SERIOUS GAMES FOR TRAINING AND FACULTY DEVELOPMENT—A REVIEW OF THE CURRENT LITERATURE

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ABSTRACT

This article is a review of the current literature involving the use of serious games (SG) as a tool for training and faculty development. Noted in the review is the dearth of research into the adoption of SG for use specifically in higher education faculty development. The review looks at the viability of SG as teaching tools, the validity of SG in professional training, motivation and SG, faculty attitudes toward SG, SG used in professional development for faculty, and measuring learning when SG are used.

Keywords: Serious Games, professional development, assessment, higher education, teacher training

INTRODUCTION

Serious games (SG) first came to prominence with the expanse of the video game industry in the 1980s, and with that expanse came the proliferation of the medium of interactive simulations (Spector, 2015). Since that time their use has grown, and though they rarely act alone as a unit of training or professional development (PD), they are still looked at as an integral part of such a module of content (Spector, 2015). Serious games have more recently made their way into PD specifically targeted at and meant to facilitate faculty development. Sorcinelli, Austin, Eddy, and Beach (2006) note in Creating the Future of Faculty Development that there have been five discrete ages of faculty development:

1. The Age of the Scholar—1950s–1960s (focused on improving scholarly proficiency);
2. The Age of the Teacher—1960s–1970s (focused on improving faculty teaching endeavors);
3. The Age of the Developer—1980s (a more holistic view of faculty development with a focus on the outcomes measurement);
4. The Age of the Learner—1990s (a boom in faculty development centers, professional associations, and foundations targeting faculty development); and
5. The Age of the Network—the present (calls for increased clarity in faculty development and a network to be built between faculty and administration to find solutions to problems).

From Sorcinelli et al.’s era map, it is clear to see how PD for higher education faculty has moved from a singular focus in each era to a more holistic and systemic view of PD that recognizes its place not only in faculties’ lives but as an integrated part of any institution. Because of their malleable nature and the ability to tailor SG to suit the needs of a wide variety of disciplines and concepts, it is easy to see how they fit into the current state of higher education faculty PD. SG can aid in faculty teaching proficiency through classroom simulations, or they can help scholarship efforts by teaching faculty how to publish via an interactive game where faculty play the part of a journal editor and must evaluate articles or chapters for publication. SG can even aid in service areas where faculty could roleplay as students moving through the advising process. This better equips faculty members to help students in need of advising assistance. The application instances of SG in higher education are virtually endless and make for a compelling
addition to the PD arsenal available to institutions.

While current and future research involving PD utilizing SG for higher education faculty members is of particular interest to those involved in faculty training, this specific research field is currently underrepresented in the literature. This study examines various research examples of SG in teacher training in general (K–16) as well as learning instances designed with SG in mind that involve classroom students. The aim here is to determine the current state of literature involving SG in professional development of higher education faculty members and the overall reach and effectiveness of SG within the realm of education in general. Private industry long ago embraced SG to aid in training the workforce, and while there are some commonalities with regards to learning in the general sense, the focus here remains on teacher training specifically. SG can be easily incorporated into almost any online learning instance, making for a compelling pairing with digital or online learning. Any future research recommendations of SG and higher education faculty PD will point almost exclusively in this direction.

SG make extensive use of multimedia content in their design and must be designed with that in mind. SG is a natural fit with Mayer & Moreno’s (2003) cognitive theory of multimedia learning. SG is a type of multimedia that can assist with deep learning, which Mayer & Moreno (2003) define as, “attending to important aspects of the presented material, mentally organizing it into a coherent cognitive structure, and integrating it with relevant existing knowledge” (p. 43). Much of Mayer & Moreno’s work is concerned with the cognitive load of the multimedia learner. Since, as Mayer & Moreno (2013) note, we have limited chances for processing information, designing SG with a mind towards cognitive load is advised.

Before diving into the prominent research pertaining to SG in education and training, Laamarti, Eid, and Saddik’s (2014) article is an excellent primer. Laamarti et al. extensively survey the current literature pertaining to SG, provide definitions of terms, and clarify the terminology inherent to SG. They examine the taxonomy of SG, provide classification, and place this tool within learning instances. They also delve into the myriad applications of SG as a teaching tool and a facilitator of knowledge and training in a variety of fields. Perhaps the weakest part of the article is the call for future research. The authors seem at a loss for any real direction for future research. They mention briefly the need for further investigation and research into more physical means of interaction between the player and the game, including a nebulous call for more natural interactions and interfaces. Aside from this weakness, the article is an excellent introduction to the field of SG and primes the idea of games as teaching tools.

REVIEW OF CURRENT LITERATURE

Viability of SG as Teaching Tools

Romero, Usart, and Ott (2015) broach the broad idea of SG as teaching tools. They examine the viability of SG as a means of teaching 21st century skills, such as collaboration/teamwork, communication, creativity, social skills, problem solving, and critical thinking. These can be construed as broad categories and not necessarily unique to a 21st century learner, which is a limitation of their study. Their methodology consisted of reviewing completed studies and verifying the effectiveness of learning skills with SG. The authors acknowledge that most of the games in the studies were not created with the express idea of teaching 21st century skills. Instead, they are usually constructed around a particular set of learning objectives. Though their analysis is limited, there is value here from the sheer number of effective instances of SG learning they have managed to locate, giving credence to SG and its acceptance as a learning tool.

Katsaliaki and Mustafee (2015) continue this approach of looking broadly at SG adoption within a particular learning context, but instead of focusing on 21st century skills, they are interested in SG and teaching sustainable development and responsibly developing resources with a mind towards future sustainability. Katsaliaki and Mustafee located 49 games relevant to their research and captured 17 variables to study (some variables were ones they found, while other were pulled from existing research). Their research methodology used secondary analysis of qualitative data, which is more regularly used in a quantitative instance, but they noted that secondary analysis of qualitative data when applicable was a growing trend. They presented a variety of findings on each variable and found that while most of the games selected did teach...
some specific elements of sustainable development, there was still a need for additional pedagogical materials for a game to become an actual teaching tool. This shows the broad applicability of SG to teach a specific subject or idea.

This applicability extends as well to medical field, where SG constitute a meaningful delivery method for student learning materials. Graafland, Schraagen, and Schijven’s (2012) article identified 17 SG specifically designed for medical training and 13 commercial games that may have helped train the laparoscopic psychomotor skills on which their study focused. The researchers then narrowed the list of games to three designed for medical training. These were then validated by medical students, but none of the games completed the validation process prior to article publication, which is a major limitation of the study. None of the commercially available games were thought to have met the minimum threshold for use in training. While there is little call here for future research into SG in training at large, it is encouraging to see so many SG produced for such a specific training purpose.

*Validity of SG in Professional Training*

Succeeding in validation where Graafland et al. (2012) failed is Knight et al. (2010) with their controlled trial of using SG to teach triage techniques to learners. Learners were divided into two groups: One group was taught the techniques with a card sorting exercise while the other was taught through SG training. The usability of both the card exercise and the SG were measured using a questionnaire. The learners who went through SG-based training were significantly more likely to perform the triage procedure correctly. The researchers caution that there is still further research needed because the concept of triage is not firmly evidence based.

Just as Graafland et al. posited the validity of SG in training medical personnel, so too does Cain and Piascik (2015) for pharmacy education. Though their article is not a specific research instance and targets pharmacy education rather than higher education, its most compelling feature is its rationale for the use of SG in higher education. Cain and Piascik hang most of their argument on learner motivation, or lack thereof, in higher education. It is a thoroughly researched rationale that provides good support for the intrinsic qualities that make SG a compelling choice when designing a learning engagement. The article would have benefited from more foundational citation, rather than so many discipline specific use cases, but its argument for linking motivation and SG is nonetheless persuasive.

*Motivation and SG*

Motivation is a key contributor to the success of SG use in training or learning. Huang, Huang, and Tschoop’s (2010) article explores this at length. They surveyed university students after they engaged with an SG, acquiring 264 cases from which they base their data. A limiting factor of their research is how lopsided the gender split was between their research population—though, that was not noted by the authors. Only 50 students were male, leaving 214 females. With regards to motivation processing (using Keller’s motivation, volition, and performance theory) and the SG, the students exhibited a link between outcomes processing, and motivation processing and this link helped students sustain motivation throughout their engagement with the SG.

Huang (2011) extends this research initiative into motivation. This time 144 students participated, interacting with an SG-based learning instance utilizing Keller’s ARCS Model (Attention, Relevance, Confidence, Satisfaction). Huang used the game “Trade Ruler” because of its heavy multimedia use and cognitive activities. The participating learners exhibited high motivational processing, though the gender and major course of study of participants was not clear in the article. It would have been valuable to see if there were any differences seen along gender lines or between disciplines. Learner motivation is an important consideration when looking to institute SG into any learning engagement, as are the feelings of the faculty who are expected to incorporate or interact with these SG.

*Faculty Attitudes Toward SG*

When placing SG in such a prominent place in faculty PD, it is important to consider how faculty feel about games in learning. In a research article by Hsu, Tsai, Chang, and Liang (2016), 316 in-service teachers in Taiwan were studied and their perceptions of SG as a teaching tool were evaluated. The researchers used questionnaires to gather data and they interpreted the data through a series of independent *t*-tests and ANOVA analyses.
They categorized the data along teaching level and gender as well as age and years of teaching experience and found that gender was a predictor of game knowledge. Younger teachers had more knowledge of game-based learning content than older teachers, and those that taught younger grades had more confidence in using games in education. One of the limiting factors for their research was that it is focused on K–12 and is based on a foreign population. Also, this study is solely focused on teachers’ perceptions of games in the learning of their students, not in their own PD.

Li and Huang (2016) also examined Taiwanese teachers’ predilections with regards to SG in K–12 learning. They studied a sample size of 307 teachers, using questionnaires to survey the populace and SPSS to analyze the data collected, settling on four types of adopters—enhancing learning, ease of use, social norms, and compatibility and interactive. Four one-way ANOVAs were also performed to analyze the lifestyles—being fashionable, life expansionist, enjoying life, no-media skeptics, preference for foreign products—of the four types of adopters. They found that lifestyles heavily impacted the level of SG adoption, while demographics only had a marginal effect. They also noted that while traditionally most nonadopters had limited resources, which contributed to their lack of adoption, in this study resources were not a concern and that failure to adopt SG may have been due to time constraints. They make a well-observed case for future research into factors beyond limited resources that may contribute to lack of adopting SG or any general technology adoption.

While not unilaterally focused on SG adoption, Ketelhut and Schifter’s (2011) article is a discussion of the direct implementation of a unit of PD that involves the use of an SG meant to help teach science curriculum for middle school students. Ketelhut and Schifter used a cross-case analysis to examine the success of the PD project. This was a constantly evolving, eight-year project, with multiple rollouts. They used Schifter’s own PD model as a critical lens for their analysis and the three primary delivery models of PD studied were online, train-the-trainer, and hybrid, with hybrid yielding the best teacher satisfaction rating. While they discussed the delivery modalities, equal weight was afforded to the teachers’ feeling about adopting SG in learning. They found that teachers needed adequate time to develop comfort with the SG and enough support to develop satisfactory efficacy in using the SG.

Kapralos, Hogan, Pribetic, and Dubrowski’s (2011) article continues this idea of gauging faculties’ feeling with regard to SG in learning, but they also include students’ perceptions in their research instance. They distributed two surveys: An initial survey was aimed at both faculty and students and was designed to measure their perceptions of SG, while the second survey was aimed only at students and focused on their video game habits and their feelings about SG. The target populations were faculty and students at a laptop-based institution. The most compelling thing to come from their research were the three main issues that resulted from their survey data. For students to adopt SG in a learning instance, they must feel that there is a link between the SG and the course materials. Also, the SG must be user friendly. Finally, the same applies to faculty members—they must be able to fully integrate the SG into their learning materials and easily use the SG so they may explain its function and use to their students.

**SG in Faculty PD**

As faculty look to incorporate SG into their own lessons and materials, so too do training and PD facilitators. Here is the real crux of this literature review—the use of SG in faculty PD, specifically higher education faculty. Unfortunately, there is little representative research dealing with SG use in higher education faculty PD, so examples from K–16 will be cited. Tyler-Wood, Estes, Christensen, Knezek, and Gibson’s (2015) article explores the use of the SG simSchool in training preservice teachers. They examine research data on simSchool from the United States Department of Education, the National Science Foundation, and Educause. They found that regular and special education preservice teachers who trained using simSchool felt more prepared than the control group. They also found that simSchool provided a cost-effective supplement to field-based training. The one weakness of the article is a lack of call for future research, especially in a broader sense of the applicability of SG to faculty PD in general.

In an interesting twist, Annetta, Frazier, Folta, Holmes, Lamb, and Cheng (2013) engage in research where SG function as both the PD and
the end product of the PD. The researchers studied K–12 science faculty as they engaged in PD and concurrently built an SG designed to teach science-based standards to students in the district. They then used the qualitative data they gathered to help determine the level of teacher efficacy for those involved. Their mixed methods research was a “non-randomized, pretest-posttest, intervention group only design” (Annetta et al., 2013, p. 51). Overall, they found that teachers responded positively to using SG in teaching science to students. They also found that teachers felt the need to place their own preferences aside in favor of using methods that would benefit their students. The researchers also made the salient point that future research should include input from the SG user base—students—to give a voice to the audience they are trying to serve.

Another instance of K–12 PD science training is provided by Annetta et al. (2014). This research involved preservice teacher playing an SG called STIMULATE (Science Training Immersive Modules for University Learning Around Teacher Education) meant to teach lab safety in K–12 science. The researchers engaged in a research design utilizing two phases: The first involved participants describing their concerns or issues with chemical lab safety, and the second looked at the usability of the initial game build and employed feedback from phase one. The research employed a “one-group, non-randomized, pretest—posttest, quasi-experimental design” (Annetta et al., 2014, p. 66). Their research found that the SG increased learner understanding of lab safety, though they had tempered expectations to the results due to the one-group design. One of the needs identified for future investigation is identifying minimum and maximum training times using STIMULATE to gain appreciable effect.

Preservice teachers are also the subject of Pellas and Boumpa’s (2016) research involving SG devised in Open Sim and Sloodle (both utilize open virtual worlds). Using a one-group, pretest-posttest design, 135 foreign language preservice teachers participated in three activities utilizing SG in hopes of teaching them “basic concepts that are related to information technology literacy” (Pellas & Boumpa, 2016, p. 407). The results showed significant improvement in learner outcomes, especially among those learners who exhibited poor beginning performance. They also found that all participants benefited from the training regardless of their beginning proficiency. The study’s findings are limited due to a lack of qualitative data and the fact that preservice teacher characteristics may differ from country to country.

SG involving open virtual worlds is also the subject of Nussli and Oh’s (2015) research involving teacher PD and Second Life. Utilizing a mixed-methods, exploratory case study, the researchers sampled graduate students taking a graduate-level technology course. The sample consisted of 18 special education teachers who interfaced with the virtual world through a variety of activities and afterwards participated in surveys and interviews providing actionable research data. The researchers found that participants’ attitudes towards the use of virtual worlds had improved and that teachers saw it as a viable method of teaching special needs students social skills. The researchers do acknowledge the limitations of their study due to possible gender bias (2 male participants versus 16 female). They also recommend future research with larger sample sizes to help generalize the study.

For a different perspective, where the instructor becomes a participant in the SG along with the learner, Taylor, Backlund, and Niklasson (2012) examine teacher PD from their defined modality of coaching-by-gaming—a technique where the “instructor gives the trainee challenges, feedback, and directions, by becoming a game player alongside the trainees” (Taylor et al., 2012, p. 649). The researchers collected empirical data through several training sessions where SG were used. Rather than an extended research instance, the researchers have positioned this article as a means to define and produce a theoretical and empirical framework for their coaching-by-gaming modality. A particularly interesting call for future research involves an investigation into the advancement of artificial intelligence to aid human instructors in coaching-by-gaming.

Using educational design research in an exploratory research endeavor, Vrasidas and Solomou (2013) look at the possibilities SG provide for teacher training and the challenges that may arise from such implementations. Participants in the study consisted of 12 female in-service teachers enrolled in a graduate technology course (this is a concerning limitation of the research due to the gender bias and the relatively small sample size).
Data were gathered during an 11-week period during design, revision, and implementation of the SG. Overall, the participants were engaged with the SG and found it a better method of learning than through books or other traditional resources. The most compelling statement made by Vrasidas and Solomou was that if “we want teachers to use games in their teaching, we need to use games in teaching teachers” (2013, p. 204).

**Measuring Learning When Using SG**

With such extensive use of SG in faculty PD, a final question to be asked is how do we measure any learning taking place with the use of SG? Wouters, van der Spek, and van Oostendorp’s (2011) research explores Kraiger’s concept of structural assessment—organizing knowledge into structures that contain important concepts—and its ability to measure the learning of complex skills taught by SG. In their research, 19 participants engaged with the game, Code Red: Triage, to learn triage techniques. The participants were a mixture of various medical proficiencies, from novices to experienced professionals. They found that structural assessment measures learning differently than verbal assessment. Structural assessment adds depth to the learned skills and concepts that the learner found important. The authors acknowledged that their small sample size and the brevity of the instruction time (15 minutes or less) is a limitation of the study.

**RESULTS**

After examining the current literature, there is little to be found by way of assessment with regards to SG, especially in the realm of faculty development. There is even concern over what assessment in SG should be. A typical SG assessment is conducted with a pretest and posttest model because of the relative ease of the assessment modality (Bellotti, Kapralos, Lee, Moreno-Ger, & Berta, 2013). While pretests and posttests are a fine starting point for SG assessment, there is room for improvement. There have been calls for in-game assessment using player metrics and player data (even the creations of standardized player profiles that may be transferable between game instances) to help assess learners while they interface with the SG (Bellotti et al., 2013). The field of teaching and learning with SG would benefit greatly from such a level of assessment and data standardization. Of course, such protocol uniformity is difficult due to the proprietary nature of gameplay data, thereby making it largely inaccessible to researchers (Loh & Sheng, 2014).

**FUTURE RESEARCH**

The biggest gap identified in this literature review is the application of SG in PD for higher education faculty. Higher education faculty PD in general is in need of more expansive levels of research, but particularly when it comes to SG. The need for further research into SG for higher education faculty PD parallels the need to assess the learning effectiveness of such tools. The research available does show the value inherent in using SG in learning instances. The field is ready to explore the value of SG in higher education faculty PD research endeavors, and it is particularly ripe for research instances involving online learning, SG, and higher education faculty PD.
REFERENCES


