bug testing in exchange for game rewards.

References:

- [1] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," *Phil. Trans. Roy. Soc. London*, vol. A247, pp. 529-551, April 1955. (references)
- [2] J. Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.
- [3] I.S. Jacobs and C.P. Bean, "Fine particles, thin films and exchange anisotropy," in *Magnetism*, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.
- [4] T. Ha, "The psychology of saving energy: Alex Laskey at TED2013." [Online]. Available: <http://blog.ted.com/2013/02/27/the-psychology-of-saving-energy-alex-laskey-at-ted2013/>. [Accessed: 19-Aug-2014].
- [5] R. Nicole, "Title of paper with only first word capitalized," *J. Name Stand. Abbrev.*, in press.
- [6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," *IEEE Transl. J. Magn. Japan*, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
- [7] M. Young, *The Technical Writer's Handbook*. Mill Valley, CA: University Science, 1989.
- [8] "About - JouleBug." [Online]. Available: <http://joulebug.com/about/>. [Accessed: 19-Aug-2014].
- [9] "Operant Conditioning | Education.com." [Online]. Available: <http://www.education.com/reference/article/operant-conditioning/>. [Accessed: 22-Jan-2015].
- [10] "Platform numbers for June 2013: Android 4.x on the rise, 2.3 holding strong | Android Central." [Online]. Available: <http://www.androidcentral.com/platform-numbers-june-2013-android-4x-rise-23-holding-strong>. [Accessed: 22-Jan-2015].
- [11] "Gamification Examples | PlayGen." [Online]. Available: <http://playgen.com/gamification-case-studies-and-examples/>. [Accessed: 22-Jan-2015].