

The Publishing Game: An Analysis of “Game” Related Academic Publishing Patterns

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ABSTRACT

Growth in the electronic games industry is evidenced by numerous reports citing an increasing proportion of “gamers” in the general population. Of particular interest is the shift in the conceptualization of the “typical gamer” from a very narrow stereotypical player to those meeting a much broader set of demographic characteristics. This has perhaps occurred in synergy with expansion in the types of games available. Similarly, we hypothesize that diversification has also occurred in academic research on games, primarily as a result of a simultaneous increase in interest in the use of electronic games for purposes beyond entertainment. In this research we extract 7842 distinct academic publications from major publishing databases to explore temporal patterns in the number of publications in the area of computer games. We also consider changes in disciplinary diversity over time. Our results show that computer game related research has undergone three development periods: the *hibernation* period from 1957 to 1980, the *emergence* period from 1981 to 2003, and the *active* period from 2004 to 2013. The broad domain of ‘science technology’ received the highest level of research interest among the three research domains: ‘science technology,’ ‘social sciences,’ and ‘arts humanities’. Interestingly, ‘learning’, in the context of computer games, has become a popular research topic from 2004. We also propose future work to extend our analysis to author collaboration and country of origin to inform understanding of the spatial-temporal patterns in game-related research.

Categories and Subject Descriptors

H.3.7 [Information Storage and Retrieval]: Digital Libraries – Collection.

General Terms

Management, Measurement.

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Keywords

Academic Publications; Bibliometrics; Game-related Research; Research Area; Research Output; Systematic Review.

1. INTRODUCTION

The proliferation of computer gaming in society has increased over recent times. More and more people are engaged in playing computer games, with a consequential change in the demographic characteristics of players evident. Bond University conducted Australian-wide, national studies of computer game audiences in 2005, 2009, and 2012 [1]. These research reports indicate that:

- the number of households who engaged in playing games grew from 76% in 2005 to 92% in 2012;
- the age of the average player increased from 24 in 2005 to 32 in 2012;
- the proportion of players who are female rose from 38% in 2005 to 47% in 2012; and,
- parents who play video games increased from 66% in 2005 to 83% in 2012.

It is obvious from these figures that, over the last decade, the gender and age distribution of players has changed, as well as the involvement in games by members within a household. Games have dispersed further into the general populations’ lives. Consequently, the game industry itself is rapidly growing [2, 3]. The types of games being played have also undergone dramatic changes in the last decade. In addition to games for traditional entertainment purposes, games are also designed for educational purposes such as assisting children to learn [4], teaching science courses [5], and improving students’ differentiating knowledge [6]. In the last decade, a broader range of ‘serious’ games has appeared on the market. These games focus on educational skill development in areas such as business strategy games [7], military training games [8], health related games [9], and social games [10]. While the game types are expanding, the technologies supporting games are under rapid development too. The game devices are extended from hand-held consoles and computers, to mobiles [11], tablets [12], and wireless hand-held consoles with motion detection functionality [13].

With the dramatic changes in the players of the games, and the expansion in the types of games and the ways they are used, we hypothesize that a sharp increase of interest in the amount of game related research in the academic community has occurred.

Inline with this, we also expect that the research areas of interest, as evidenced by the broad disciplines that academic publications appear in, have become more diversified.

Academic publication is a method for communication and exchange of research findings and results [14]. Academic research will lead to new knowledge discovery. To avoid the loss of new knowledge [15], research results are commonly published through an academic paper. Through publication, scientific papers allow the original scholar(s) to obtain critical responses [14] and allow other scholars to verify the reliability of knowledge [14, 15]. Thus, the quantitative analysis of scholarly research outputs or bibliometrics is a valuable method for evaluating changes in academic interest in a particular research topic or field over time.

In the following sections, we present our analysis of game related academic publishing patterns. In the Method section, we outline the research questions and our research method. The results of the analysis, and corresponding answers to the research questions, are provided in the Results section. We summarize our findings and provide a discussion of possible future development trends in game related research in the Discussion section.

2. METHOD

The primary purpose for our analysis is to investigate game related academic publishing patterns. We aim to identify the historical and current areas of academic research interest in the area of gaming, and thereby further classify game literature development patterns.

More specifically, our work aims to answer the following research questions:

- RQ. 1: What changes have occurred in the quantity of game related academic publications over time?
- RQ. 2: How have the areas of research interest in game related academic publications changed over time?

To answer the research questions, we adopt a systematic approach to the review of game related academic publications. A systematic review is a literature review methodology which follows a well-defined process to gather, evaluate, and analyze all the available literature relevant to a particular research question, or area of interest, based on a well-defined process [16, 17]. In our review, we limited the literature search for game related publications to the bibliographic databases of Scopus and Web of Science (WoS). The literature search is directly related to: digital games, computer games, electronic games, video games, and/or serious games. The search sources and parameters used are listed in Table 1.

Table 1. Search sources and parameters

Bibliography Databases:	Scopus and WoS
Article Type:	Article, conference paper, abstract, letter, correction, meeting, editorial, news, book chapter, review, and other
Search Keywords:	digital gam*, computer gam*, electronic gam*, video gam*, or serious gam*
Search On:	Title
Sort:	Sort by publication date
Language:	All languages

Publication period:	All publication years
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The searches were conducted in April 2014 on Scopus database and WoS database, which have the broadest disciplinary coverage among bibliographic databases [18]. Datasets returned from the Scopus and WoS search were combined together resulting in 9975 records, based on the unique article titles from the Scopus dataset. Because our search terms were defined as gam*, the terms gamma, gamut, gambusia, and gambl* were erroneously included in the search results. Therefore, we excluded the publications without games*, game*, and gaming* via a computational approach, and received 7927 relevant records. We identified a further 85 duplicates with the same article title, publication year, and authors. These were manually removed as the last step.

From the two bibliographic databases, we identified a total of 7842 distinct publications using our search strategy. The workflow of gathering and evaluating of the literature from Scopus and WoS is shown in Figure 1.

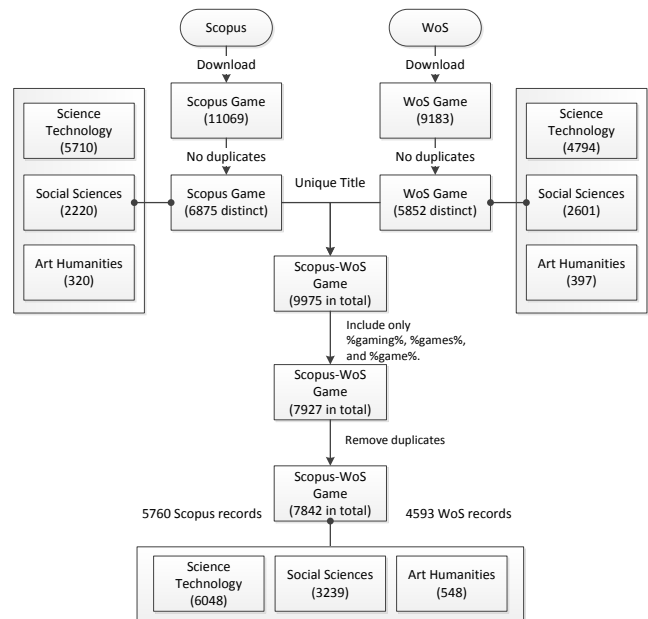


Figure 1. Workflow diagram to gather and evaluate game related academic publications from Scopus and WoS.

3. RESULTS

The results of the analysis are structured based on the research questions stated in the Method section. These results are based on the 7842 relevant publications, finalized through the process of searching, screening, mapping, data extraction, and quality assessment.

3.1 RQ. 1: What change has occurred in the quantity of game related academic publications over time?

To answer this research question, we consider the total number of publications by year. The distribution of the number of publications per year is shown in Figure 2. Based on the search parameters, the first game related publications appeared in 1957, with the number of publications published peaking in 2012.

Two distinct change points are evident, thus we divide the total time period covered by the located research into three development periods: 1957 - 1980; 1981 - 2003; and 2004 - 2013. The first period commenced in 1957, when the first computer game related research article was published. There was very slight development in research on computer games in this period of time, with an average of 6 publications per year, thus we call it the 'hibernation' period. During the second period, there was slightly more research occurring than during the *hibernation* period. The number of publications gradually grew during this time to an average of 61 per year, thus we call it the 'emergence' period. During the third period, the number of publications increased rapidly to an average of 616 per year, thus we term this the 'active' period.

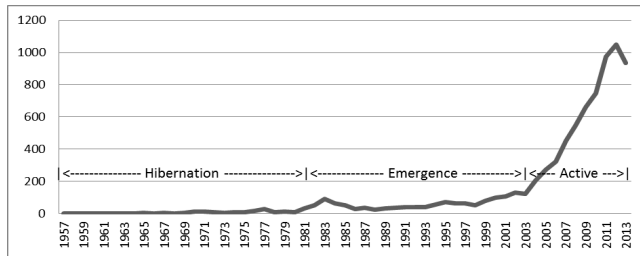


Figure 2. Number of game related publications by year.

3.2 RQ. 2: How have the areas of research interest in game related academic publications changed over time?

3.2.1 Number of publications

Game related publications indexed in WoS are grouped into three main research domains: 'science technology,' 'social sciences', and 'arts humanities' – which we follow in our analysis. Based on the domains specified by WoS, the publications downloaded from Scopus were manually grouped into these domains. 'Arts and humanities' is classified as 'arts humanities'; 'social sciences', 'economics, econometrics and finance', 'psychology', and 'business, management and accounting' are classified as 'social sciences'; and the remaining research areas are classified as 'science technology'. Because some research articles are cross-disciplinary, a single publication may be assigned to one or more research domains. The distribution of the number of publications in each of the three domains by year is shown in Figure 3. The broad domain of 'science technology' received the highest level of research interest between 1957 and 2013.

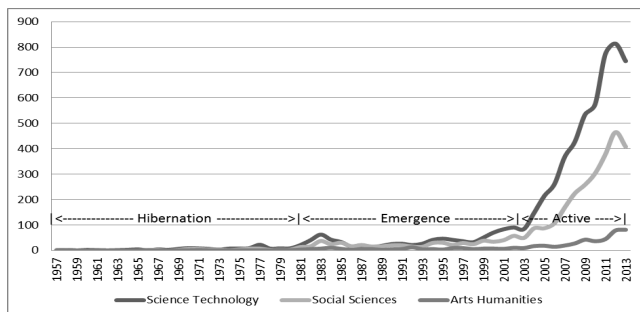


Figure 3. Number of game related publications in 'science technology', 'social sciences' and 'arts humanities' by year.

Although Figure 3 clearly shows the increase in the number of publications in 'science technology', 'social sciences', and 'arts

humanities' for the three development periods, detail of small magnitude changes are hidden by the scale. To better understand the distribution of the interest in these three domains during *hibernation* period, the distribution for this period is provided in Figure 4. The first game-related article, published in 1957, belonged to both the 'science technology' and 'social sciences' domains. Since then 'science technology', as the interest leader, continued to develop consistently, while major 'social sciences' interest picked up from 1965 and real interest from 'arts humanities' perspective only began in 1978.

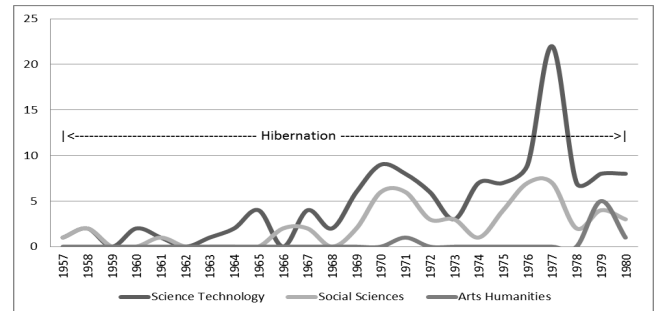


Figure 4. Number of game related publications in 'science technology', 'social sciences' and 'arts humanities' from 1957 to 1979

To understand recent developments in the *active* period, the distribution of the number of publications in the three domains from 2000 to 2013 is shown in Figure 5. 'Science technology' shows a strong increase in publication numbers from 2004, with 'science technology' maintaining higher overall publication rates for computer game literature in respect to the other two domains. The strong interest increase in 'social sciences' didn't happen until 2007. A marginal increase in interest with 'arts humanities' was evident from 2009. During the active period, 'science technology' has 454, 'social sciences' has 234 papers, and 'arts humanities' has only 36 papers published per year on average.

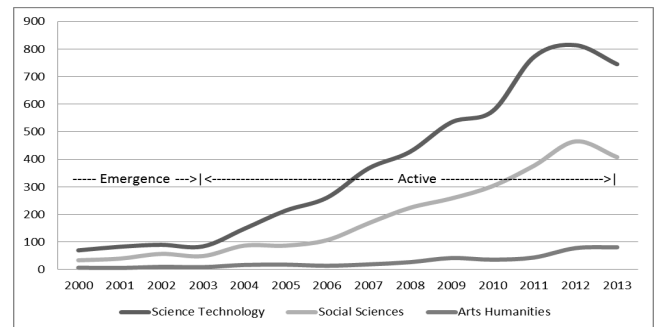


Figure 5. Number of game related publications in 'science technology', 'social sciences' and 'arts humanities' from 2000 to 2013

3.2.2 Growth in publications

To better understand the growth in the number of publications in each of the three domains, the gradient is calculated. The equation used to calculate the gradient from two points is:

$$\text{Gradient} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

where, x-axis is the year of publication, and y is the number of publications in a given year. To capture the period of most rapid

growth in computer game publications over the study period, the data set from the start year of 2003 to the end year of 2012 are selected. To provide context for the rapid growth, the data set for the preceding ten year period from the start year of 1993 to the end year of 2002 was selected. Accordingly, we extract the number of publications for each of the three domains, for the years 1993, 2002, 2003, and 2012 (Table 2).

Table 2. The number of publications in ‘science technology’, ‘social sciences’ and ‘arts humanities’ in 1993, 2002, 2003, and 2012.

Publication Year	Number of Publications		
	Science Technology	Social Sciences	Arts Humanities
1993	26	14	4
2002	90	57	10
2003	84	49	9
2012	814	465	78

The results of gradient calculation for 2003-2012 are shown in Table 3. During the period from 2003-2012 inclusive, the number of publications in ‘science technology’ increased at a rate of approximately 81 publications per year, followed by ‘social science’ at 46 publications per year. ‘Arts humanities’ shows an increase of less than eight publications per year over the same period.

Table 3. x-values, y-values, and gradient results for ‘science technology’, ‘social sciences’ and ‘arts humanities’ in 2003 and 2012.

Research Domain	2003 Point		2012 Point		2003-2012 Gradient
	x1	y1	x2	y2	
Science Technology	2003	84	2012	814	81.1
Social Sciences	2003	49	2012	465	46.2
Arts Humanities	2003	9	2012	78	7.7

To compare with gradient value of 2003-2012, the results of gradient calculation for 1993-2002 are shown in Table 4.

Table 4. x-values, y-values, and gradient results for ‘science technology’, ‘social sciences’ and ‘arts humanities’ in 1993 and 2002.

Research Domain	1993 Point		2002 Point		1993-2002 Gradient
	x1	y1	x2	y2	
Science Technology	1993	26	2002	90	7.1
Social Sciences	1993	14	2002	57	4.8
Arts Humanities	1993	4	2002	10	0.7

During the period from 1993-2002 inclusive, the number of publications in ‘science technology’ increased at a rate of approximately 7 publications per year, followed by ‘social science’ at approximately 5 publications per year. ‘Arts humanities’ shows a very slightly increase of less than one publication per year over the same period. The increase in the number of publications between 2003 and 2012 is more than 10

times that of the preceding 10 years from 1993 to 2002.

3.2.3 Topic changes

While the changes in the number of publications in these broad domains are of interest, we are also interested in analyzing changes at a finer resolution. For the three research domains, three different years were identified due to the rapid increase in the number of publications in the particular year: 2004 for ‘science technology’, 2007 for ‘social sciences’, and 2009 for ‘arts humanities’. To identify the topic changes for the three domains in these specific years, we disassembled the article titles into individual words. These words were then grouped and the frequency of use counted. The frequently used words are identified in Table 5. Grey-shaded terms are the new words used in article titles in each domain compared with the respective previous year. The frequencies of the words being used in the article titles are shown beside each term; for example, ‘learning’ was used 16 times out of the 168 ‘social sciences’ articles in 2007, and not used at all in 2006.

Table 5. New words used in article titles for ‘science technology’, ‘social sciences’ and ‘arts humanities’ in the specific year.

Science Technology 2004	Social Sciences 2007	Arts Humanities 2009
148 articles in total	168 articles in total	42 articles in total
79 Computer	73 Games	22 Computer
64 Games	73 Video	19 Games
60 Game	65 Game	15 Video
47 Video	59 Computer	12 Game
7 Children	21 Digital	6 Art
10 Electronic	12 Violent	
10 Interactive	8 Violence	
10 Learning	9 Games	
9 Virtual	6 Game-based	
8 Digital	8 Children	
7 Performance	16 Learning	
7 Design	9 Study	
7 Violence	9 Development	
7 Violent	8 Gender	
	8 Serious	
	7 Research	
	7 Effects	
	6 Educational	
	6 Aggression	
	6 Training	

Obviously, terms such as ‘computer’, ‘video’, and ‘game*’ are the most commonly used in the article titles. The term ‘violence’ entered article titles in ‘social sciences’ earlier than ‘science technology’. In 2004, when the sudden increase in the number of publications in ‘science technology’ occurred, the terms ‘electronic game’, ‘digital game’, ‘interactive game’, ‘game performance’, ‘game design’, ‘learning’, and ‘violence’ were introduced into article titles. In 2007, when the most substantial

increase in the number of publications in ‘social sciences’ occurred, the terms ‘serious games’, ‘games’ for ‘learning’, ‘games’ for ‘training’, ‘games’ for ‘education’, and ‘game development’ appeared. In 2009, when the increase in the number of publications in ‘arts humanities’ occurred, not only was overall interest in ‘games’ evident, but also ‘art’ was introduced to article titles. It warrants mentioning that ‘learning’ has become a popular research topic for both ‘science technology’ and ‘social sciences’ during the *active* period.

3.2.4 Relationship to industry

The noted increases and changes in academic game publishing appear to correspond to observed pattern changes within the video game industry. Specifically, in their analysis of the dynamics of inter-firm game industry networks, Balland, De Vaan and Boschma [19] identify six life cycle generations between 1972 and 2007. These generations align to the standard chronological classification of game consoles within the games industry. Comparing the average number of games produced in each generation with the *hibernation*, *emergence*, and *active* game publication periods reveals a very similar pattern for the period from 1972 to 2004 (Figure 5). This result suggests that technological changes in game platforms may be a driver of change in the pattern of game related academic publication.

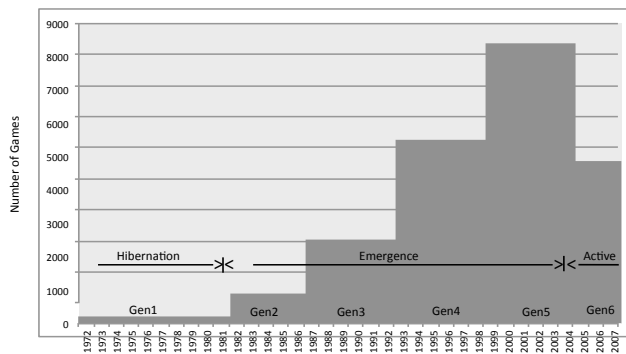


Figure 5. Average number of games per generation, and associated academic publication periods between 1972 to 2007

A tailing off in growth in the number of games occurs between 2005 and 2007, and the number of academic publications decreases in 2013, which is the final year of data. We attribute these decreases to a lag in data collection and thus are considered artificial artifacts.

4. DISCUSSION

A systematic review approach was adopted for this research to understand changes in publication quantity and research areas for game related academic publications over time. A total of 7842 distinct publications were identified and grouped into three research domains: ‘science technology,’ ‘social sciences,’ and ‘arts humanities’. The broad domain of ‘science technology’ has received the highest level of research interest among the three research domains overall.

Since the first game-related research published in 1957, computer game related research has undergone three distinct growth periods: the *hibernation* period from 1957 to 1980, the *emergence* period from 1981 to 2003, and the *active* period from 2004 to 2013. In terms of the number of publications, the development in the *active* period, the years between 2003 and 2012, is more than 10 times that of the preceding 10 years.

Comparing these growth periods to the number of games released during each of the six generations related to console development reveals an interesting correspondence. This is suggestive of a relationship between console development and the number of academic publications. Given the new wave of touchless and virtual reality interfaces entering the game industry, it is reasonable to suggest that a new period of game related academic publication will emerge. However, more detailed analysis on the focus of the actual publications is needed to confirm this relationship.

There are also potential limitations associated with the methods employed in this study. The literature collected for this research is limited to that which is indexed in the WoS and Scopus bibliographic databases. There are potentially academic articles published that are not in journals or conferences indexed in these databases and are therefore not included in this analysis. Also, search terms are limited to ‘digital gam*’, ‘computer gam*’, ‘electronic gam*’, ‘video gam*’, and ‘serious gam*’. It is conceivable that relevant game related publications exist that do not contain words that match these search terms within their titles and have therefore not been included in this analysis. Despite these limitations, the large number of publications included is considered to provide a representative sample for analysis.

From bibliometrics perspective, there is an opportunity for future work to extend the analysis to consider author collaborations and the country of the origin. This further analysis will help us understand the spatial-temporal patterns of game related publication. This information is useful for determining academic game research “hotspots” and growth areas.

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