

ENHANCING EDUCATION IN GENETICS AND GENOMICS THROUGH A VIRTUAL CAMPUS

Javier Sierra

Universidad Francisco de Vitoria, Madrid (Spain)

Abstract

In the context of Erasmus KA220-HED program, the project HealthTEK was developed, consisting in the design of a virtual campus working around flipped learning, personalized learning and gamified immersion. The “Virtual Campus HealthTEK” includes a set of courses for life and health sciences and technology addressed to biomedical engineers and medicine students beyond others. In this scenario we have included a unit related to the Genetics field. The aim of the Genetics and Genomics unit is to provide students of medicine or biomedical engineering with a self-learning tool to interpret the structure, function and variation of the human genome and to understand the procedures related to precision medicine. The unit is divided into subunits addressing the areas of fundamentals of molecular genetics, genetic variation, structural genomics and functional genomics. Diverse learning resources are included such as video tutorials in which the contents of the sub-unit are developed, quizzes or exercises for self-assessment and gamified content. The game simulates a real case of pharmacogenomics in which a genetic analysis of the patient is carried out before prescription of a drug. Results related to the satisfaction of the users with the platform are provided.

Keywords: *Health technology, virtual campus, genetics.*

1. Introduction and methodology

The Health Technology sector is rapidly growing worldwide, and leading universities have started educational programs adapted to virtual education. However, they are finding some troubles while adapting to these, as moving clinical cases to the virtual space needs new methodologies and modules to teach their disciplines (Fraser, 2014). In the context of Erasmus KA220-HED program, the project HealthTEK was developed, consisting in the design of a virtual campus working around flipped learning, personalized learning and gamified immersion. The “Virtual Campus HealthTEK” includes a set of courses for life and health sciences and technology addressed to biomedical engineers and medicine students beyond others.

In this scenario we have included a unit related to the Genetics field. The aim of the Genetics and Genomics unit is to provide students of medicine or biomedical engineering with a self-learning tool to interpret the structure, function and variation of the human genome and to understand the procedures related to precision medicine. The unit is divided into the following subunits:

- **Fundamentals of molecular genetics:** basic content on the structure and expression of genetic material is covered.
- **Structural genomics:** the structure of the human genome and of a specific gene is analyzed using the European genome browser Ensembl.
- **Mapping variation:** an alteration in a gene is located within the human genome using the Ensembl genome browser¹ and the OMIM² and ClinVar³ databases.
- **Functional genomics:** tools and procedures for precision medicine are introduced.

Each sub-unit contains the following training resources:

- Video tutorials in which the contents of the sub-unit are developed.
- Videos or cartoons to facilitate the learning of the contents in the videotutorials.
- Quizzes or exercises for self-assessment (solutions provided).

¹ Ensembl: <https://www.ensembl.org/index.html>

² Omim: <https://www.omim.org/>

³ ClinVar: <https://www.ncbi.nlm.nih.gov/clinvar/>

- Further resources to deepen: articles that raise current issues, related to the content of the sub-unit.
- Gamified content.

Gamification is a powerful digital strategy that can be applied to the education system to enhance engagement, motivation, and learning outcomes (Dicheva et al., 2015). The game we propose simulates a real case of pharmacogenomics in which a patient has high cholesterol, and the student objective is to determine whether this patient can take the drug simvastatin, performing a genetic analysis before the drug can be prescribed. The student should have completed the course material before playing and two types of questions are offered to the student: text input questions in which the student needs to write down the answer and multiple-choice questions. This game will allow the student to self-assess and revise contents and tools previously worked with the video tutorials, videos and quizzes: gene structure and gene and variant mapping in Ensembl and use of OMIM and ClinVar databases.

2. Results

To assess the usability and effectiveness of the gamified content, a System Usability Scale (SUS) survey was administered to participants. The survey included 10 statements, rated on a scale from 1 to 5, where 1 indicates strong disagreement and 5 indicates strong agreement. The highest-rated statement was Q5 ("I found the various functions in this system were well integrated"), with a mean of 3.9, indicating strong integration of features in the system. Q9 ("I felt very confident using the system") also scored highly, with a mean of 3.6, reflecting a positive user experience and confidence. Statements related to complexity, such as Q6 ("I thought there was too much inconsistency in this system") and Q8 ("I found the system very cumbersome to use"), received low scores, with means of 1.4 and 1.9, respectively, indicating minimal usability challenges. Q4 ("I think that I would need the support of a technical person to be able to use this system") also received a low mean score of 1.9, suggesting that users did not feel they needed additional technical support.

3. Conclusions

The results of the SUS survey for the Genetics and Genomics game indicate overall positive feedback, with participants appreciating the integration of system functions and expressing confidence in its usability. Areas for improvement may include enhancing the simplicity and intuitiveness of the game to increase user engagement further. Nonetheless, the low scores on complexity and technical dependency reflect a user-friendly and well-designed gamified learning experience.

References

- Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society*, 18(3), 75-88.
- Fraser, K. (2014). *The future of learning and teaching in next generation learning spaces*. Bradford: Emerald Group Publishing Limited.