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ARTICLE

Simulations and games

Use and barriers in higher education

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ABSTRACT This article explores the use of simulations and games in tertiary education. It examines the extent to which academics use different simulation-based teaching approaches and how they perceive the barriers to adopting such techniques. Following a review of the extant literature, a typology of simulations is constructed. A staff survey within a UK higher education (HE) institution is conducted to investigate the use of the different approaches identified within the typology. The findings show significant levels of use of both computer and non-computer-based simulations and games. The main barrier to teaching with simulations, as perceived by the respondents, is the availability of resources. However, further analysis indicates that use of simulations is not associated with perceptions of resource issues, but rather is influenced by views on the suitability of, and risk attached to, such learning methods. The study concludes by recommending improved promotion of simulation-based teaching through enhanced information provision on the various techniques available and their application across subject areas.

KEYWORDS: *barriers, games, role play, simulations*

Introduction

As HE provision has expanded, so too has the variety of methods used for teaching and learning. There has been a movement towards more active and experientially based learning. Amongst those techniques that have gained acceptance are those that might be embraced within the term *simulation*. However, to date there have been relatively few published studies exploring the range of simulation techniques that are employed for teaching within HE. The purpose of this paper is to examine the use of simulation and gaming approaches for teaching and learning in HE and to analyse the perceived barriers to the employment of such techniques. The study is based upon the findings of a 2005 survey of academic staff working across a range of subject disciplines in a UK university.

Literature

A number of studies support the utility and effectiveness of simulations and games for teaching and learning (see Feinstein, 2001; Keys and Biggs, 1990; Wolfe and Crookall, 1998). Ruben (1999), tracing the evolution of such experiential learning approaches from the late 1960s, argues that these methods address many of the limitations of more traditional teaching. Specifically, he identifies their value in addressing cognitive and affective learning issues and in facilitating interactivity, collaboration, peer learning and active learning.

Simulation-based learning approaches aim to imitate a system, entity, phenomenon, or process. They attempt to represent or predict aspects of the behaviour of the problem or issue being studied. Simulation can allow experiments to be conducted within a fictitious situation to show the real behaviours and outcomes of possible conditions. However, simulations cannot simply be regarded as a homogenous collection of approaches. Whilst overlaps between activities exist (Yorke, 1981), previous studies have identified three specific types of simulation-based learning: role play, gaming and computer simulation (Feinstein et al., 2002; Hsu, 1989). Each type is different in its composition and utility. In a role playing exercise, participants act out the role of a character in a particular situation following a set of rules and interacting with other role players. Role play might also be non-interactive, for example in the case of presentations where students adopt a particular character role. With gaming, the key elements entail interaction within a predetermined context, often involving forms of competition, cooperation, conflict or collusion. These interactions are constrained by set rules and procedures. Finally, computer simulations aim to replicate system characteristics using mathematics or simple object representations (Feinstein et al., 2002). Ellington (2001) also considers differences in format as a means of distinguishing types of simulation. He presents a hierarchical classification of simulations, within which a key distinction is made between manual exercises and electronic exercises. Examples of manual exercises identified by Ellington include card, board and field games.

Maier and Größler (2000) elaborate further the particular differences in types of computer-based simulations. In their typology, they develop the principal categories of *modelling oriented simulation tools* (i.e. those used to model particular issues) and *gaming oriented simulation tools*. The latter is further divided into *simulators* and *planning games*, the former identified as single-user applications (played against a computer model) and the latter as multi-user applications (played against other users through a computer application). Hays and Singer (1989) refer to simulators specifically as training devices

used to develop or maintain defined skills. Feinstein et al. (2002) note that such applications can be distinguished by the lack of any interpersonal element.

Figure 1 presents a typology of simulation types derived from the findings of previous studies. This typology forms the basis of the research presented within the current study.

Use of simulations, games and role play

Evidence on the extent to which simulation approaches are used for teaching in HE is patchy. There is an abundance of studies relating to the development, use and evaluation of specific simulation activities. Furthermore, largely descriptive studies exist which explore the use of simulation within specific subject areas. However, there is limited statistical evidence on using simulations (in all their different forms) across subject areas. A review of published research in specific subject areas or relating to specific simulation approaches nevertheless provides a useful indication of the

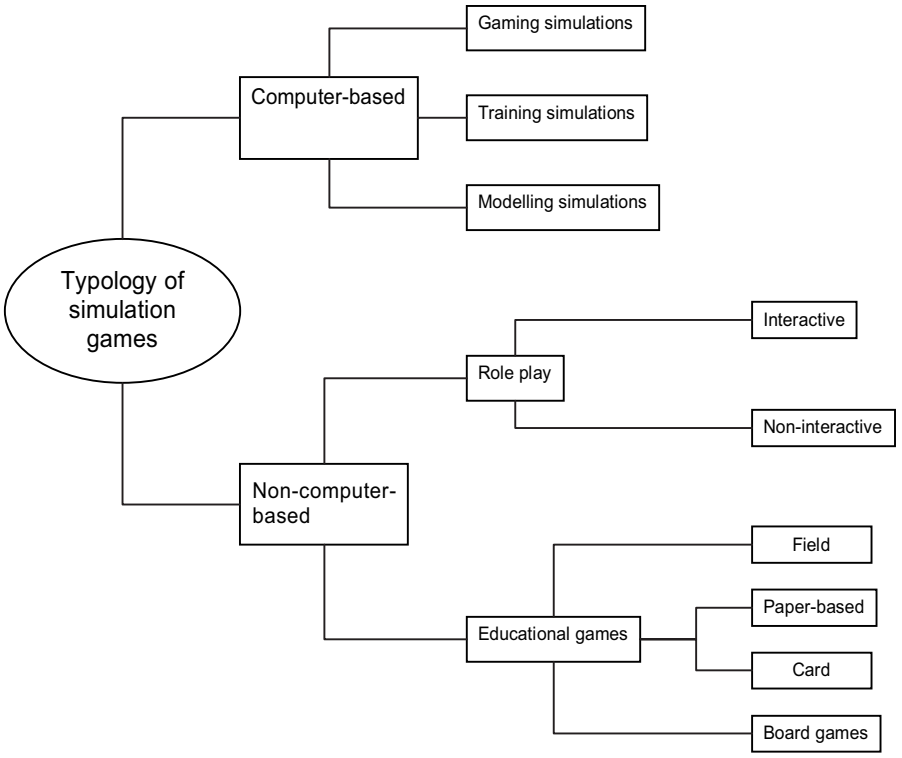

Figure 1 **Typology of simulations**

intensity with which these techniques are employed. The most substantive studies to date relate to the use of computer-based simulation games in business education. Faria and Wellington (2004) review several studies on the use of simulation games across US business schools. These show that the proportion of schools using simulation games has grown from 71.1 per cent in the early 1960s (Dale and Klasson, 1962) to 97.5 per cent of schools by 1998 (Faria, 1998). Faria and Wellington's 2004 investigation focuses on the use of simulation games by individual academics. The findings show that 30.6 per cent of the 1085 respondents are current simulation game users, 17.1 per cent are former users and 52.3 per cent have never used simulation games for teaching business. These figures are higher than Chang's (1997) findings in Hong Kong business schools. In this study, some 24.5 per cent of staff are either current or former users of simulation games.

Burgess (1991) provides the most significant evidence relating to business simulation game use in the UK. His study, which predates the re-classification of UK polytechnics into universities in 1992, finds that there is a difference in the adoption of business games between polytechnics and universities, with the former having a higher level of use. This could be attributed to the more vocational nature of educational provision in polytechnics. Since 1992, these differences may have become less apparent owing to the significant increase in business education provision in so-called 'old' (pre-1992) universities. Nevertheless, this difference is important to note given that the host for this current study is a former polytechnic. Overall, Burgess finds that the level of usage of business games in UK polytechnics (at 92% school uptake) is broadly similar to levels of adoption found by Faria (1987) in US business schools (at 95%).

There appear to be no substantive surveys on using computerized simulation games in non-business subjects. Similarly, there is limited statistical evidence relating to modelling-based and training-based simulations. However, individual descriptive or evaluative studies of specific computer-based simulation activities indicate that such techniques are employed across a range of disciplines. In relation to simulation games, these include sociology (Hofstede and Pedersen, 1999), architecture (Sipes, 2004), media studies (Rettburg, 2004) and engineering (Kumar and Labib, 2004). Modelling-based simulation is widely used to teach engineering but is also used to teach other disciplines (see, for example, Chwif et al., 2001; Jan and Jan, 2000). Training-based simulation is common in disciplines such as medicine, safety, shipping and aeronautics. Examples include Yang et al. (2001) and Rolfe and Hampson (2003).

Much of the literature on role play is rather descriptive and there is little empirical evidence on the extent of use in HE (Armstrong, 2003). Nevertheless, a review suggests that the approach is employed across disciplines.

These include geography (Oberle, 2004), foreign languages (Ladousse, 1987), health studies (Goldenberg et al., 2005), social work (Moss, 2000), religious studies (Couture, 1999) and science (Sleigh, 2004).

Evidence on the extent to which non-computerized educational games are used in HE is again limited. However, a review of studies reporting on specific instances of use confirms that games are employed across degree programmes. Most studies relate to board or card games and examples of their use span subjects including economics (Stanley, 2001), chemistry (Russell, 1999), psychology (Weisskirch, 2003), biology (Taylor and Jackson, 1996), mathematics (Baker, 1999) and creative writing (Morice, 1992).

Barriers to using simulations, games and role play

A number of studies evidence the barriers to using simulation. Most of these relate to either gaming simulations or role play within specific learning environments. These studies help to identify a number of common issues that face educators. Faria and Wellington (2004), examining the use of gaming simulations in business schools, ask academics who have never used simulation games what has prevented them from adopting the teaching method. The most important factor is preparation time (35.7% of respondents). This constraint is also highlighted as the most significant barrier in Chang's (1997) study. The next barrier elicited by the Faria and Wellington survey is a poor fit with the courses being taught (34.4%). A lack of information on simulations is also reported by 29.9 per cent of respondents. The problem of information is further highlighted in that only 26.2 per cent of 'never-users' are 'very familiar' or 'somewhat familiar' with simulation games. As the authors note, 'it is difficult to be a business game user if one is not familiar with business games' (Faria and Wellington, 2004: 198). Other less important barriers reported are a preference for alternative pedagogical approaches, the amount of class time required for simulations, funding, administrative issues and technical issues. In the same study, the authors also ask former users why they stopped. The top two responses to some extent mirror those identified by non-users, with 32.8 per cent citing changed teaching responsibilities (i.e. simulation games were no longer appropriate for courses taught) and 28 per cent indicating the time involved in using games against the learning benefits achieved. Chang's study indicates that the number of academics who stop using simulation games is high, with only 10 out of 35 past users continuing with the approach.

Examining the use of simulation games in agribusiness and agricultural economics, O'Rourke (2001) elicits responses from game users on the problems associated with employing the method. The most significant

problem is found to be updating and maintaining software, followed by taking time away from other activities.

Time demands also emerge as key barriers associated with role play. Francis and Byrne (1999) estimate that the preparation workload for role play exercises is 50 per cent more than is required for a conventional lecture. Similarly, Moss (2000) concludes that role play 'is one of the most "labour-intensive" ways of working as far as the teacher is concerned' (2000: 481). Like other authors (Alden, 1999; Armstrong, 2003) he highlights the demands of the approach during the implementation stage as well as the preparation stage. Armstrong (2003) also discusses how role-play may be regarded as a challenging or risky teaching approach in that it is often unfamiliar to students and staff, and may therefore result in anxiety amongst students. In addition to having to manage the possible negative reactions of students, lecturers must also deal with outcomes that are often unpredictable and difficult to control (see also Jones, 1988). Armstrong finally identifies resource issues (both human and non-human) as potential challenges.

Grisoni (2002) presents qualitative research findings relating to experiential learning practice in HE. In particular, she highlights the uncertainty felt by many academics considering experiential learning approaches. Some lecturers appear not to be confident about how students will react to such approaches and how successful these techniques will be. The study also reveals that some academics feel experiential approaches to be 'non-academic' and less suited to university-level education than more theoretically based approaches. The study also identifies significant cost and resource challenges. Grisoni does however highlight the possible role of technology-based approaches as mechanisms for reducing the high costs associated with staff time.

Overall, the literature presents a fairly uncertain and incomplete picture about the extent to which different simulation approaches are used in HE. Furthermore, whilst there is some understanding of the possible issues that might act as barriers to using simulation, there is little evidence relating to the relative importance of these issues across the full range of simulation methods. Needless to say, there also appears to be no empirical exploration of the possible associations between the barriers to simulation use as perceived by staff, and their actual use by academics.

Aims and methodology

The purpose of this study is to examine the use and perceived barriers to use of simulation and gaming approaches for teaching and learning in HE. To achieve the study's purpose, a typology of simulations was first

developed from the preceding literature review (see Figure 1). The study aims to address the following research questions:

What proportion of staff in the host institution are 'current', 'former' and 'never' users of each of the forms of simulation identified in the typology?

How important do staff perceive the different barriers to the use of simulation approaches to be?

Do any associations exist between staff perceptions of barriers and their use of the various simulation approaches?

During the first phase of primary data collection, a small number of grounding interviews were conducted with academics. These interviews assisted in the identification of issues relating to using games and simulations, and in particular their implementation in the host university. In providing a clear picture of the institutional context for using these methods, the interviews played an important role in informing the development of a questionnaire form.

The research sampling frame for the questionnaire survey comprised all academics across six faculties of the institution. Hence results would represent the characteristics and perceptions of staff teaching across many subject domains covering all years of study and a variety of class sizes. Initially, in this second phase, a pilot survey was conducted using a small sub-sample of academic staff. Feedback resulted in minor changes to the design and content of the questionnaire. Subsequently, 963 of the revised forms were distributed across the faculties. The sections significant to this study were:

Use of simulations and games: role play, non-computerized educational games, computer-based gaming simulations, computer-based training simulations, computer-based modelling simulations;

Perceived barriers to the use of games and simulations: subjects were asked to gauge their level of agreement or disagreement with 10 items. Each item was scored on a five point scale from strongly agree (1) to strongly disagree (5). The items were developed from the grounding interviews held in phase one and the literature reviewed.

158 forms were returned, giving a response rate of 16.4 per cent. Whilst this response rate is relatively low, it is not atypical for surveys of this nature. For instance, the largest study to date of the use of simulation games by academics achieved an effective response rate of 8.4 per cent (Faria and Wellington, 2004). Nevertheless, the limited number of responses and the possibility of response bias should be considered in interpreting the survey results.

Analysis of results

Use of simulations and games

Table 1 below shows results on the use of the different forms of simulation. The table presents the proportion of staff who described themselves as *current users*, *former users* and *never users*. The last category is disaggregated to show those staff who would consider using the method in the future.

Role play is most prevalent amongst the learning techniques listed in the table, with 58.3 per cent of staff being either current or former users. Also, non-computerized games have fairly significant application amongst the academics surveyed. Levels of use of computerized simulation approaches are generally low in comparison to non-computerized approaches. Of those that have never used the various approaches listed, it is worth noting that a large proportion would consider using such methods in the future. This latent interest suggests that there may be real or perceived barriers to the adoption of simulation and gaming for teaching.

Perceived barriers to use

Table 2 below shows the extent to which the responding academics agreed with a series of ten statements relating to possible barriers to using simulation and gaming approaches.

The levels of agreement with the statements varied across the respondent group. A number of assertions did encourage more skewed responses in both directions (see responses to statements 1, 3, 5, 8, 9, 10). The findings show particularly strong concurrence with the assertion that limited time was available for teaching development. Nearly 82 per cent agree or strongly agree with this statement. The limited availability of resources to allow new methods of teaching can also be cited as a point upon which academics agree, with 64 per cent of respondents strongly agreeing or agreeing with this statement. Sixty-four per cent of respondents strongly

Table 1 **Respondent use of different types of simulations (%)**

	Current user	*Former user*	*Never used, would consider using*	*Never used, would not consider using*
Role play	35.9	22.4	22.4	19.2
Non-computerized games	20.5	13.9	47.0	18.5
Gaming simulations	5.4	9.4	64.4	20.8
Training simulations	6.5	4.5	66.5	22.6
Modelling simulations	13.8	7.2	54.6	24.3

Table 2 **Staff perceptions of the barriers to the use of simulation and gaming (%)**

		Strongly agree	*Agree*	*Neither*	*Disagree*	*Strongly disagree*
1	I have limited time available for teaching development	32.6	48.6	9.0	6.3	3.5
2	I feel that using new methods is risky	4.1	13.1	23.4	40.0	19.3
3	I am not aware of available methods and products	17.2	43.4	21.4	11.0	6.9
4	I am satisfied with current teaching methods used	5.4	30.6	33.3	29.3	1.4
5	There is limited availability of resources to allow the use of new methods	16.4	47.9	21.9	11.6	2.1
6	These methods are not suited to my subject	5.5	18.5	29.5	31.5	15.1
7	There are no simulations/games available for my subject	5.0	15.7	42.1	27.1	10.0
8	Students won't react well to these methods	2.8	4.2	27.1	45.8	20.1
9	Teaching innovation is a relatively low priority in my school	5.5	15.1	19.2	40.4	19.9
10	There is limited support available (e.g. technical or admin.) for new methods	22.1	42.1	20.0	13.8	2.1

agreed or agreed that limited technical or administrative support was available. The lack of awareness of available methods and products also resonated amongst the staff, with 60 per cent strongly agreeing or agreeing with this proposition. Encouragingly two statements generated responses with which staff largely disagreed; 66 per cent of respondents disagreed with the assertion that students would not react well to these learning methods, whilst 60 per cent disagreed with the statement that teaching innovation is a relatively low priority in their school.

Associations between use and perceptions of barriers

To simplify the data for further analysis, scores corresponding to the 10 items on barriers to simulation and gaming use were subjected to a

principal components (*factor*) analysis. The purpose of this analysis was to identify whether there was a smaller number of underlying variables (factors) which explain variance in the responses to the items in the survey. A more meaningful analysis of the associations between simulation and gaming use and staff perceptions of the barriers to using these approaches could then be undertaken.

The suitability of the data was confirmed by Bartlett's test of sphericity ($\chi^2 = 250.098$, df = 45, p = 0.000), and Kaiser-Meyer-Olkin's (KMO) test (KMO = 0.620, all diagonal elements of the anti-image correlation matrix > 0.48). There were four factors with eigenvalues greater than 1. However an examination of the scree plot output from the analysis suggested three main factors which represented 55.4 per cent of the total variance. These factors were extracted. An examination of the content of items loading at or above 0.5 (and using the higher or highest loading in instances where items cross-loaded at greater than this value) gave rise to the following factor labels:

Factor 1 (F1) – Suitability (25.0% of variance explained)
Factor 2 (F2) – Resources (19.4% of variance explained)
Factor 3 (F3) – Risk of unknown (11.0% of variance explained)

Table 3 lists the three factors, their associated items and factor loadings after Varimax rotation with Kaiser normalization.

Factor 1 represents items relating to the perceived suitability of simulation and gaming for teaching and learning activities. Factor 2 contains items associated with resource issues. The final factor represents items concerned with risk.

Table 3 **Factor loadings for barriers to simulation and gaming**

Suitability	
I am satisfied with current teaching methods used	0.635
These methods are not suited to my subject	0.782
There are no simulations/games available for my subject	0.730
Students won't react well to these methods	0.760
Resources	
I have limited time available for teaching development	0.499
There is limited availability of resources to allow the use of new methods	0.751
Teaching innovation is a relatively low priority in my school	0.668
There is limited support available (e.g. technical or admin.) for new methods	0.761
Risk of unknown	
I feel that using new methods is risky	0.684
I am not aware of available methods and products	0.813

For the purpose of subsequent analysis, factor scores were calculated using the regression method (Tabachnick and Fidell, 2000: 597–600, 627). To assist in the analysis, the following null hypothesis was proposed:

> H_0: There are no significant differences in staff perceptions of the barriers to simulation and gaming use between user and non-user groups.

A multivariate analysis of variance (MANOVA) was conducted using the three extracted factors as dependent variables and the following independent variables: use of role play, use of non-computerized educational games, use of computer-based simulations. For the independent variables, respondents were either users (current or former) or non-users of the approach.

A marginally significant difference was observed in relation to the combined dependent variables and the use of non-computerized educational games (Pillai's Trace significance = 0.059, see Table 4). The interaction between the use of role play and the use of computer-based simulations was also significant for the combined dependent variables. A univariate analysis for each of these main effects is presented in Table 5. This indicates that the associations are with Factor 1 (Suitability) and Factor 3 (Risk).

Table 5 also reveals further significant differences relating to Factor 1 (suitability) and both the use of role play and the use of computer-based simulations. These results indicate a clear association between academics' use of different simulation and gaming approaches and their perceptions concerning suitability. There are no associations relating to perceived resource barriers. Overall, the results suggest the rejection of null hypothesis H_0.

Discussion

Within this host institution the study findings indicate that simulations, games and role play are used for a variety of teaching and learning

Table 4 **Significant associations between simulation and game use and combined dependent variables**

Source of variance	*Pillai's Trace*	*Hypothesis df*	*Error df*	*Multivariate F*	*Sig.*
Use of non-computerized educational games	0.062	3	116	2.548	0.059
Use of computer-based simulations by use of role play	0.073	3	116	3.061	0.031

Table 5 **Significant associations between simulation and gaming use and perceptions of barriers to simulation and gaming**

Source of variance	*DV*	*df*	*Mean square*	*F*	*Sig.*
Use of non-computerized educational games	Suitability	1	5.092	7.034	0.009
Use of computer-based simulations by use of role play	Risk	1	8.612	9.258	0.003
Use of computer-based simulations	Suitability	1	3.310	4.572	0.035
Use of role play	Suitability	1	2.774	3.832	0.053

purposes. An encouraging level of use of a variety of simulation approaches is evident. However, role play and other non-computerized games represent the most frequently used techniques. This on the face of it is quite surprising given the technical- and science-based heritage of the university. However, the results reflect the shift in focus to a broader academic portfolio of subjects over recent years, in particular a relative growth in academic programmes in the arts, humanities and social sciences.

The fact that a majority of those staff who have never used simulations would not discount their use in the future suggests that there is scope for higher levels of adoption of such approaches in the future. Such growth however is likely to be moderated by staff perceptions of the barriers to using simulations and games. Results from the survey show that resource related issues are perceived to represent significant barriers. Limited time, resources and support are the three principal obstacles to the employment of these learning techniques, though a lack of awareness of simulation approaches is also of importance. The findings relating to time and resources are understandable given the pressures placed on staff as a result of the competing demands of teaching and research (particularly the expectations and potential rewards associated with the UK Research Assessment Exercise). Of course, it is not unusual in any organizational context for time and resource limitations to be cited as factors encumbering progress and higher achievement. It is useful therefore to look at the associations between perceived barriers and actual levels of use of the various simulation techniques. Factor analysis and MANOVA results indicate homogeneity in staff perceptions pertaining to resource barriers, with no significant variations between users or non-users of the simulation approaches examined. This indicates that whilst most staff highlight resource related limitations as constraints, this does not prevent many of them from going ahead and using simulation-based approaches in their

teaching. The study results suggest that in fact, the use of simulations is associated primarily with issues concerning suitability. In other words, decisions are made mainly on the basis of academic judgements regarding the appropriateness of different teaching approaches.

Other results from the survey indicate that with computer-based simulations and role play, the unknown risk of their use as perceived by academics may be associated with levels of adoption. Consideration of the factor items for Factor 3 (Risk) may lead to the suggestion that insufficient accessible information exists on the use of these approaches to provide some staff with the level of confidence required to employ them. It might also be that the outcomes of using such approaches (in terms of both possible practical difficulties and learning benefits) are regarded by staff as being less predictable than is the case for other teaching techniques. Armstrong's 2003 study certainly indicates that this may well be true of role play. These results suggest that improved promotion of simulation-based methods within HE institutions is desirable. Better information about available approaches may result in a clearer view amongst academics of the risks involved in their use, and in turn, encourage higher levels of adoption. In addition, some of the risks associated with using simulations could be reduced by employing external organizations to deliver learning inputs. The growth in the number of training organizations marketing outsourcing services to HE organizations perhaps presents opportunities to limit the risks involved in delivery. However, the costs involved are often high, and integration with other learning inputs may be challenging.

Conclusion

Overall, the findings of this study suggest that increasing resources for supporting simulation use per se may not have a significant impact on the uptake and maintenance of simulations, games and role plays as active learning approaches. The results suggest that academics make the decision to use these techniques based upon their professional judgement of benefit and risk, rather than on the resources available. If academics are motivated to use simulations, resource limitations will generally not stop them. In the light of the influence that suitability and risk seem to have on the propensity of staff to use simulations, there may be a role for awareness building activities and improved information about these approaches. This would assist academics with an interest in such approaches to make more informed judgements as to their suitability within a given learning context, the possible risks that might be involved and how these can be minimized. Further, such information could stimulate an interest in simulations amongst staff not familiar with the method.

It should be noted that the findings of this study relate to one specific HE institution and that further research across institutional boundaries would be desirable to add further validity to, or refute the findings of this study. In particular, further research might usefully investigate how universal the findings are across universities with different traditions, missions and constituencies. In addition, there would be value in assessing the association between simulation and gaming adoption and factors such as class size, student year of study, academic subject and staff characteristics.

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