Shih, JL. et al. (Eds.) (2023). Proceedings of the 31st International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Technology-Enhanced Environmental Learning: Co-design of Educational Mobile Application Case

Ewa DUDA[a*], Helena ANACKA[b], Jolanta KOWAL[c], Iwona NOWAKOWSKA[a] & Hanna OBRACHT-PRONDZYŃSKA[d]
[a]*Maria Grzegorzewska University, Poland*
[b]*Gdańsk University of Technology, Poland*
[c]*University of Wrocław, Poland*
[d]*University of Gdańsk, Poland*
* eduda@aps.edu.pl

Abstract: The process of co-creating an educational mobile application to support environmentally friendly behavior is presented in this paper. The research material consisted of quantitative data collected on the application during the first testing phase by early adopters. The results suggest that the most frequently used features of the app were related to transport and educational activities. While women tended to split their time between transport and learning, men focused mainly on transport. This study contributes to the growing field of the use of educational mobile applications for the promotion of environmentally friendly behavior. The study results can support the design and development of future applications that encourage sustainable practices, benefit society, and contribute to a more sustainable future.

Keywords: mobile application, pro-environmental behavior, technology-enhanced learning, urban education

1. Introduction

Mobile applications have played a significant role in our everyday routines for many years. It appears reasonable to utilize them to tackle contemporary problems, such as those associated with mitigating climate challenges (Takaoka et al., 2023). One example of a working application in Europe is PULA, which motivates pro-environmental behaviors in city dwellers. It aims to combine the benefits of a community currency and digital means of a mobile application to tackle a European city's environmental and urban challenges. This study presents the research outcomes of the PULA project implementation. Prior systematic literature review, case analysis, and in-depth interviews led to the identification of two research questions, namely: (RQ1) Whether PULA mobile application can increase ecological awareness and enhance environmentally-friendly activities among urban dwellers?; (RQ2) Which gamification actions of PULA application are the most popular among its users?

2. Related Works

Raising awareness and educating city dwellers about environmental issues is an area where applications can help and encourage pro-environmental behavior. Interactive mobile applications can educate users about how their daily behavior affects the environment and provide straightforward, practical suggestions for minimizing this impact. By disseminating reliable scientific information, such applications help to strengthen pro-environmental behavior (Wilson et al., 2019; Ahn, 2022). By breaking down educational material into short, engaging segments, it is possible to take advantage of the user's fragmented time and meet the demands of a fast-paced life (Chung et al., 2020).

Applications can be utilized to educate people on sustainability, reduce energy consumption, promote green transportation, encourage behaviors enhancing air quality,

manage waste, and conserve water (Douglas & Brauer, 2021). By adopting these applications, urban residents can scrutinize their consumption patterns and make more green choices (D'Arco & Marino, 2022). Such applications can stimulate sustainable actions through rewards and challenges (Cudok et al., 2022). Social engagement and inclusion influence individuals' behavior patterns and bring a sense of efficiency, effectiveness, and affiliation to the performed activities and community goals. Mobile applications proved to be egalitarian and inclusive tools that strengthen communities' cooperation, especially through gamification related to pro-environmental and local actions (Douglas & Brauer, 2021).

3. Methodology

To respond to the research aim and questions, following the method of Diffusion of Innovation Theory (Rogers, 2003), we analyzed data provided by the early adopters of the PULA application. According to the method, we fulfilled all its five phases: knowledge, persuasion, decision regarding the adoption or rejection of the innovation, implementation, and confirmation. By analyzing the behaviors of PULA early adopters, we evaluated the quality of the persuasion stage, observed the tendencies on the decision stage, aiming to plan the final implementation and prove stages of diffusion. The process involved 29 users (20 women and 9 men), while 44% represented the 18-25 age range and active employees or students already engaged in environmental activities, thus open to testing the PULA application. The testing phase took nine weeks. The paper presents the evaluation of data from the application.

4. Results and Discussion

The patterns of PULA application usage suggest that it has the potential to raise pro-environmental awareness in city dwellers. None of the testers gave up using the application (RQ1). The most utilized functionalities by PULA users were transportation activities and quizzes (RQ2). These activities were the most engaging, indicating participants' strong interest in environmentally friendly transportation options and knowledge acquisition.

4.1 Transport-oriented Functions

Overall, 70% of all transportation activities are associated with urban public transport, followed by cycling and walking. Gained results confirm that application users willingly opt for public transportation, thus reducing energy consumption and carbon footprint. Furthermore, the testing phase results suggest that an individual uses one preferred transportation means regularly, and its use notably prevails over other transportation activities of the same user. Nevertheless, it is difficult to formulate general conclusions based on a limited testing group and obtained data sample.

4.2 Knowledge Gaining Functions

The learning environment, which has been enhanced by the technology represented by the mobile app, is an effective tool for supporting environmental education. Learning activities, including quizzes and news stories, constituted a substantial part of the participants' tasks. The inclusion of news materials was notably prevalent. These activities were regularly sustained over time, especially among women.

Our findings provide evidence that mobile application-enhanced learning can support the development of environmentally friendly practices, including the use of public transport, beyond the scope of previous research (Ahn, 2022). Among the various quizzes tested on the PULA app, the briefest ones were the most favored. Previous research states that shorter learning materials are especially captivating on mobile applications (Chung et al., 2020) as they aid learning during non-urgent instances. In our study, these included breaks during lunchtime or, while driving to work/ university or on the journey back.

4.3 Gender Observations

Quantitative research results suggest that females are engaged in various types of activities in the application, paying particular attention to knowledge-gaining and educational activities, e.g., quizzes. On the other hand, males at large strongly emphasize transport functions, which are rewarded with the highest amount of points in the application. Therefore, the conclusion is that female and male users apply different strategies and are guided by different considerations while using the application. Gender differences were also observed in studies conducted under the framework of diffusion innovation theory, suggesting a moderating effect of gender between the perceived strengths of innovation and use intentions (Loarne-Lemaire et al., 2021). This trend is particularly apparent regarding technological advancements to tackle climate change and raise ongoing awareness of it.

5. Conclusion

Research results address two research questions: PULA mobile application can increase ecological awareness and enhance environmentally-friendly activities in urban dwellers (RQ1); urban public transport and quizzes are among the most frequently used app functionalities with the highest gained total points, with challenges being less frequent, yet characterized by the highest users' turnout (RQ2). The research findings, outlined in a full-length paper (Duda et al., 2023), could benefit ecological tech startups dealing with mobile tools, local authorities, educators, researchers, and sociologists unraveling effective technological solutions to boost pro-environmental activities. A limitation of the study presented is its pilot nature. Early adopters formed a small research sample, and their conduct is prone to bias. Due to the users' awareness of their participation in the pilot, they may have intentionally modified their behavior. Therefore, a more thorough investigation will take place soon, involving a larger study group and app users rather than testers.

Acknowledgments

The research is supported by funding from Iceland, Liechtenstein, and Norway under the EEA Funds and the state budget of Poland, grant no. NOR/IdeaLab/GC/0003/2020.

References

Ahn, J. (2022). Impact of cognitive aspects of food mobile application on customers' behavior. *Current Issues in Tourism, 25*(4), 516-523.

Chung, E., Noor, N. M., & Mathew, V. N. (2020). Are you ready? An assessment of online learning readiness among university students. *International Journal of Academic Research in Progressive Education and Development*, *9*(1), 301-317.

Cudok, A., Lawrenz, S., Rausch, A., & Vietor, T. (2022). Circular Economy Driven Communities–Sustainable Behavior Driven by Mobile Applications. *Procedia CIRP*, *105*, 362-367.

D'Arco, M., & Marino, V. (2022). Environmental citizenship behavior and sustainability apps: An empirical investigation. Transforming Government: People, *Process and Policy, 16*(2), 185-202.

Douglas, B. D., & Brauer, M. (2021). Gamification to prevent climate change: a review of games and apps for sustainability. *Current Opinion in Psychology, 42*, 89–94.

Duda, E., Anacka, H., Kowal, J., Nowakowska, I., …& Zawieska, J. (2023). Encouraging pro-environmental behaviour through an educational mobile application: preliminary insights from early adopters. *International Journal of Pedagogy, Innovation and New Technologies, 10*(1).

Loarne-Lemaire, S. L., Bertrand, G., Razgallah, M., Maalaoui, A., & Kallmuenzer, A. (2021). Women in innovation processes as a solution to climate change: A systematic literature review and an agenda for future research. *Technological Forecasting and Social Change, 164*, 120440.

Rogers, E.M. (2003). Diffusion of innovations (5th ed.). New York: Free Press.

Takaoka, A. J., Ahlers, D., … & Jaccheri, L. (2023). Towards understanding digital support contributing to climate neutral, inclusive, and beautiful cities: A systematic literature review. *GREENS,* 30-37.

Wilson, C., Tabor, A., & Bateman, S. (2019). Diversifying pro-environmental behaviors: redesigning applications to incorporate environmental "spill-over". *Proceedings of the 2019 ACM International Symposium on Wearable Computers,* 1097-1098.