A VISUALIZATION ANALYSIS ON THE RESEARCH FRONTS AND KNOWLEDGE BASE OF EDUCATIONAL GAMES

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Abstract

A visualization analysis is carried out by means of CiteSpace II on the documents of educational games in SCI, SSCI, and A&HCI between 2003 and 2013. Important journals, authors, institutions, countries, key words, and key papers are identified. The research fronts and knowledge base of this field are discovered. It reveals that this field is still at its initial stage. It needs to absorb knowledge from education science, psychology, behaviour science, as well as cognitive science, *etc.* At the same time, it needs to do deep and extensive theoretical and applied research so as to form its own unique knowledge system gradually. It also demonstrates that one should guarantee the quality of input data and verify pivotal points while using CiteSpace II.

Key Words

Educational games, research fronts, knowledge base, knowledge map, CiteSpace II

1. Introduction

Educational game is considered one of the main educational media in future and will have a significant impact on education and learning styles. However, there is still a lack of superior educational games. It is necessary to step back and have a more systematic and in-depth scanning on educational games, for this may help us have a better understanding on educational games and develop outstanding products. For this purpose, this paper utilizes CiteSpace II, an information visualization analysis tool, to analyse the research literatures on educational games in SCI, SSCI, and A&HCI. The knowledge mapping on educational games is drawn, and the research fronts and knowledge base of this field are identified. Hopefully, both researchers and practical workers in the field of educational games will benefit from this work.

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2. Methods

2.1 Using Co-citation Network to Reveal Research Fronts and Knowledge Base

For the development of any disciplines, it is crucial to make clear the knowledge base, and to identify and track the research fronts, and bibliometrics provides wonderful methods to do this. There are citation and cited relationship among scientific literatures. The more literatures refer to each other, the stronger the degree of connectivity among them. Citation analysis is a kind of bibliometric analysis method that takes the reference relationship among literatures as the analysing object and the degree of connectivity among literatures as the measuring unit. The two or more papers that cite the same paper simultaneously are called coupled papers. If two or more papers are cited by one or more papers later published, then there is a co-cited or co-citation relationship among these two or more papers. The network established upon this relationship is called co-citation network. Apply the concept of co-citation on other aspects of literature, other types of co-citation relationship will be formed, such as journals co-citation, authors co-citation, subjects co-citation, *etc.* So the complicated citation relationship among literatures can be revealed from different angles [1].

Price is the first scholar who proposed the concept of "research fronts." In his opinion, the research fronts of some field are embodied by the papers that cited by scientists actively. The famous Swedish literature metrologist, Persson (1994), has done a special study on the problem of research fronts and knowledge base. He pointed out that from the point of bibliometrics, citations form the research fronts and cited literatures form the knowledge base [2]. Applying the method of citation analysis to build the co-citation network of some field, analyse this co-citation network, one can discover the knowledge base and research fronts of this field.

2.2 The Visualization Analysis Tool CiteSpace II

CiteSpace II is a Java application program used to analyse and visualize co-citation networks, developed by

Dr. Chaomei Chen, and it is mainly used to analyse new trends in knowledge fields. It conceptualizes research domain as a mapping function between research fronts and knowledge base and has successfully realized three great functions of identifying research fronts, tagging research domain and identifying new trends and mutation. In CiteSpace II, the research fronts are ascertained according to the burst words extracted from titles, abstracts, descriptors, and identifiers of literature records. Descriptors are words or phrases used for indexing the subjects of literatures. Dr. Chen applied this tool in two instances, the research fronts identified was confirmed by domain experts and the analysis result was also validated by studying the content of a large number of literatures [3]. Since then it has been applied widely. These applications have achieved satisfying results and demonstrated that CiteSpace II has become a relatively mature analysis tool. CiteSpace II is open to global users for free. Version 2.2.R11 [4] is used in this paper.

2.3 Sources of Data

Educational games involve multiple disciplines, and its research literatures distribute in wide range. So this study takes the three subsets of database *Web of Science*, SCI, SSCI, and A&HCI as data sources. Time range is for all years, and the retrieval date is on November 29, 2013. Take "educational game*" as search term and retrieve it in "subject" field, getting 483, 671, and 51 items in SCI, SSCI, and A&HCI, respectively. Some data are not related to the topic, such as game theory. By reading the title and abstract of each paper, unrelated data are eliminated. The effective data on computer educational games in three citation databases are 242, 291, and 8 items, respectively. Set the download mode as "complete records and contains references cited," download and save data in files named as "download*.txt." Put all three files in the same folder.

3. Results Analysis

3.1 Key Authors

In CiteSpace II, select "Cited-Author" for "network node," "title/abstract/descriptor/identifiers" for "Term Source," choose "pathfinder" as the path search algorithm, set data extraction object as top 30, select the default threshold value, and choose "Burst Terms" for "Term Type." Because the preceding database retrieval results show that the earliest literature was published in 2003, so set "Time Scaling" for "2003–2013," set time partition as "1" year for each partition. Run CiteSpace II and get the author analysis map, as shown in Fig. 1. Key authors can be listed according to data in Fig. 1, as shown in Table 1.

In Fig. 1, each node stands for an author. The size of the node represents the times that this author has been cited. The larger the node, the more the author has been cited. The connection line between two nodes represents the reference relationship between the corresponding two authors. The thickness of the connection line represents the times cited between the two nodes. The thicker the line, the more cited times there are. Centrality is an index for measuring the status and role of nodes in a co-citation network. Higher centrality means greater influence in the network.

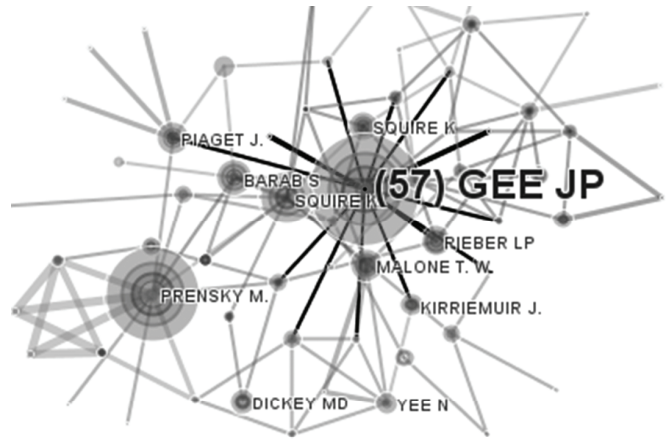

Figure 1. This is the author co-citation network map of educational game research.

Table 1
Key Authors in Educational Game Research

No.	Citation Frequency	Centrality	Authors (Year of Publication)
1	57	0.06	Gee JP (2003)
2	49	0.06	Prensky M (2005)
3	31	0.06	Squire K (2003)
4	19	0.01	Rieber LP (1996)
5	19	0.03	Barab S (2005)
6	18	0.01	Squire K (2001)
7	18	0.03	Piaget J (1965)
8	17	0.02	Malone TW (1981)
9	16	0.00	Dickeny MD (2003)
10	15	0.00	Kirriemuir J (2004)
11	15	0.00	Yee N (2006)

One can find from Table 1 that the work with the highest citation frequency is published by Gee in 2003, the second is Prensky's (2005), and the third is Squire's (2003). Although the citation frequency of these three works is different, the centrality is the same, 0.06. This means that they are all key authors in this field. The citation frequency of the work of Dickeny, Kirriemuir, and Yee are 15 or more times, but the centrality is 0. This shows that their influence in the network map is not big. There is no author with a centrality bigger than 0.1.

It should be pointed out that in CiteSpace II, sorting is based on the citation frequency of each work. If one author has published several papers on a same topic, and

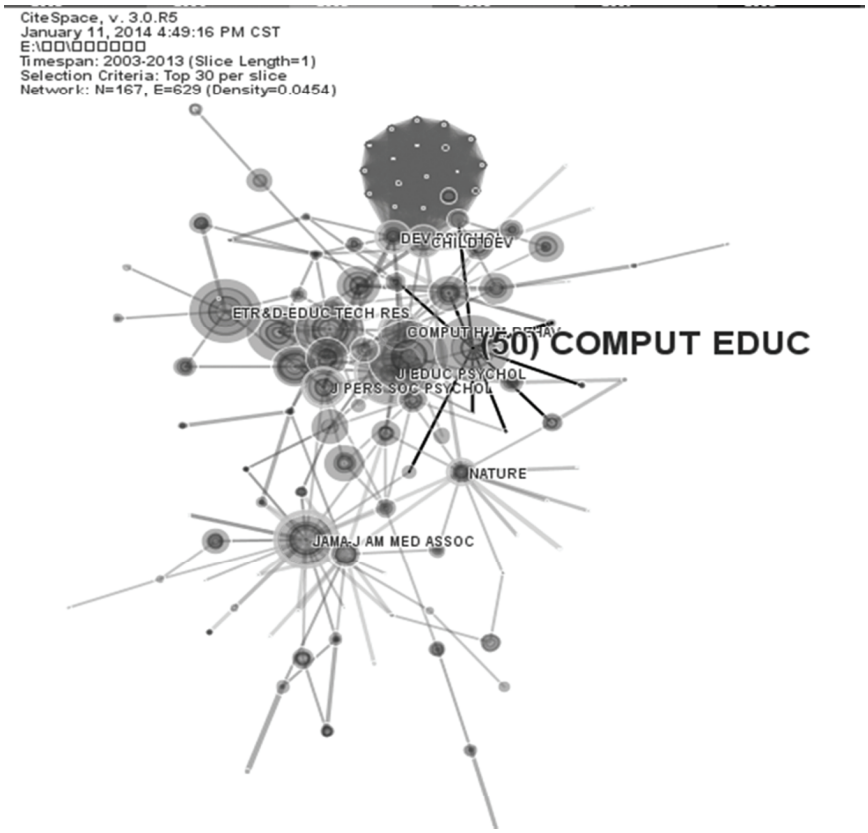

Figure 2. This is the journal co-citation network map of educational game research.

all are indexed by SCI, SSCI, and A&HCI, then each paper will be listed separately. In Table 1, for example, Squire appears two times. Actually they are the same author.

3.2 Important Journals

Select "Cited Journal" for "network node," keep the other parameters unchanged, run CiteSpace II, a journal co-citation network map appears, as shown in Fig. 2. Based on the data of Fig. 2, list all journals with a centrality no less than 0.1, as shown in Table 2.

In the co-citation networks of CiteSpace II, the outer ring of the nodes with a centrality of 0.1 or more is marked purple. These are crucial nodes connecting different clusters and have an important position in co-citation networks [3]. There are eight such nodes in this journal co-citation network, and the corresponding eight journals have important influence in this network. In this journal co-citation network, there are seven journals of which the citation frequency of single paper has reached 30 or more, with *Computers and Education* as the most highly cited. These are also important journals in the field of educational games.

From the figure and table, one can also find that papers on educational games are widely distributed in terms of discipline ranges. They are published in journals in special field of game design such as *Game-based Learning*, *Simulation Games*, as well as in journals of learning science, education, psychology, behaviour science, medicine, computer science, *etc.* Some papers are published in comprehensive journals such as *Nature* and *Science*. The centrality of *Nature* is 0.18. Although the centrality of *Science* is as low as 0, the citation frequency of single paper is as high as 20.This means that, to do research on educational games, it is necessary to have cooperation among multiple disciplines, and it is very difficult to produce significant progress. It also suggests

Table 2
Important Journals in Educational Game Research

No.	Centrality	Journals
1	0.27	*The Journal of the American Medical Association*
2	0.18	*Nature*
3	0.16	*Developmental Psychology*
4	0.15	*Journal of Personality and Social Psychology*
5	0.12	*Child Development*
6	0.11	*Computers in Human Behaviour*
7	0.10	*Journal of Educational Psychology*
8	0.10	*British Medical Journal*

Table 3
The Top 10 Countries and Regions in Education Game Research

No.	Citation Frequency	Countries and Regions
1	162	United States
2	39	England
3	24	Canada
4	19	Taiwan
5	16	Australia
6	15	Germany
7	15	Spain
8	13	Italy
9	12	The Netherlands
10	12	Brazil

that once a significant breakthrough takes place, it will bring great changes to the learning style of human being.

3.3 Countries, Regions, and Organizations

Keep the other parameters unchanged, choose "Country" for "network node", run CiteSpace II, and a national and regional co-citation network map comes out. Sorting the results by citation frequency, one can get the top 10 countries and regions in educational game research, as shown in Table 3.

It is easy to find from the table that the research on educational games is mainly in developed countries in Europe and North America, with the United States as the leader. Taiwan of Asia is listed as the fourth, and Brazil of South America is ranked the tenth. Observing the map, one can see that the nodes are utterly scattered. There are very few mutual references, and no network takes form. This indicates that research interests in this field are extremely dispersed, and the research focus is not formed. In addition, except the centrality of the Netherlands is 0.01, the centrality of all other countries and regions is 0. This manifests that the influential research centre of this field has not formed.

Select "Institution" for "network node," keep the other parameters unchanged, and run CiteSpace II, one can get an institutions co-citation network map. From the map, one can find that the institutions rarely refer to each other. From the corresponding data, one can see that the highest citation frequency is only 7, and the centrality of all institutions is 0. It further indicates that at present peoples' research interests in this field are quite dispersed, and there is no influential research centre. This suggests that this area is still at its initial stage.

Table 4
Hot Keywords of Educational Game Research

No.	Centrality	Keywords
1	0.37	Children
2	0.30	Adolescents
3	0.28	Computer games
4	0.28	Knowledge
5	0.21	Games
6	0.21	Educational games
7	0.14	Environments
8	0.13	Education
9	0.13	Video games
10	0.11	Game
11	0.10	Simulation

3.4 Research Hotspots of Educational Games

In quantitative analysis of key words, key words with high frequency are often used to identify the hotspot issues in the field of study. In CiteSpace II, select "Keyword" for "network node," keep the other parameters unchanged, run CiteSpace II, a hotspot co-citation network map composed of keywords appears. Array the results by centrality and citation frequency of keywords in descending order, list the keywords with a centrality of 0.1 or more, one can get the 11 hot keywords, as shown in Table 4.

In this table, the most highly cited keyword is education, with a citation frequency of 46. The second is games, with a citation frequency of 32. They are also two basic keywords of educational game research. The centrality of "interactive learning environment" is 0.08, and this is also a very important keyword.

Analysing these keywords, one can find that the research hotspots of educational games are on four aspects, *i.e.*, teenagers, games, game-based learning environment, and simulation. Actually, surveying the literatures in this field, one can also discover that the main research objects of educational games are children and adolescents, and the research content are focusing on the influence on their learning of educational games after carrying knowledge.

3.5 Time Series Analysis

Select "Cited Reference" for "network node," and keep the default threshold value, choose the "timezone" view, run CiteSpace II, get the time series map of educational game research, as shown in Fig. 3.

Fig. 3 clearly shows the evolution path of educational game research, which can be roughly divided into three stages. The stage between the late 1980s and early 1990s is the gestation period. The situated cognition theory, flow theory, and intrinsic motivation theory have laid a

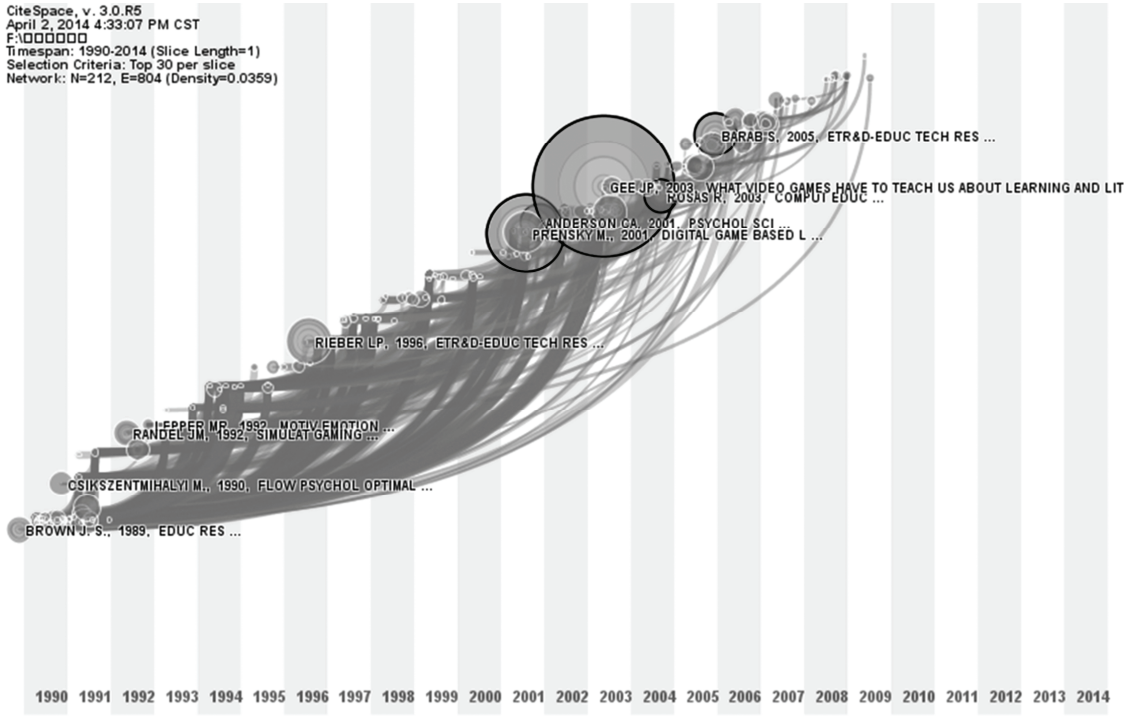

Figure 3. This is the time series map of educational game research.

theoretical basis for the development of educational games. There are several representative works in this period, but the citation frequency is no more than 10, with the highest centrality of 0.05. Among them, Brown (1989) thinks that knowledge is a product of activities, environment, and culture. The learning of knowledge must be set in a particular situation [5]. The work of Kubey and Csikszentmihalyi (1990) is used to explain how games produce flow experience [6].

Randel (1992) analysed 67 empirical studies on educational games and concluded that satisfying game-based learning outcome will produce only when learning content and the goal is very clear and specific [7]. Lepper (1992) summarized a series of teaching cases and found that educational activities that can stimulate intrinsic motivation and interests would produce better effects [8]. The middle and later periods of 1990s is a stage of germination when scholars began to explore how to combine the advantages of playing and computers to design interactive learning environment. Rieber's (1996) paper is prominent with a citation frequency of 16 and centrality of 0.05. This paper studied the problem from the perspective of education, psychology, and anthropology. It regards playing as a powerful intermediary for learning in a person's life, suggesting to build interactive learning environment according to constructivism and to integrate elements of game and simulation [9]. The period since 2001 is the stage of initial development, where several pivotal documents have appeared, namely the nodes with purple out ring, of which the centrality is no less than 0.1. People have realized the significance of educational games and began to discuss how to design wonderful educational games. Now let us scrutinize these pivotal documents.

3.6 Analysis on Pivotal Documents

In co-citation network map, the node documents with big centrality are often considered key documents that plays the role of "pivotal point" in the development of domain knowledge [7, 10]. In CiteSpace II, select "cited reference" for "network node," keep the other parameters unchanged, run CiteSpace II, get the document co-citation map of educational game research. Sort the results by descending order, list the documents of which the centrality is no less than 0.1, these are the five pivotal documents in the field of educational game, as shown in Table 5.

Prensky published *Digital game-based learning* in 2001, the first book systematically studying educational games, and it became a classic. Prensky thinks that game designers have formed unique professional knowledge in terms of how to attract players, and they have successfully realized the integration of learning content with game motivation. He proposes to educate digital native with digital games, and by examples, he proves that this method is fruitful [11].

Barab's (2005) paper introduces the design concept, design method, and application effects of the educational game *Quest Atlantis*. This game has realized the combination of entertainment, education, and social responsibility. It also successfully combined business game strategy with research results of learning and motivation. The game has been constantly adjusted according to feedback. At the same time, the problem- and situation-based learning style are adopted to stimulate students to apply the knowledge learned in game in real life [12]. This paper is unique in terms of design ideas, methods, and applications of educational games, and has important reference value.

Table 5
Key Documents of Educational Game Research

No.	Centrality	Author	Journal or Press	Title
1	0.17	Prensky (2001)	Paragon House Publishers	Digital game based learning
2	0.16	Barab (2005))	*Educational Technology Research and Development*	Making learning fun: Quest Atlantis, a game without guns
3	0.15	Anderson (2001)	*Psychological Science*	Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect physiological arousal, and pro-social behavior: A meta-analytic review of the scientific literature
4	0.12	Rosasa (2003)	*Computers & Education*	Beyond Nintendo: Design and assessment of educational video games for first and second grade students
5	0.10	Gee (2003	Palgrave Macmillan	What video games have to teach us about learning and literacy

In the third paper, Anderson and Bushman (2001) used meta-analysis method to analyse research literatures on video games. They found that violent video games increase the violent behaviour of adolescents, increase physiological arousal and aggressive thoughts and emotions, and reduce altruism [13]. This paper has no direct link with the topic of educational games. When the term "education games" appears in the paper, it is talking about a question, *i.e.*, although there are some educational games, sports games, and other non-violent games, there are large numbers of violent games on the market and large numbers of games in consumption are also violent games. Then why this paper is so outstanding in terms of citation frequency and centrality? One possible reason is that in studying educational games, or the educational functions of games, people need to analyse why games are so popular and how can games attract players, *etc.*, so they refer to this important paper. If one wants to ascertain the motives and reasons of every citation, it is necessary to do detailed analysis on all the documents citing this paper.

In the fourth paper, Rosasa (2003) reported a 3-month educational game test carried out in elementary schools of an undeveloped area in Chile. In this test, educational video games are introduced in the first and second grade classes for learning conventional contents, *i.e.*, reading comprehension, spelling, and basic knowledge of math. There are 1,274 pupils from five schools taking part in the test, and the game-based learning was carried out only in one school. Students are divided into three groups, namely, the experimental group, the internal control group, and the external control group. In the experimental group, 758 pupils of 19 classes do game-based learning in conventional classroom learning time. In the internal control group, 347 pupils of 9 classes in the same school learn in conventional classrooms, namely teachers teach and pupils listen and practice. They do not play games. As for the external control group, 169 pupils from other 4 schools do conventional classroom learning without participating in the game-based learning. Results show that the academic records of pupils from the school of game-based learning, whether of the experimental group or of the internal control group, are significantly better than that of the external control group pupils, who are all from the schools without taking part in game-based learning. The difference between the experimental group and the internal control group is not obvious in terms of academic records. This suggests that though educational games cannot obviously improve learning effects, they at least can achieve the same effect as conventional classroom teaching. Test also shows that educational games can significantly improve pupils' learning consciousness, enthusiasm, and initiative [14]. This is a typical educational game research.

Like Prensky, Gee also published a book on educational games in 2003. He studies players' cognitive development in the process of gaming and find that the learning principles discovered by cognitive science are fully reflected in games. Motivation is the most important factor to drive learning, and games blend motivation with itself quite well. Both Prensky and Gee, experts in education, recognized the conflict between the current education and the reality environment, and realized the great potential of educational games. Due to the role and impact of these two books, in 2003, ACM (Association for Computing Machinery) published two papers in *ACM Computers in*

Entertainment in the September/October issue, introducing the main ideas and content of the books. These two papers have the same titles as the two books. Both their books and papers are the first works in the field of educational games research, and they are all pivotal documents [15, 16].

4. Discussion

According to Persson's opinion and the working principle of CiteSpace II, citations form the research front and cited documents form the knowledge base. With the above analysis results as basis, now let us discuss the research fronts and knowledge base of educational games.

4.1 A Preliminary Judgment on the Research Fronts and Knowledge Base of Educational Games

The research fronts of a subject are embodied by their hotspot keywords. In the field of educational game research, there are 11 keywords with a centrality no less than 0.1, and they can be summarized as teenagers, games, game-based learning environment, and simulation. Among them, game-based learning environment is a unique keyword of the field of educational games and the other three are common keywords in the field of games or education. This suggests that the research on educational games is not in-depth enough, and it is necessary to do a large number of special research to accumulate rich material, so as to gradually form its own knowledge system. While doing the author co-citation analysis, it is found that there is no author with a centrality no less than 0.1. This also suggests that the study in this area is not mature yet, there is still a long way to go.

Then, how about the knowledge base of educational games?

In doing pivotal document analysis, it is found that there are only five documents of which the centrality is no less than 0.1. Among these, Anderson's paper studied violent games and the aggressive behaviour caused by them, and it cannot be count as a pivotal document of educational game research. The works of Prensky and Gee triggered a boom on educational game research. Although the ideas and methods of Barab's and Rosasa's studies undoubtedly have important significance, they belong to individual cases. Obviously, in the research of educational games, the law of universal significance, and easy to spread and master, has not been found yet, and its knowledge base has not been formed.

In the analysis of journal co-citation network, it is found that the papers on educational game study are widely distributed in journals of many disciplines, such as game-based learning, learning science, education science, psychology, behaviour science, medicine, cognitive science, *etc*. There are eight journals of which the centrality is no less than 0.1, but most of them are in medicine, psychology, and behaviour science. Journals of games and education have not become high impact journals in the field of educational game research. This also shows that educational game research is absorbing knowledge from medicine, psychology, cognitive science, and other disciplines, and it has not formed its own unique knowledge system.

In addition, the retrieved data indicated that the literature on the theme of educational games have not appeared until 2003. This also shows that educational game is a new field of study, and there is still a long time to go to make significant progress.

4.2 Validation from other Perspectives

In strict accordance with the method of CiteSpace II, it is found there are only four pivotal documents in the field of educational game research. This is because there is only 10 years of history in the study of educational game, so considerable critical documents have not been produced. Therefore, it is necessary to use other methods to identify some important documents. In doing journal co-citation analysis, it is found that there are two authority comprehensive journals, *Nature* and *Science*. Now let us examine what problems are studied in the papers published in these two journals. Take an advanced retrieval in SCI database. Fill the term "educational game*" in the field of "subject," and "Nature" in the field of "journal title," do search, and two papers are retrieved. One paper is written by Green and Bavelier (2003). Through a series of brain and cognitive science experiments, it proves that video action games are able to improve the speed and accuracy of visual response and expand the scope of the vision [17]. Another one is a communication passage published by Pellegrini (2010). It differentiates the meaning and applicable occasions of play and game [18]. In the above retrieval, fill in the field "journal title" with "Science," then do search, and four papers are found. Only two of them are relevant. One is published by Greenfield (2009). The informal learning environment such as TV, video games, and the Internet brings learners with the development of visual spatial skills, so the author suggests that traditional education should make use of the formal education means such as reading, audio media to remedy the weakness of informal education in high-end intelligence such as abstract vocabulary, concentration, reflection, inductive problem solving, critical thinking, and imagination [19]. The other one is published by Mayo (2009). By analysis, he found that games are highly interactive media and possess a number of key properties as mature teaching methods do. Good games always effectively embed teaching activities into game design. He thinks that games have great potential for education, and they can be used to spread education of science and mathematics to millions of people. To this end, several key problems need to be solved, *i.e.*, to build the infrastructure to increase the number of users, to improve the quality of products, and to establish a business model of sustainable development. In his opinion, at present, game-based learning is still in the embryonic stage [20]. *Nature* and *Science* are famous for publishing great scientific breakthrough. In 10 years, there is only one research paper, Green and Bavelier's (2003), published in the two journals; this also suggests that the research of

educational games has not acquired a breakthrough. From this paper, one can see that brain and cognitive sciences is not only the knowledge base of educational game research, the research in this field also forms the research fronts of educational games. Mayo's judgment about the stage of educational game research is in line with our conclusion.

The horizon report published by the New Media Consortium of USA in 2011 verifies the conclusion of this paper from another angle. This report declares that since Gee's description of games' impact on cognitive development in 2003, game-based learning has caused considerable concern. The educational value and potential of games are beyond suspicion, but it is not easy to design good educational games. Although the study of educational game is becoming more extensive and deep, good educational games are still scarce, and this also hinders the acceptance of educational games by users. Massive online games are very suitable for large-scale education, but the expenditure for research and development is huge, and professional game developers have not invested on it [21].

5. Conclusion

By means of CiteSpace II, a co-citation visualization analysis has been made on the documents of educational game research in citation databases SCI, SSCI, and A&HCI between 2003 and 2013. It reveals the important authors, core journals, the main countries and institutions, research hotspots, and pivotal documents. On this basis, the research fronts and knowledge base of educational games have been analysed. It is discovered that the research of educational games is still at its early stage of development. On the one hand, it needs to absorb knowledge from other disciplines such as education science, psychology, behaviour science, cognitive science, and games, *etc*. On the other hand, it is necessary to do more broad and in-depth theoretical and applied research. To make a breakthrough, collaborative research among multiple disciplines is in demand. Undoubtedly, these conclusions are of important reference value for those peers engaging in the research of educational games, as it can help both new and mature researchers get a whole picture and some important details of the field quickly. This study also demonstrates that CiteSpace II is a mature analysis tool, as it can help researchers dig up valuable information from huge amounts of data quickly and efficiently. To make the information meaningful, it is essential to analyse the information and make connections among different information, as demonstrated in this typical study.

The study also found that when using CiteSpace II to do visualization analysis, one needs to pay attention to the following issues.

First, use the retrieval strategy carefully to ensure the relevance of documents.

When applying the term "educational game*" in the field of "subject" and searching in SCI database, only 120 items are retrieved. Delete the double quotation marks (search term = educational game*) and search the database again, 483 items are retrieved. Then what search term should be used? After investigation, it is found that the subject terms (descriptors) in SCI, SSCI, and A&HCI are not extracted by manpower. When users try to retrieve in the field of "subject," actually the system will search in the field of titles, abstracts, and keywords. In other words, if there is an "educational" or "game" in title, abstract, or keywords in a document, it will be retrieved [22]. In this way, many irrelevant items will be retrieved, and this is the limitations of these citation databases. Therefore, one should choose proper search items and search style to get all relevant documents, so as to have a good dataset for information analysis.

Second, do data cleaning before visualization analysis.

As mentioned above, this study screened data by reading title and abstract one by one, finally more than 50% items are removed. The basis of analysis is data. If the original data are not accurate, one may get inaccurate and even wrong conclusions. To avoid the phenomena of "garbage in, garbage out," one should carefully clean up data before visualization analysis, excluding irrelevant data and erroneous data.

Third, it is essential to verify pivotal documents.

In his paper, Dr. Chen clearly points out that the role of pivotal documents can be verified by consulting experts in the field or by surveying relevant documents. In this study, the method of analysing pivotal documents combining with surveying relevant important documents is adopted to verify the research results, so as to make the conclusions more dependable. Simply making judgement according to analysis, results of the tool may result in absurd conclusions. Quite a lot of papers simplified the study process as three steps, *i.e.*, retrieving data, visualization analysis, and make conclusion. It usually leads to incredible conclusions. Therefore, in this kind of study, one must carefully screen and scrutinize important documents to validate pivotal points.

Due to limited time, the investigation to the important documents and visualization analysis results is not sufficient. Further efforts will be made in this aspect.

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