

Knowledge Improvement of Dental Students in Thailand and UK Through an Online Serious Game in Dental Public Health

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Abstract. A serious game for Dental Public Health (DPH), GRAPHIC, was developed to support students in designing health promotion programmes at King's College London. Based on the evaluation data from an initial pilot study, there was evidence that GRAPHIC had the potential to be a global learning tool. Taking this evidence into account, a new version of GRAPHIC in Thai language was developed for students at Mahidol University in Thailand. King's and Mahidol dental students piloted these two otherwise identical versions in January and February 2015 to test the knowledge acquisition in DPH. The students were given the opportunity to carry out activities in GRAPHIC, including completing pre- and post-knowledge tests. The initial findings support the effectiveness of GRAPHIC as a learning tool because the disciplinary knowledge of students from both institutions was significantly improved after interacting with the game. The paper presents these findings and makes recommendations for further improvements to the game.

Keywords: Dental education · Dental public health · Educational game · Online learning · Serious game

1 Introduction

Computer based gaming has been applied to government, military, education, and healthcare sectors, where related applications come under the term 'serious games' [1]. Serious games can provide new teaching and learning environments, which can engage students [2, 3]. In the context of Dental Public Health (DPH), which is defined as "the science and art of preventing oral disease, promoting oral health and the quality of life through the organized efforts and informed choices of the society, organisations, public and private, communities and individuals" [4], it would be very helpful for learners to experience authentic situations where they must make decisions about the suitable oral health promotion programmes in a simulated environment.

GRAPHIC (Games Research Applied to Public Health with Innovative Collaboration), a serious web-based game for DPH, was developed to support students in designing health promotion programmes for a given population at King's College London. Based on the data from an earlier pilot study at Mahidol University, in Thailand, the design of GRAPHIC was considered suitable for use as a global learning tool in Europe and Asia [5, 6]. The evaluation identified some required modifications, most notably translation of the content into the Thai language. Therefore, a new version of GRAPHIC in the Thai language was developed to pilot test GRAPHIC in Thailand.

This study aimed to investigate the feasibility of using GRAPHIC for DPH knowledge improvement in the UK and Thailand as part of a wider study evaluating the impact of serious games as learning tools, ultimately supporting students in different learning cultures. The paper therefore presents the evaluation of the knowledge improvement of the multilingual pilot version of GRAPHIC by assessing students' knowledge acquisition through using GRAPHIC in UK and Thailand.

2 Methods

To achieve the objective, we engaged a quantitative methodology approach to collect research data. The following sections provide a description of the methods we employed.

2.1 GRAPHIC Design

GRAPHIC was developed as a web-based application, built with Java Enterprise technologies and was deployed on a secure cloud server, where dental students can access the game using a web browser, such as Internet Explorer, Safari, Chrome, etc. Within GRAPHIC, the students were expected to learn several topics in DPH, which included common risk factors, the Ottawa Charter, and the Dahlgren and Whitehead model. To achieve this, students were firstly given information about the context of the game: i.e. that as game participants they would be operating in a simulated town, where they would be exposed to influencing factors in a real life context from provided demographic data of a virtual community. After that, they needed to complete the game by making decisions regarding the suitability of oral health programmes in simulated situations and selecting the best five recommended options of the programmes in order to improve the oral health of the population in the community of the game. The latest version of GRAPHIC has a revised game engine, learning design, and content (e.g. learning scenario) that has been modified to suit students in both countries of this investigation. The modifications were based on the findings of previous studies of GRAPHIC, including taking serious game theories and the outcome of related research into account. The game also has been developed to include English and Thai versions. King's and Mahidol dental students piloted this latest version of GRAPHIC in January and February 2015 respectively to assess the acquisition of knowledge in DPH as part of a wider feasibility and impact study of the game (Fig. 1).

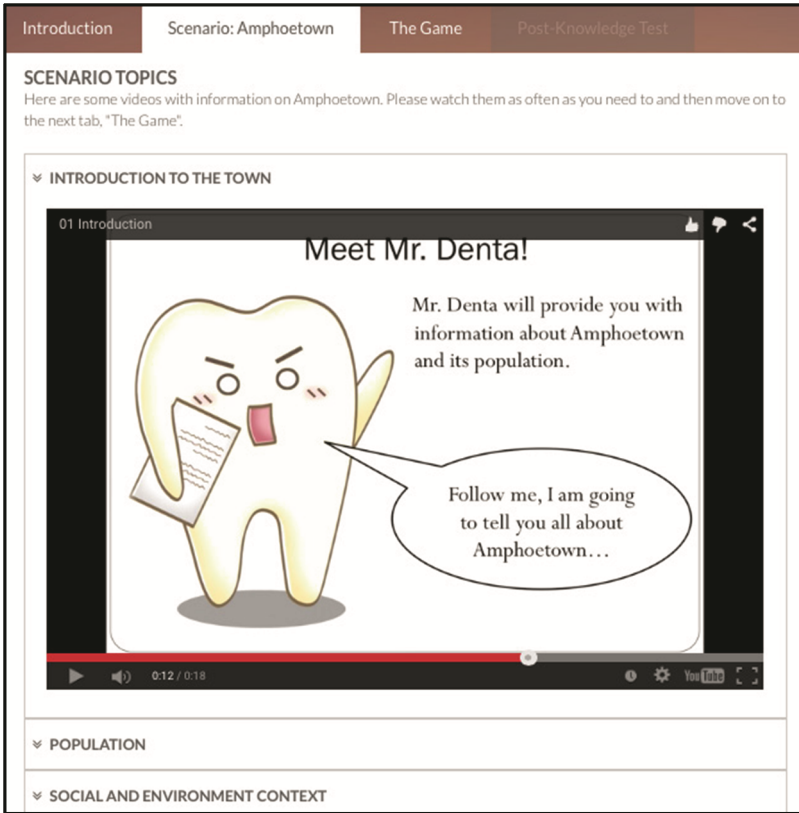


Fig. 1. A screen capture of GRAPHIC where information of a learning scenario is provided

2.2 Participants

Undergraduate dental students with similar levels of achievement in the dental curricula of UK and Thailand were assigned to complete GRAPHIC as a mandatory activity. All students who were eligible to use GRAPHIC must have used the game as a requirement of the courses, but they could decide whether to participate in this study by submitting a consent form. Unique identifiers were used in order to identify students to participate in the study.

2.3 Data Collection

The students from both institutions were given similar guidance about the process and the same preparatory information including a video on YouTube. However, the set-up could not be identical, as there was a limitation due to insufficient space of Mahidol computer room. The process was that the students from both institutions were asked to complete a pre-knowledge test in order to assess their pre-knowledge. After that,

they had to complete the game by submitting the best five oral health promotion interventions. Finally, they were asked to complete a post-knowledge test in order to assess their post-knowledge after interacting with the game. They were all given unlimited attempts of answer submissions to complete the game but were required to submit the pre- and post- knowledge tests in one attempt. The tests consisted of 20 questions relating to the learning outcomes, which were validated by the King's tutors with an agreement from the Mahidol tutors. The questions were similar, but question sequencing was different between the pre- and post-tests. The students were also asked to complete a feasibility questionnaire voluntarily. The tests were automatically recorded as part of the quiz function of the game, and the results made available through spreadsheets downloaded from the analytics capability of the gaming engine. The scores of the pre- and post-tests were compared using paired *t*-test in each country in order to evaluate the knowledge improvement after interacting with the game. In addition, differences of the pre- and post-test scores were compared between two countries using independent *t*-test in order to assess whether there were differences in the knowledge of the students between institutions.

2.4 Ethical Considerations

Ethical Approval had previously been obtained from Biomedical Sciences, Dentistry, Medicine and Natural & Mathematical Sciences Research Ethics Subcommittee (BDM RESC), King's College London (KCL) College Research Ethics Committees (CREC), application number BDM/13/14-117 on 15th July 2014 and Faculty of Dentistry and from Faculty of Pharmacy, Mahidol University, Institutional Review Board (MU-DT/PY-IRB), application number MU-DT/PY-IRB 2015/002 on 19th January 2015.

3 Findings

There were 82 King's and 92 Mahidol students who decided to participate in the feasibility study and completed the game including the pre- and post-tests. This represents 55.41 % of the UK and 80.7 % of the Thai student groups that were targeted.

According to Table 1, for the King's students, the mean of pre-test score was 14.87 (SD = 3.05) and the mean of post-test score was 16.06 (SD = 2.98). The post-test score was significantly higher than the pre-test score ($t = -3.841, p \leq 0.001$). Similarly, for the Mahidol students, the mean of pre-test score was 14.49 (SD = 3.55) and the mean of post-test score was 15.23 (SD = 3.24). The post-test score was significantly higher than the pre-test score ($t = -2.036, p \leq 0.05$). The data suggest that the knowledge of the students from both institutions was significantly improved after interaction with GRAPHIC.

According to Table 2, there were no significant differences in pre-test score, post-test score, and score difference between both institutions. The findings suggested that the students from both institutions had broadly similar level of pre-knowledge and knowledge improvement.

Table 1. Pre- and post-test scores

Samples	Pre-test score		Post-test score		t-value
	Mean	SD	Mean	SD	
King’s	14.87	3.05	16.06	2.98	-3.841***
Mahidol	14.49	3.55	15.23	3.24	-2.036*

Note: *Significant at $p \leq 0.05$; ***Significant at $p \leq 0.001$.

Table 2. Comparison of test score between two institutions

Scores	King’s		Mahidol		t-value
	Mean	SD	Mean	SD	
Pre-test score	14.87	3.05	14.49	3.55	0.746
Post-test score	16.06	2.98	15.23	3.24	1.756
Score difference	1.2	2.82	0.74	3.48	0.942

4 Discussion

The findings support the educational value of GRAPHIC as a global learning tool (a tool which, because of its particular design and content knowledge, has an impact on learners, coming from two different locations and cultures), in UK and Thailand, as the knowledge of students from both institutions was improved after interacting with the game, which supports the effectiveness of GRAPHIC. Another aspect that should be taken into consideration is that students in different learning cultures tend to have different attitudes towards their learning, e.g. Asian students may not be familiar with self-directed learning [7], and GRAPHIC is a self-directed learning tool, where students are able to complete the game on their own time and place. However, the findings suggest that students’ performance from both countries was not significantly different when using GRAPHIC, although their learning cultures were different. It could be argued that, as digital natives, students from both countries were familiar with technologies, especially video games. In addition, there was an induction, introductory video where students can learn how to navigate the game. These may be able to facilitate students’ use of the game.

Based on the initial findings of this feasibility study, the running of GRAPHIC in both institutions was shown to be feasible. Although it is the first time that all final year Mahidol dental students used GRAPHIC, there appeared to be no issues with access and use in Thailand, supporting the use of GRAPHIC half way across the world would work. However, knowledge improvement alone is not enough to evaluate the game quality, but there should also be further evaluation of usability, including how many attempts learners use to complete the game, how students navigate through the game, and how the game engages the students.

5 Conclusion

Overall, this study demonstrates that both UK and Thai students have improved their DPH knowledge in playing GRAPHIC. Therefore, a serious game like GRAPHIC can be used for DPH courses in both institutions. An enhanced version of GRAPHIC will be developed to be used in the academic year 2015/16 and it will take these findings into account, as part of the wider study. In addition, to enhance the validity of this study, GRAPHIC trial settings in both schools will be further harmonised.

References

1. Zyda, M.: From visual simulation to virtual reality to games. *Computer* **38**(9), 25–32 (2005)
2. Breuer, J., Bente, G.: Why so serious? On the relation of serious games and learning. *Eludamos. J. Comput. Game Cult.* **4**(1), 7–24 (2010)
3. Davis, J.S.: Games and students: creating innovative professionals. *Am. J. Bus. Educ.* **4**(1), 1–11 (2011)
4. Gallagher, J.E.: Wanless: a public health knight. Securing good health for the whole population. *Community Dent. Health* **22**(2), 66–70 (2005)
5. Sipiaryuk, K., Gallagher, J.E., Hatzipanagos, S., Cornforth, J., Reynolds, P.A.: An evaluation of the analytic data from the GRAPHIC game II (Games Research Applied to Public Health with Innovative Collaboration) played by a cohort of year 5 undergraduate dental students. *BULLGIRSO* (in press)
6. Sipiaryuk, K., Gallagher, J.E., Hatzipanagos, S., Cornforth, J., Reynolds, P.A.: A global setting for GRAPHIC: an online serious game for dental public health – a pilot study. (Abstract). In: *Proceedings, 13th Innovations in Education Colloquium, University of Brescia, Italy, 22–26 April 2015*
7. Tweed, R.G., Lehman, D.R.: Learning considered within a cultural context: Confucian and Socratic approaches. *Am. Psychol.* **57**(2), 89–99 (2002)