Mersin Üniversitesi Eğitim Fakültesi Dergisi
Mersin University Journal of the Faculty of Education

Three-Dimensional Virtual Worlds: Research Trends and Future Directions

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Abstract*:* Use of three-dimensional (3D) virtual world platforms has been increasing worldwide. These online multi-user environments, where users move and interact in simulated 3D spaces, provide many opportunities for learning and teaching. Educators have been experimenting with these technologies by investing in research and development. The purpose of this study is to analyze research trends in 3D virtual world literature. Therefore, this study analyzed research from 2008-2013 using the constant-comparative method across five categories: (a) use cases of virtual worlds, (b) research topics, (c) disciplines, (d) platforms, and (e) participants. The results revealed that virtual worlds have been used in three ways, e-learning, experiential learning, and social interaction. Moreover, the attitudes and experiences of learners were the most commonly examined topics, followed by collaboration/social interaction and social presence. Foreign language, medical, and teacher education were notable disciplines studied in virtual worlds, and participants were generally students in higher education. The results also revealed that Second Life was the most commonly used platform.

Key Words: three-dimensional virtual worlds, education, research trends

Özet: *Üç Boyutlu Sanal Dünyalar: Araştırma Eğilimleri ve Gelecek Yönelimleri.* Dünya çapında, üç boyutlu (3B) sanal dünya platformlarının kullanımı her geçen gün artmaktadır. Internet üzerinden çok kullanıcılı bir ortamda üç-boyutlu etkileşimin mümkün olduğu bu platformlar öğrenme-öğretme sürecine birçok fayda sağlamaktadır. Eğitimciler, araştırma ve geliştirmeye büyük miktarda zaman ve mali yatırım yaparak bu ortamların sunduğu imkanlardan yararlanmaya çalışmaktadır. Bu çalışmanın amacı üç boyutlu sanal dünyaların kullanımına yönelik yapılan araştırmaları alanyazın taraması ile incelemektir. Bu amaç doğrultusunda, bu çalışmada üç boyutlu sanal dünyalar ile ilgili alanyazındaki 2008-2013 yılları arasında yapılan çalışmalar beş kategoride içerik analizi ile incelenmiştir: (1) kullanım örnekleri, (2) araştırılan konular, (3) disiplinler, (4) platformlar, ve (5) çalışma grupları. Sonuçlar sanal dünyaların e-öğrenme, yaşayarak öğrenme ve sosyal etkileşim olmak üzere üç farklı kullanım örneğinin olduğunu göstermiştir. Ayrıca, yapılan araştırmalarda, en yaygın olarak tutum ve tecrübe konularının incelendiği dikkat çekmektedir. Bu araştırma konularını işbirliği/sosyal etkileşim ve sosyal farkındalık takip etmektedir. Dil eğitimi, sağlık ve öğretmen eğitimi sanal dünyaların en fazla uygulandığı disiplinler olduğu dikkat çekmektedir. Sonuçlar ayrıca Second Life platformunun en yaygın kullanılan platform olduğunu ve yükseköğretimin çalışma gruplarında odak noktası olduğunu ortaya koymuştur.

Anahtar Kelimeler: üç boyutlu sanal dünya, eğitim, araştırma eğilimleri

INTRODUCTION

Advancements in innovative technologies are creating changes in every aspect of life. The use of web technologies is no longer limited to accessing information; through Web 2.0 technologies, it is also possible to contribute to knowledge, sharing and collaborating with others. Recently, with the development of three-dimensional technologies, interactive virtual reality environments have become widespread. Three-dimensional (3D) virtual worlds, an example of 3D technologies, provide new ways to communicate and offer many opportunities for both traditional and distance learning. Technological advances in broadband, audio and

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video, wireless computing, and ubiquitous learning have made 3D virtual worlds more practical and functional (Dalgarno and Lee, 2010; Dickey, 2005; Warburton, 2010).

The literature demonstrates a large growth in the use of virtual worlds for educational purposes. Despite existing justification for the use of virtual worlds to provide immersive learning experiences, it is important to analyze past studies to reveal trends. Therefore, the purpose of this study is to contribute to the literature by reviewing past studies on virtual worlds in terms of use cases, research topics, disciplines, platforms, and participants.

3D Virtual Worlds: Definition and Properties

The commonly used term 3D technology includes "Massively Multiplayer Online Role Playing Games" (MMORPGs) like World of Warcraft and virtual worlds like Second Life. In both technologies, users act through an avatar in a 3D interactive environment. Although the terms multiplayer games and virtual worlds are sometimes used interchangeably, these technologies differ in terms of focus and purpose.

MMORPG platforms include a story where users perform specific tasks according to the guidelines of the game. However, virtual worlds do not follow a predefined story; users choose their own purposes in the environment. Moreover, users can contribute to the development of a virtual world, creating and shaping certain aspects of it. Dickey (2005) defined virtual worlds as "networked desktop virtual reality in which users move and interact in simulated 3D spaces" (p. 439). In another study, virtual world was defined as an "immersed 3D virtual environment in which a learner acts through an avatar to engage with the other avatars for the explicit purpose of learning" (Kapp and O'Driscoll, 2010, p. 55).

Dalgarno and Lee (2010) have suggested that representational fidelity and learner interaction are the two characteristics of virtual worlds that distinguish them from other technologies. With the realism provided by a 3D environment, users feel immersed in the setting. Unlike other technologies, users do not feel isolated. Even though users are physically separated, they share the same environment (Biocca, Harms, and Burgoon, 2003; Slater, Sadagic, Usoh, and Schoeder, 2000). Instead of exploring simultaneously in different places, users explore together in the same simulated place at the same time.

As in real life, representation of self in virtual worlds is important. Users create their own identity and embody themselves through their avatars. Moreover, users interact with each other in real time by using both verbal (voice and text chat) and non-verbal communication tools (gestures). Within an immersive 3D environment, by representing themselves as avatars, users can feel socially and psychologically connected (Biocca et al., 2003; Schroeder, 2002). Therefore, they may feel more comfortable expressing themselves and becoming part of a community.

Recent statistics show developments and trends in the use of virtual worlds. For example, KZero's radar charts indicate that the number of virtual worlds and MMORPGs was 900 as of 2013 (KZero, 2013). Moreover, KZero's universe chart revealed 1,899 million registered users in virtual worlds and massively multiplayer online games (MMOs) as of 2013. As statistics support the rapid development observed in the literature, the use of virtual worlds for educational purposes will likely continue to increase. Therefore, it is crucial to identify research trends and future directions in 3D virtual world literature.

Some studies have examined the use of virtual worlds in education. Hew and Cheung (2010), for example, examined 15 studies conducted prior to 2008 by focusing on virtual world usage, research methods, and research topics. They found that virtual worlds have been used as communication spaces, simulated spaces, and experiential spaces. Moreover, they found that descriptive research was used in the majority of the studies. Participants' affective domain, learning outcomes, and social interactions were the three main topics. In another study, Inman, Wright, and Hartman (2010) analyzed studies by focusing on research methodologies, participants, and activities in virtual worlds. By analyzing 27 studies conducted prior to 2009, they found qualitative, quantitative, and mixed-method researches to be equal in number. In addition, they found that participants were predominantly higher education students. Finally, their results showed that most studies had used virtual worlds for student-centered activities, such as role-playing, simulations, project-based learning, group learning, and explorative

learning. In another study, Kim, Lee, and Thomas (2012) analyzed studies conducted prior to 2011 in terms of educational applications, research methods, platforms, applied disciplines, and participants. They used Hew and Cheung's classification of the educational applications of virtual worlds and found that most studies focused on simulated spaces, followed by communication spaces. They also found that Second Life was the most commonly used virtual world platform. In terms of methods, they found studies conducting experimental and descriptive research. Furthermore, foreign language, science, computer, and general education were found to be the most commonly applied fields. Finally, they found that most studies involved students in higher education.

Purpose of the Review

Although previous studies have reviewed virtual world literature, they each included different categories in their analysis and, except for Kim et al. (2012), they did not classify the studies by year, making it difficult to observe trends. Analysis of more recent studies is essential. The purpose of this review is to analyze studies from the last five years to reveal trends. Therefore, the study aimed to answer the following research questions:

- What are the use cases of virtual worlds?
- What research topics have been examined in virtual world studies?
- Which disciplines has been studied in virtual world studies?
- Which platforms have been used in virtual world studies?
- Who are the participants in virtual world studies?

METHODOLOGY

Data Sources and Search Procedures

This study included articles on virtual worlds published between 2008 and 2013. In order to identify research articles in peer reviewed journals, we searched databases such as Academic Search Complete; ERIC; Library, Information Science and Technology Abstracts with Full Text; PsycARTICLES; and PsycINFO for the keywords "virtual world." As of March 2013, a total of 1080 full text studies were listed. We examined the abstracts of the articles to eliminate duplicates, opinion papers, conceptual papers, and non-empirical description papers. A total of 55 articles were included in the study.

Data Analysis

We used the constant-comparative method to analyze the papers (Glasser and Strauss, 1967), assessing each text according to the following categories: use cases of virtual worlds, research topics, disciplines, platforms, and participants.

Codes for each category were not determined prior to the study; rather, they emerged during the analysis of the two researchers' coding. The constant-comparative method was conducted as follows. The first paper was read and established as the first content of the first code under the first category, "use cases of virtual worlds." The next paper was read and compared to the first paper. If it was similar, it was added as the second content of the first code under the first category; otherwise, it was added as the first content of the newly created second code under the first category. Each paper was compared to the previous documents in a similar way. The two researchers conducted constant-comparative analysis independently and then worked together to reach a consensus for codes under each category.

RESULTS

This study analyzed articles about virtual worlds from the last five years according to use cases, research topics, disciplines, platforms, and participants. Below, detailed results of the content analysis are provided for each category.

Use cases of virtual worlds

According to the literature analysis, virtual worlds are used for three purposes: (a) e-learning, (b) experiential learning, and (c) social interaction.

E-learning

Studies of using virtual worlds for e-learning showed that presentation and discussion methods were used in the accompanying lessons. As shown in Figure 1, 5% of the studies used virtual worlds for e-learning purposes only. Another 18% of the studies used virtual worlds to promote social communication in addition to e-learning. Use of virtual worlds for e-learning usually takes place at the higher education level for online or blended courses in disciplines such as literature (Mansour, Bennett, and Rude-Parkins, 2009), programming (Esteves, Fonseca, Morgado, and Martins, 2011), engineering (Okutsu, DeLaurentis, Brophy, and Lambert, 2013), life-long learning (de Freitas, Rebolledo-Mendez, Liarokapis, Magoulas, and Poulovassilis, 2010), and archaeology (Edirisingha, Nie, Pluciennik, and Young, 2009).

Experiential learning

With experiential learning in virtual worlds, students learn by doing, engaging in activities which would otherwise be expensive, dangerous, or impossible to attempt in real life. Offering the possibility to communicate with voice and text, virtual worlds are well designed for problem-based and role-playing activities. Among the analyzed studies, 25% used virtual worlds only for experiential learning activities (see Figure 1). Another 16% used virtual worlds to promote social communication in addition to experiential learning. Problem-based and scenario-based learning spaces have been created for this type of usage in such disciplines as foreign language education (Blasing, 2010; Henderson, Huang, Grant, and Henderson, 2012; Ibáñez et al., 2011; Wehner, Gump, and Downey, 2011), teacher education (Bulu, 2011; Gregory and Masters, 2012; Kennedy-Clark, 2011; Vasileiou and Paraskeva, 2010), and medical education (Creutzfeldt, Hedman, Medin, Heinrichs, and Felländer-Tsai, 2010; Conradi et al., 2009; Mitchell et al., 2011; Loke, Blyth, and Swan, 2012; Wiecha, Heyden, Sternthal, and Merialdi, 2010). In some studies, experiential learning was used alongside e-learning (O'Connor, 2010; Penfold, 2009; Rogerson-Revell, Nie, and Armellini, 2012).

Social communication

As mentioned above, analysis showed that studies have also used virtual worlds to facilitate social communication alongside e-learning (18%) and experiential learning purpose (16%). Among the remaining studies, 27% used virtual worlds for social communication alone (see Figure 1). For example, virtual worlds have been used to facilitate communication within learning communities in such disciplines as nursing (Puterbaugh, Shannon, and Gorton, 2010), librarianship (Cote, Kraemer, Nahl, and Ashford, 2012; Lorri, 2012), and tourism (Denizci Guillet and Penfold, 2013). In another example, conversation groups were formed to facilitate interaction between foreign-language learners (Blasing, 2010; Wehner et al., 2011). Discussion groups have also been formed for topics such as health and stress (Cowdery, Kindred, Michalakis, and Suggs, 2011; Hall, Conboy-Hill, and Taylor, 2011; Hoch et al., 2012).

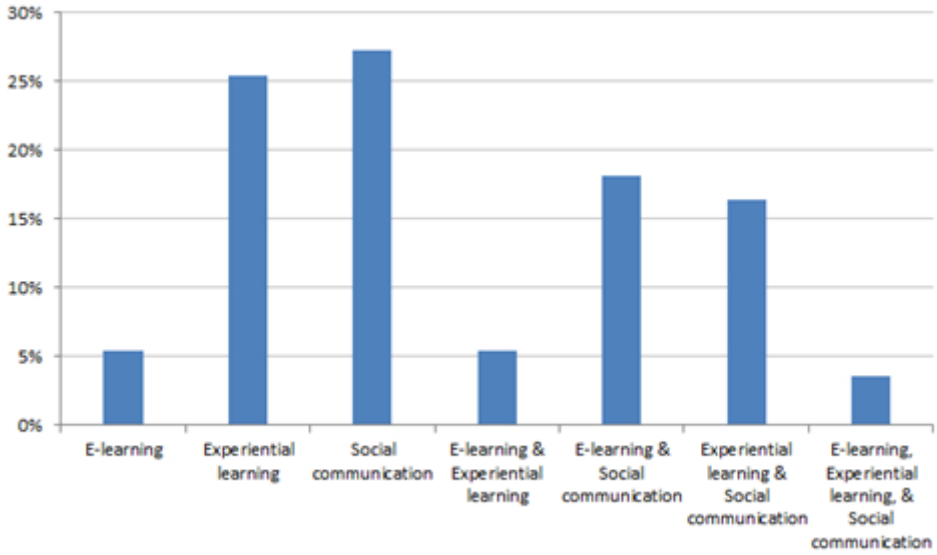

Figure 1. Use cases of virtual worlds

The analysis of the virtual world usage by year showed that, use of virtual worlds for experiential learning and social communication have been increased in 2009 and reached their highest level in 2012 (Figure 2). The results also showed that experiential learning use case along with the social communication has also been increased over years. Moreover, results showed that use of virtual worlds for experiential learning and social communication has been increased more than use only for e-learning. However, results revealed that use of virtual worlds for e-learning along with social communication have been increased since 2008. Moreover, e-learning use case along with experiential learning has been increased over time.

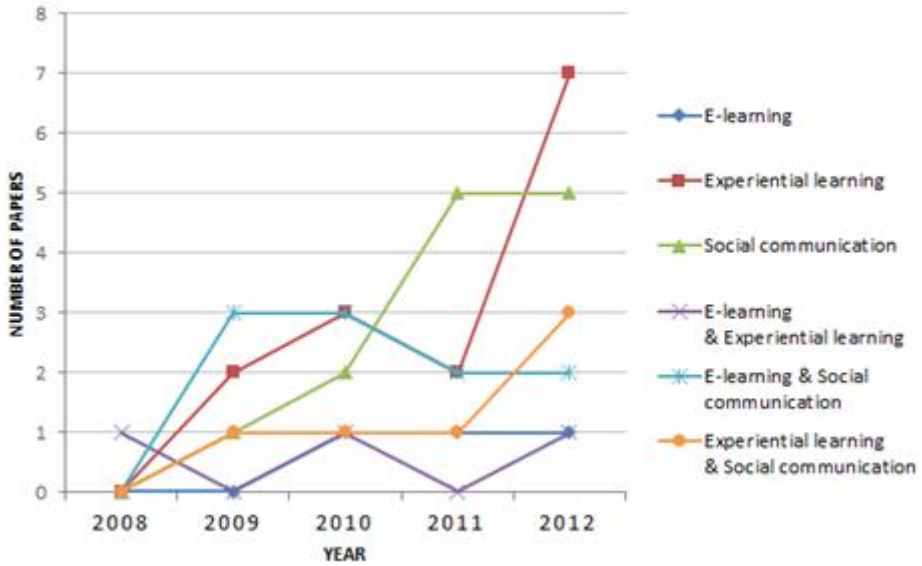

Figure 2. Use cases of virtual worlds over time

Research topics

According to the analysis, research topics in virtual world studies can be grouped in five areas: (a) attitude/experience, (b) learning, (c) collaboration/social interaction, (d) social presence, and (e) identity. As shown in Figure 3, the majority of the studies (71%) investigated the attitude/experience of virtual world users, followed by collaboration/social interaction (11%) and social presence (8%). Finally, while 5.5% of the articles examined learning, 4.5% of the articles examined identity in virtual worlds.

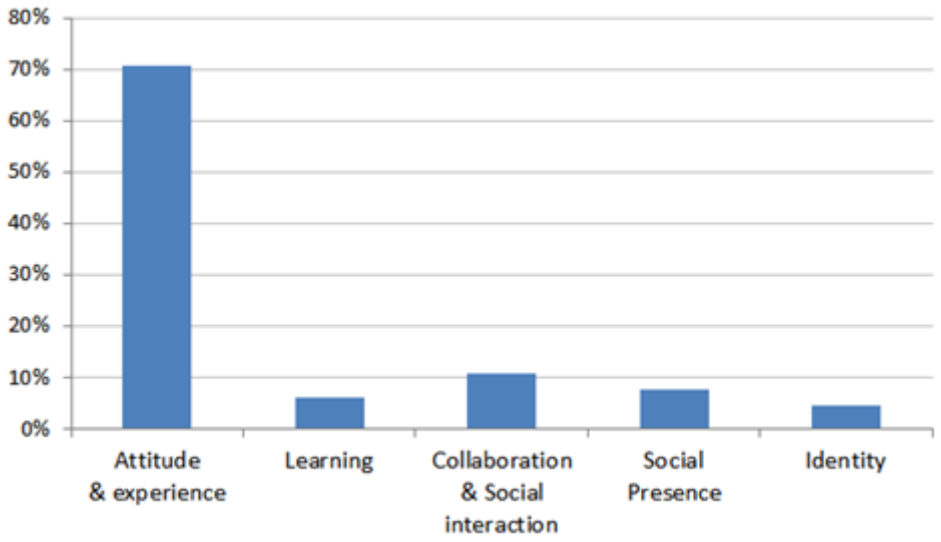

Figure 3. Research topics in virtual world studies

The analysis of research topics by year showed that studies investigating attitude and experience have increased since 2008, reaching the highest level in 2012 (Figure 4). Although studies examining collaboration and social interaction showed a slight increase in 2010, they decreased in 2012. In addition, the analysis showed that while studies have been investigating identity since 2011, they have been examining learning since 2010.

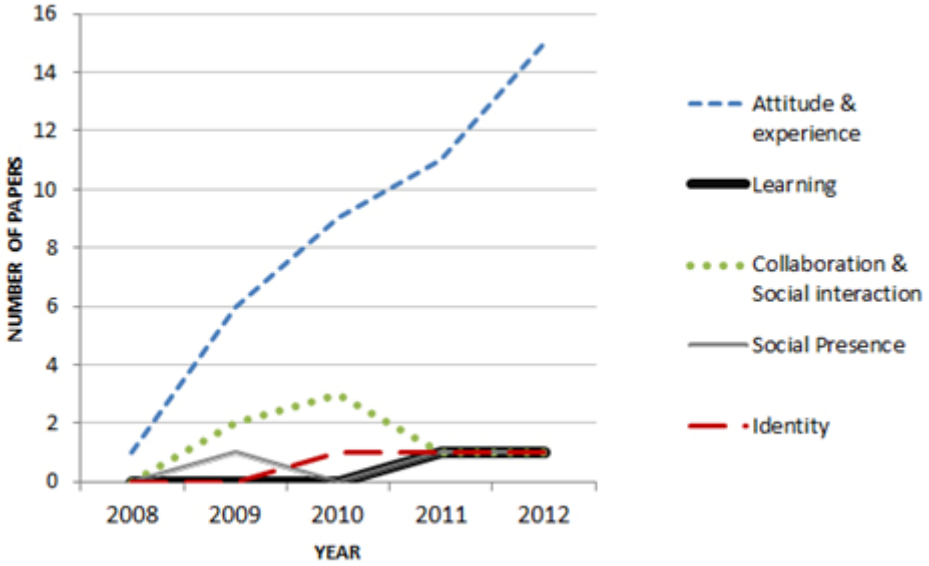

Figure 4. Research topics in virtual world studies by year

Disciplines

According to the analysis, eight disciplines have been studied in virtual world literature: (a) teacher education, (b) language education, (c) programming, (d) medical education, (e) librarianship, (f) tourism, (g) commerce, and (h) life-long learning (see Figure 5). The results revealed that language education (16%), medical education (15%), and teacher education (11%) were most commonly studied, followed by commerce (7%), programming (5%), life-long learning (5%), tourism (4%), and librarianship (4%). Additional disciplines have also been examined in a few studies, such as literacy (Merchant, 2010), digital literacy (Merchant, 2009), archaeology (Edirisingha et al., 2009), communication (deNoyelles and Kyeong-Ju Seo, 2012; Jarmon, Traphagan, Mayrath, and Trivedi, 2009), mathematics (Bouta and Paraskeva, 2012), aerospace engineering (Okutsu et al., 2013), and scientific research (Schifter, Ketelhut, and Nelson, 2012).

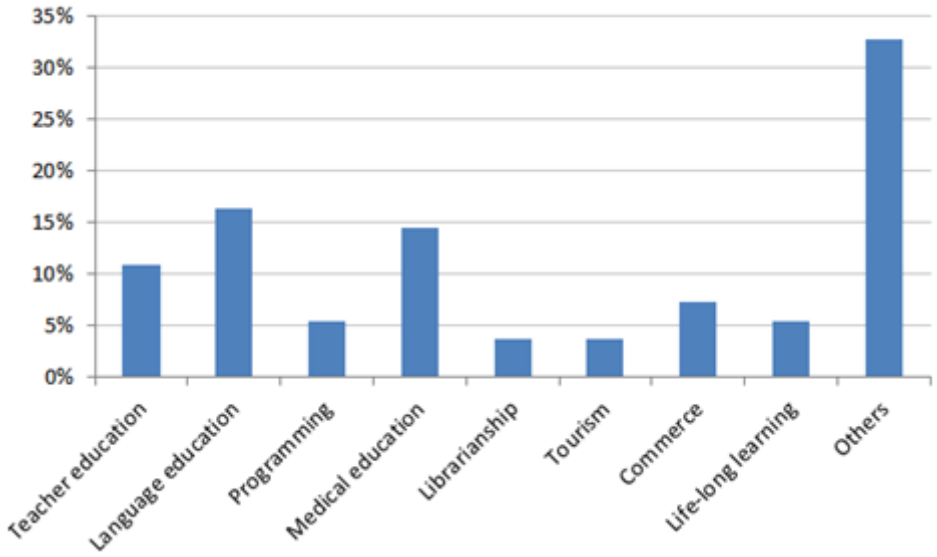

Figure 5. Disciplines in virtual world studies

Used Platforms

Results of the content analysis revealed Second Life (85%) as the most commonly used platform in virtual world studies (see Figure 6). Active Worlds was used in three studies (Bouta and Paraskeva, 2012; Merchant, 2009; 2010), and Open Wonderland (Ibáñez et al., 2011) was used in one study. Other virtual world platforms used in the studies include Alice (Parker, 2012), Olive (Creutzfeldt et al., 2010), Save Science (Schifter, Ketelhut, and Nelson, 2012), and 3DVLE (Lin, Tutwiler, and Chang, 2012).

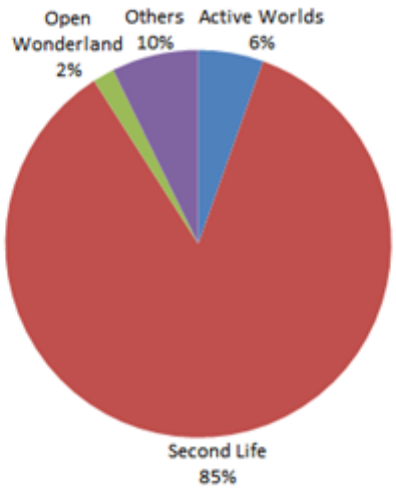

Figure 6. Platforms used in virtual world studies

The analysis of platforms used in the studies by year showed that the use of Second Life (SL) has been increasing over time (see Figure 7). On the other hand, the use of other platforms began increasing after 2010 as well.

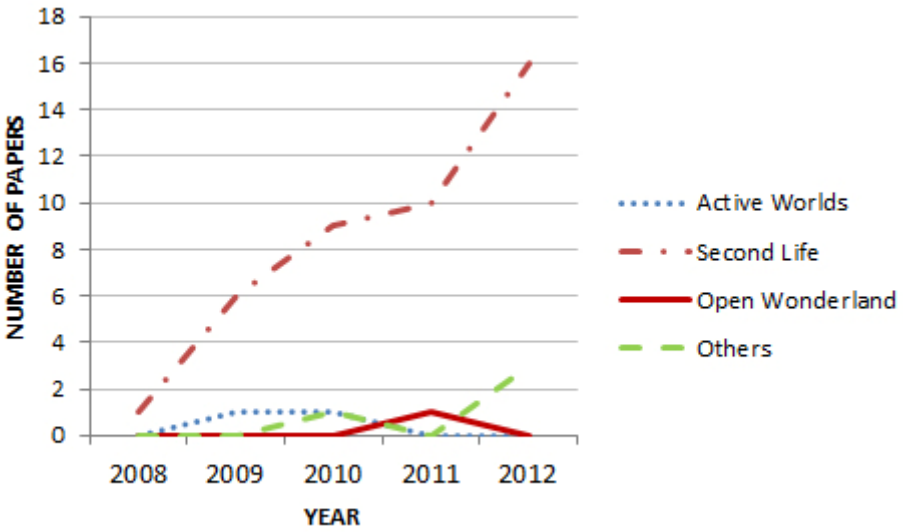

Figure 7. Platforms used in virtual world studies by year

Participants

According to the analysis, participants in virtual world studies can be grouped into four categories: (a) primary education, (b) secondary education, (c) higher education, and (d) adult learners (see Figure 8). The results showed that participants in virtual world studies were mostly higher education students (53%), followed by adult learners (20%), primary students (7%), and secondary students (4%). Some studies also had participants from different levels (16%).

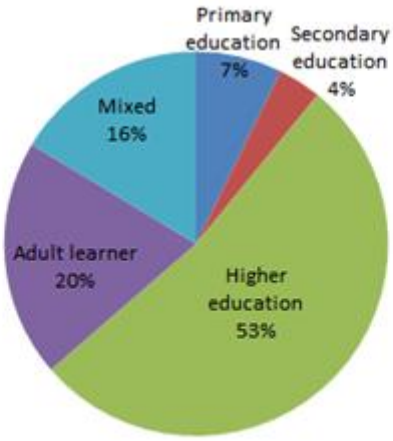

Figure 8. Participants in virtual world studies

DISCUSSION AND IMPLICATIONS

The use of 3D virtual world platforms for educational purposes and their accompanying research studies have shown a tremendous increase in recent years. Reviewing these studies to reveal research trends about virtual worlds is crucial in order to provide guidance to educators who plan to conduct future research in this area. For this purpose, this study analyzed literature from the years 2008-2013 by using the constant-comparative method across five categories: (a) use cases of virtual worlds, (b) research topics, (c) disciplines, (d) platforms, and (e) participants.

As for use cases, results showed that virtual worlds have been used in three ways: e-learning, experiential learning, and social interaction. In line with the findings of previous reviews (Inman et al., 2010; Kim et al., 2002), the results suggest that virtual worlds are most commonly used for experiential learning, and the use of virtual worlds by year showed that experiential learning applications have been increasing. Considering the potential of virtual worlds to create meaningful learning experiences through immersive and problem-based environments, it is anticipated that this usage will continue in the future. The results indicate that social communication is the second major type of virtual world usage. As seen in the results, virtual worlds have been used to facilitate social communication alongside both e-learning and experiential learning purposes, as well as to facilitate communication within learning communities, for foreign-language learners, and for life-long learning. Characteristics of virtual worlds affect social communication among learners by enabling them to feel involved in the environment and socially connected. Therefore, it is also expected that using virtual worlds for social communication will continue to increase in the future. While e-learning use in virtual worlds has not been as widespread, the results did reveal an increase in the use of e-learning together with experiential learning and social communication. Therefore, it is anticipated that the use of virtual worlds will continue to increase across all types of use cases in various combinations.

Results identified attitude/experience, learning, collaboration/social interaction, social presence, and identity as research topics commonly examined in virtual world studies. Attitudes and experiences of learners were the most frequent, followed by collaboration/social interaction and social presence. These findings are in line with the literature in that affective domains have been more popular topics in virtual world studies when compared to learning outcomes (Hew and Cheung, 2010; Kim et al., 2002). However, learning as a research focus has slightly increased in the last year. Although it is expected that studies about attitude, experience, and social interaction will continue to be conducted, future studies should also examine learning by using experimental research.

Results showed that virtual worlds have been examined in various disciplines, including teacher education, language education, programming, medical education, librarianship, tourism,

commerce, and life-long learning. Foreign language education was the most commonly applied field, which is supported by the findings of Kim et al. (2002). Findings also revealed that medical education and teacher education, commonly seen in experiential learning, are noteworthy disciplines studied in virtual worlds. As the use potential of virtual worlds has been realized, it is predicted that studies in various disciplines will increase in the coming years.

Concerning platforms, the results showed that Second Life (SL) was most commonly used in virtual world studies, which is in line with the literature (Inman et al., 2010; Kim et al., 2002). Moreover, the analysis of platforms by year revealed an increase in the use of SL. However, the results of the study also showed that other platforms have seen an increase in recent years. It is anticipated that with an increased use of open-source platforms and game engines, proprietary virtual worlds will become more widespread in the near future, which is also supported by published statistics (KZero, 2013). It is further expected that these new virtual world platforms, with advanced communication and productivity tools and easy integration of learning management systems, will inspire educators to experiment with them. In turn, more users would boost demand for development of new platforms.

As for participants, the results showed that students in higher education were the focus of many studies, which is supported by the literature (Inman et al., 2010; Kim et al., 2002). The second most common group was adult learners. Considering the most commonly used platform is SL, which has an age limit, it is not surprising that primary and secondary education students were the focus of only a few studies. However, it is anticipated that more studies will include younger students with the increase of platforms specially developed for each audience.

Research on virtual worlds has been increasing in importance and popularity, but more research is needed to provide case studies in different disciplines. Moreover, studies are needed that focus on learning outcomes in addition to affective domains of learners. Choosing a virtual world platform is key; therefore, more research is needed to experiment with different platforms, comparing effectiveness. Researchers and educators should guide their research agendas based on the highlights provided in this review.

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