



A narrative literature review of games, animations and simulations to teach research methods and statistics



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ABSTRACT

Basic competence in research methods and statistics is core for many undergraduates but many students experience difficulties in acquiring knowledge and skills in this area. Interest has recently turned to serious games as providing engaging ways of learning. The CHERMUG project was developed against this background to develop games to support students in learning about research methods and statistics. As a first step in designing the CHERMUG games a narrative literature review was carried out to establish whether similar games, animations and simulations already existed. Search terms used in the literature review included varied terms for digital games, simulations and animations, terms relevant to the twin goals of learning and engagement in games and terms for research methods and statistics. Application of the inclusion criteria led to 26 papers which were considered relevant. Synthesis of the papers suggested that there is reason to be optimistic that a game-based approach might be effective in learning in this area.

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1. Introduction

There is an increasing recognition of the need for students across many disciplines to acquire competence in research methods and statistics. This is often referred to as statistical literacy, defined by Gal (2005, p. 70) as “the ability to interpret, critically evaluate, and communicate about statistical information and messages”. Nikiforidou, Lekka, and Pange (2010, p. 798) also acknowledged the importance of statistical literacy as requiring consideration of the “the synergy of content, pedagogy and technology”.

1.1. Difficulties and misconceptions

However, acquiring methodological and statistical expertise poses significant challenges for many students (Tishkovskaya & Lancaster, 2010). The material is challenging because it is highly abstract and requires the consideration of inter-related logical reasoning, critical thinking, data analysis and interpretation and evaluation skills. Students perceive statistics as difficult and boring and this leads to anxiety and a lack of self-efficacy. Castro Sotos, Vanhoof, Van den Noortgate, and Onghena's (2007) systematic review of students' statistical misconceptions found that students have many misconceptions surrounding statistical constructs such as sampling distributions, hypothesis testing and confidence intervals.

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1.2. New ways of teaching research methods and statistics

In recent years there have been criticisms that traditional methods of teaching research methods and statistics do not inspire a passion for research in students and do not allow students to apply their knowledge. Consequently teachers are continually looking for new ways to make research methods and statistics more appealing to their students. The extensive research of [Garfield, Ben-Zvi, Chance, Medina, and Roseth \(2008\)](#) on the characteristics of Statistical Reasoning Learning Environments identified a number of principles which can help students to learn about statistics, such as using real datasets in classroom activities, providing opportunities to explore and analyse data, developing statistical reasoning and using appropriate technological tools to allow students to test hypotheses. [Pfannkuch and Wild \(2004\)](#) argued that students find it difficult to apply their statistical knowledge and to overcome this they argued that statistics teaching should focus more on covering key statistical concepts (especially variation), develop the ability to explore and learn from data, develop statistical argumentation, use formative assessment and try to understand students' reasoning. Tishkovskaya and Lancaster also proposed a number of strategies to help students learn statistics more effectively, such as shifting the focus of statistics curricula to practical tasks, using problem-based learning and real life examples in project work, developing statistical literacy by supporting critical thinking skills and communication about statistics, using technology and on-line resources and targeting misconceptions through discussion and assessment. Many of these suggested principles and strategies seem to align very well with the functionality of serious games.

1.3. Games for learning

Serious games and games for learning have recently been suggested as an engaging way of helping students to learn ([Joint Information Systems Committee, JISC, 2007](#)). Interest in serious games emerged initially from speculation that games could provide highly engaging activities which could be utilised in learning ([Boyle, Connolly, & Hainey, 2011](#)). More importantly however games offer methods of learning which are highly consistent with modern theories of effective learning which propose that learning activities should be active, situated, problem-based, interactive and socially mediated (Boyle et al.). [Nadolski et al. \(2008\)](#) suggest that serious games can be a useful tool for Higher Education Institutions to develop and deploy, to enhance the student experience and to assist them in achieving the intended learning outcomes.

The CHERMUG quantitative and qualitative games (www.chemrug.eu) are digital games designed to support students as they learn about research methods and statistics. The games were conceived against the background of finding a more engaging, activity-based approach to learning in this area and the recognition that games might help to provide this. The CHERMUG games were initially targeted at nursing and social science students for whom methodological and statistical expertise is an area of core competence. In nursing education there is a strong focus on evidence-based practice and critical evaluation modules which emphasise the need for nurses to acquire useable knowledge which makes links between research findings and practice ([Barker, 2010](#); [Emanuel, Day, Diegnan, & Pryce-Miller, 2011](#); [Newell & Burnard, 2011](#); [Winters & Echeverri, 2012](#)).

1.4. Aim of the current paper

The aim of the current paper is to report on a narrative literature review which was carried out to establish to what extent a games-based approach is currently being used to teach research methods and statistics. A meta-analysis carried out by [Larwin and Larwin \(2011\)](#) showed the advantages of using Computer-Assisted learning in postsecondary statistics education with an overall effect size of 0.566 from 70 studies. However CAL has been around for much longer than games and there has been time to build up an evidence base for its effectiveness. Since games-based learning is still a relatively new area of research, it was predicted that well-designed studies of games in this subject domain may be scarce at this stage. A previous review of the use of digital games in learning ([Connolly, Boyle, Hainey, MacArthur, & Boyle, 2012](#)) confirmed this and indicated that the research designs of papers looking at games are varied and rarely report Randomised Control Trials (RCTs), the design of choice for evaluating educational interventions. For these reasons the focus in the current review was not so much on establishing effect sizes for studies using games for teaching research methods and statistics, but on establishing the state of knowledge in the area. Consequently a narrative review was considered to be most appropriate. While the review was important groundwork for the design of the CHERMUG games, it is also relevant to the games community where there is interest in developing games to support the teaching of core 21st century skills ([Dondlinger, 2007](#)).

2. Method

2.1. Search terms

The search terms for the literature review were derived from a previous search carried out on the evaluation of computer games which addressed the variety of digital games that might be played ([Connolly et al., 2012](#)). While we were primarily interested in games, search terms for simulations and animations were also included as these might include elements of gamification. e-Learning and Computer Assisted Learning (CAL) were excluded as search terms as these were too wide-ranging for the current review. Terms used for games were:

("computer games" OR "video games" OR "serious games" OR simulation OR "simulation games" OR "games-based learning" OR "MMOG" OR "MMORPG" OR "online games" OR animation)

To narrow down the search to focus on games relevant to the twin goals of games for learning, i.e. learning and engagement, the following terms were also used:

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