Chapter 36

Green Chemistry:
Classroom Implementation of an Educational Board Game Illustrating Environmental Sustainable Development in Chemical Manufacturing

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ABSTRACT

Games in a variety of formats are viable educational tools for a range of disciplines and students of all ages. However, the adoption of serious games within sciences is limited, particularly so in higher education (HE). This chapter describes the classroom adoption of an educational board game based on chemical production, pollution mitigation and green chemistry principles. Design and development considerations in creating the Green Chemistry game are outlined. The game is available free-of-charge as print-and-play files. Environmental sustainability concepts modeled in the game are described. Questionnaire-based feedback is presented from chemistry HE tutors and from students at three institutions which trialed the game. Responses indicate there is a desire for more game resources in chemical science HE and that the activity is enjoyable and instructional. The educational objectives of the game are partially met through play but are enhanced by using supplementary activities, examples of which are described.

INTRODUCTION

An outline of the design and development of an educational board game is provided in this chapter with examples of how the game has been introduced to the classroom at three higher education (HE) European establishments. The theme of this game focuses on imparting better understanding of the role of "Green Chemistry" in reducing the environmental impacts of chemical manufacture. Green Chemistry is an area of research that the real-world chemical industries in many countries adopt to improve environmental performance, including waste reduction, the use of low toxicity and abundant materials, and reduced energy use. Various educational approaches have been used to introduce green chemistry to HE students, including laboratory practical, curriculum lecture

content and problem-based learning exercises (Andraos & Dicks, 2012). Sustainability in the broader sense, inclusive of economic, ecological and social elements (Burmeister et al., 2012), has also become prominent in the content and structure of many educational courses (Holbrook & Rannikmäe, 2007).

The designed game is intended primarily for use in HE, particularly at the secondary-to-tertiary level transition, as the activity permits student interaction and group participation which may also prove helpful for the development of cohort cohesion.

Games in Formal and Informal Education and in Business

Games for educational and training purposes in schools, colleges, universities and industry have been viably applied across a range of disciplines. From early years through primary and secondary education, games have a positive impact on student attitudes to learning (Najdi & El Sheikh, 2012; Meluso et al., 2012). With a business and development studies focus, games have successfully promoted education for sustainable development via contextualized and experiential learning (Dieleman & Huisingh, 2006). In mathematics and engineering, game theory motivates and improves student engagement through competition-based learning (Burguillo, 2010). The design of conflict simulation games by university students has formed a major part of course assessment (Sabin, 2013). The precise format of game play varies. Physical movement of players between locations is used in one historical/geographical exercise (Akkerman, et al., 2009). In contrast the widespread adoption computer-based game is sedentary (e.g. Kim, B. et al., 2009). Role-play, where students take positions they can readily envisage in the "real world" is widely used and is often linked to the development of transferable skills including teamwork, debating skills and oral and visual presentation skills (Henderson, 2010).

Beyond educational institutions, in the wider business community games are viewed as useful tools in promoting specific products or enhancing the company/organization profile. One example, "Aquaquest," a game illustrating the protection and management of water supplies in a trans-boundary context, was promoted at the major international water business conference Aquatech (Amsterdam, 2008). The designer, Griffioen Design BV, specializes in producing business related games and puzzles to illustrate process or business principles.

Games can be to develop understanding of complex real-world problems. One example is the card-game "Terra" (designer Bruno Faidutti, publisher Days of Wonder) in which the players manage solutions to tackle generic world crises (socio-economic, environmental or diplomatic-military problems) of differing magnitudes in different regions. Players score individually and to the benefit of others by playing co-operatively but can score more effectively by playing in a more selfish manner. However, if too many crises remain unsolved ALL players lose. UNESCO recognized the value of this game in demonstrating the complex inter-relationship between national interest and the needs of international co-operation to solve pertinent issues.

Thus games are used for educational purposes in a variety of formats across all levels of education and beyond into the work-place, and across a wide range of disciplines. In early years education games are more simplistic, but for the older students or employees games are often far from facile ("serious games") and can be designed to illustrate specific or complex subject matter. Whilst several of the above examples include elements of sustainable development implied, overt focus on this topic seems to be scant. Recent commercial board game releases indicate designers may be using aspects of sustainability as inspiration for their work (for example, "CO_2" by Vital Lacerda, published by Giochix.it, 2012), but classroom use of such games is minimal.

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