Evolution and Development of Virtual Learning Communities based on a Visual Analysis

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Abstract: With the development of technology, communities are not restricted to the conception of geographical entities, virtual learning communities have gotten a lot of attention in the past decades. In this research, the evolution and development of virtual learning communities are interpreted by means of Citespace, a software which can extract keywords from articles indexed from specified database and draw visual graphs. Through the visual operations including co-citation and co-occurrence cluster as well as timezone evolution illustration, there are three important domains emerged which consists of knowledge sharing, learning experience optimization and online environment constructed by technology and the paper aimed to explaining high-frequency phrases and central articles to analyze virtual learning communities' development process. It indicates that technology serves for education and the deep integration of technology and education improves learning experience efficiently.

1 INTRODUCTION

The coming of information era brings extremely new chance to reform traditional modes of instruction, and with the presentation of new words like MOOC, online virtual communities based on network technology rise rapidly, especially virtual communities of shopping-online which have developed wearable technology and mature community rules inside. However when it comes to virtual learning communities in educational field, there are several definitions emphasizing different features. For example, in view of social relationship, virtual learning community is like a huge network that provides environment for users and acquire, produce, analyze and construct their dialogues and behaviors while it can also stress the research of how human behave in communities from the point of interaction. Besides, virtual learning community can be described as a place where members share ideas, experience and resources to reconstruct collective knowledge and promote outcomes by means of all kinds of platforms and applications.

In general, virtual learning community is a technology-mediated online group which focuses on affiliation and learning improving. Differ from traditional class virtual learning community does not adopt communication face to face but shares knowledge in distance and through this way, it weakens the role of teacher and encourages members to participate in interaction among human, online environment and resources. Therefore it's used to be treated as informal learning supplementing traditional class but gradually occupies the forefront education through the way of integrated a part of blending learning recently. This paper aims to analyze and illuminate the evolution and development of virtual learning communities in a visual and quantized way.

2 DATA PROCESSING

2.1 Visual Tool: Citespace

The visual software in the research is named Citespace(Citation Space), programmed by an

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academic team led by professor Chaomei Chen, and the first vision is compiled in Java in 2004. The origin idea of Citespace is to draw visual graphs and assist to analyze the potential knowledge contained in scientific analysis comprehensively while after constantly amendment, its core function can achieve the visualization of a special keyword based on articles written in different stages through co-citation analysis, co-occurrence analysis, timezone evolution analysis and so on. The working principle of Citespace is the basis of a certain field consists of the co-citation primary data and the advanced knowledge is reflected by articles which quote the co-citation data in some degree, therefore the evolution process of the specific field is composed of research basis/past, development, hot topics and latest state. It's CiteSpaceV(5.0.R2 SE) Version to process origin data combined with qualitative and quantitative analysis to handle the text content in this paper.

2.2 Data Source

Statistics in the research is derived from Web of Science ™ Core Collection Database, "Science Citation Index Expanded (SCI-EXPANDED)" and "Social Sciences Citation Index (SSCI) search" specifically. Data type is set as "article" only, the time span is chosen from 2000 to 2016, and the deadline is 2nd December, 2016. Search "virtual learning community" as keyword in text box and 516 related articles are resulted shown in Figure 1 as follow. In the figure, the number of papers varies in different years and generally the tendency is upward which means more and more researchers have paid their attention to virtual learning communities since 21st century.

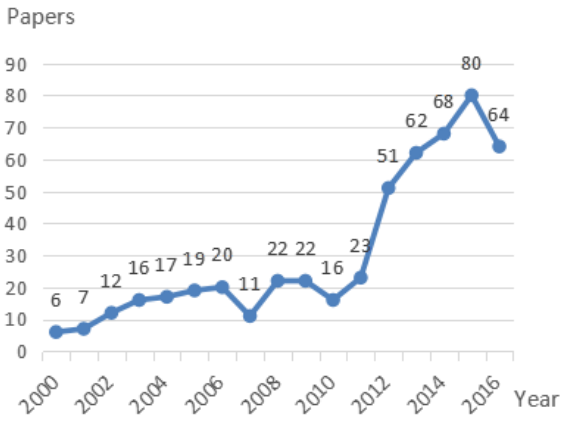

Figure 1: Number of papers varies in different years.

2.3 Parameter Setting

First of all, all papers need to be filtrated in case of repetition, which shows no repetition and cut 516articles into sections in chronological order. Then import all papers into CiteSpaceV and create a new project of this research. Time span of the interface is set from 2000 to 2016 and one year a slice, keeping accordance with data source. Next choose "Title", "Abstract", "Author Keywords(DE)", "Keywords Plus(ID)" in Term Source TabControl, "Cited Reference" of Node Types and adjust parameter "C", "CC", "CCV" as (2,2,20), (3,3,20), (5,3,20) to demonstrate the best visual graph. Finally run the software to draw the visible graph of 516 related articles like Figure 2, in which sharpness and size of words have significant meanings explained in section 3.1.1.

Figure 2: Co-citation knowledge graph.

3 VISUALIZED ANALYSIS

In this section, an elaborate description is required for diverse visual graphs, such as cluster graph, timezone view and detailed tables. Three subsections including co-citation analysis, co-occurrence analysis and timezone evolution analysis are introduced to support the evolution and development of virtual learning communities in different stages associated with technology.

3.1 Co-citation Analysis

Co-citation analysis confirms that co-citation network appears if two articles or two authors are quoted by one certain paper and there is always something in common among quoted articles in conception, theory and method, which is shown in the relationship among nodes of the visual knowledge graph. Besides, the basis of one field is approximately equal to the aggregate of co-citation

articles and the frequency of quoted articles reflect the importance of the article in the co-citation network.

3.1.1 Co-citation Knowledge Graph

In Figure 2, different sharpness and size of words have varied meanings. The deeper the color is and the larger the size is, the more significantly the keywords influence in the co-citation knowledge graph. It finds out that the three most important articles focus on topics about learning exchange, knowledge sharing as well as identity affiliation of members in communities. Some of the points are not totally same to virtual learning communities we talk about in this paper but can be regarded as the origin of how virtual learning communities work in early time. Taken WENGER E's paper as an example, which is indeed a book concerning learning and communication in community entities, WENGER E expounds the process of learning and identity affiliation and trusts negotiation makes participation come true. He thinks it's not absolutely same to require members' behaviors in community entities but must formulate definite rules to regulate conversation and behaviors suitably and legally. As for learning, he's favor on the opinion that the ability of valuable knowledge sharing and acquirement is much more important than know-all individually alone and the learning exchange can assist to predict members' performance. WENGER E's study emphasizes the importance of meaningful knowledge construction and identity affiliation, which provides reference for subsequent research.

3.1.2 Co-citation Clusters

Cluster analysis gathers high homogeneity articles and circles as well as lines in different colors means different clusters in Figure 3. Two parameters demonstrating the cluster result is valid are Modularity Q=0.7616 and Silhouette=0.6. There are 10 cluster labels in the co-citation cluster graph and the serial number starts from No.0, in which the smaller the serial number means more articles. For instance, 0# cluster is marked "computer based training" and it possesses the largest number of articles, 22. Check the clusters' content and it finds out that most articles in early time are based on survey in community entities and social communities where learning usually generates in experience exchange process. With the coming of 21st information technological revolution, Internet and computer technologies prosper and bring motivation into communities' development. Integrated in communities, a large quantities of online platforms appears and the prosperity of constructivism theory which advocates learners oriented sparing no efforts requires technologies to offer better learning experience ulteriorly. Combining with pedagogy theory and psychology theory, more and more technologies are applied as supplement of traditional class in virtual learning communities.

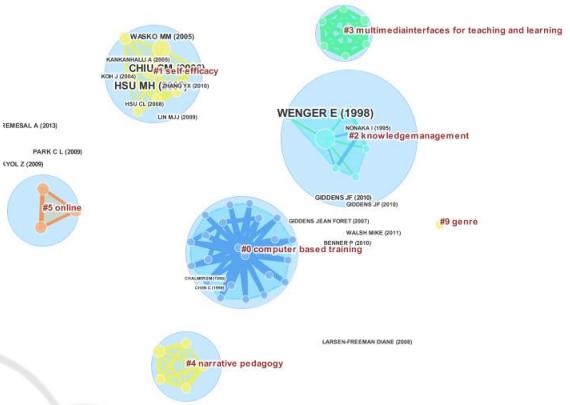

Figure 3: Co-citation cluster graph.

After co-citation analysis, we can conclude that elements of community entities such as knowledge sharing and identity affiliation are similar to them of virtual learning communities and studies on community entities contribute to research about virtual learning communities. With the development of computer technologies, community entities are "carried" on the Internet and expedite online communities which break the restriction of time and region and make experience exchange and communication more conveniently. Later on, online communities directed to learning arise such as forums and discussion board in informal learning. It's obvious that technology applied to education improve the learning efficiency and convenience, and technology construct online communities and then transform communication as well as traditional teaching networked in early times.

3.2 Co-occurrence Analysis

Co-occurrence analysis is a method quantifying common information of selected articles from all kinds of information carrier. It's to extract keywords in common characteristics to visualize and get generalities by mean of Citespace in scientific studies.

3.2.1 Co-occurrence Keywords

Adjust parameter, select keywords frequency is above 15 and separate co-occurrence keywords into two parts: interaction relied on technologies and knowledge sharing.

- Technologies realize interactive environment

Figure 4 shows the change of keyword "virtual community " and the trend is upward especially after 2012. The sharp up is related to the flourish of MOOC (Massive Open Online Courses) and the integration of cloud technology and instruction, which drives the blending of mobile learning, electronic learning and traditional teaching. Interaction can be divided into two types: man-machine interaction and person to person interaction, and the former provides basic functions like data recording, data mining and data analyzing to make better interaction while the later derives company agent to filtrate companies with same interests or goals for learners and recommends the most suitable companies as much as possible, taken the inner world such as self-efficacy and personality characteristics of learners into consideration.

In addition, learner-oriented requires technological majorization for better learning experience. On the one hand, Three-dimensional (3D) technology brings virtual simulation into not only entertainment but the construction of education which encourages learners to interact and collaborate in communities. On the other hand, a new form of game named Serious Game with exquisite environment grows and is admired by educational professors recently, which is treated as attraction for learners to insist on learning and working efficiently. For example, Second Life uses virtual character that user builds to experience different life in online virtual community. Furthermore, the construction of simulation environment is appreciate for educational experiments such as chemical experiments in danger and physical experiments under ideal conditions.

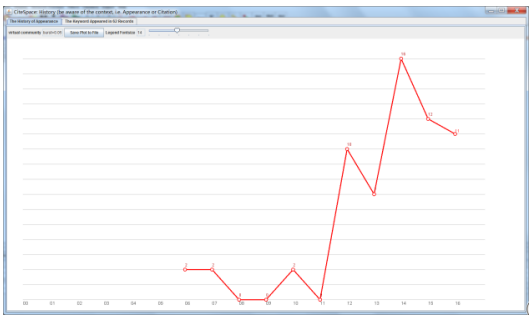

Figure 4: History of "virtual community ".

- Conditions motivate knowledge sharing

Articles in co-occurrence graph focus on factors influencing knowledge sharing and measures of creating conditions to motivate knowledge sharing, which explicate why and how to promote the awareness of knowledge sharing and participative behaviors. According to the consequence of co-occurrence keywords selected by Citespace and related references, factors are separated into internal motivation and external influencing factors.

Internal motivation consists of emotional commitment (including trust, self-efficacy, attitude, etc.) and individual's emotional response to technology which means whether learner is adaptive for technology or not. Furthermore, external influencing factors cover the ease of access to information, social relationship, reward mechanism, open technical environment that guarantee accessibility of platforms and effective community rules. All above play positive role on knowledge sharing and we can take measures involved improving emotional commitment, enhancing self-efficacy and satisfaction of learners for virtual learning communities, widening channels of informational access and social networking by means of technologies, implementing democratic community rules, and establishing effective reward mechanism to meet the needs of learners and ensure persistent participation furthest in virtual learning communities.

3.2.2 Co-occurrence Clusters

Two parameters Modularity Q=0.6452 and Silhouette=0.6727 indicate the high reliability of co-occurrence clusters. There are 13 clusters classified by size of article number and Table1 as follow shows the ten largest clusters of the cluster graph produced by LLR algorithm. From the Mean(Year), most co-occurrence clusters appear after 2010 which represents studies on virtual learning communities make significant progress after 2010 and we analyze the cluster content through clicking the node to check the detailed citing articles and the analysis result of these important articles attached to different cluster labels.

Of all clusters, 0# cluster owns the largest number of articles, and the label reveals it's associated to the distributed learning environment where social media embeds online communities and expands the range of interdisciplinary communication. Other clusters pay attention to

Table 1: Labels of clusters.

Cluster ID	Size	Silhouette	Mean (Year)	Label(LLR)
0	29	0.63	2010	perspective; role; distributed learning environment;
1	23	0.808	2014	learning environment; online learning; self efficacy;
2	22	0.76	2011	simulator; technology; wiki;
3	20	0.763	2011	knowledge sharing; online community; trust;
4	16	0.872	2014	drug discovery; descriptor; virtual screening;
5	15	0.795	2012	technology acceptance; communities of practice; twitter;
6	15	0.756	2014	children; randomized controlled trial; nursing student;
7	12	0.78	2013	virtual environment; script; community pharmacy;
8	12	0.78	2013	sense; virtual world; curriculum;
9	11	0.8	2012	impact; climate change; student;

identity affiliation and the virtual simulation of online platforms. For example, “self efficacy” of 1# cluster, “trust” of 3# cluster and “technology acceptance” of 5# cluster put their points on how to enhance learners’ identity affiliation(including trust, self-efficacy, attitude, etc.) and improve learning experience by technology application. However, words like “simulator” and ”virtual” in 2#, 4# and 7# cluster demonstrate the virtual simulation makes learners immerse in learning. On the one hand, the simulation lab guarantees real and safe experience for learners which keeps dangerous situations like hazardous chemicals explosion away. On the other hand, ideal conditions such as zero friction and vacuum state that can hardly happen in reality could be constructed well in physics simulation experiments and then makes learners feel appreciable through operation in person. Moreover, some clusters with small size concentrate on the role of leader that greatly determines the development direction of a certain virtual learning community through resource management, experience transmission and rule execution, which insures the virtual communities efficiently and orderly.

On the whole, co-occurrence keywords consistent with co-occurrence clusters identify the influence of technological interaction and knowledge sharing, and the former involves relationship among learners and human-to-environment and how to create conditions to improve interactive experience like 3D serious games and virtual simulation while the latter analyzes the factors including internal motivation and external influencing factors affect sharing sense. Little by little, with the degree of hybrid of education and technologies deepened, simple experience exchange and platform construction are transited to high-level learning skills and deep interaction.

3.3 Timezone Evolution Interpretation

The view of timezone evolution of virtual learning communities in Figure 5 is made up of lines and circles in different colors. The deeper the rose color is, the more important the labels of nodes are and the denser the lines are, the more important the labels of nodes are. In Citespace, center analysis in which centrality is regarded as important reference of evaluating nodes’ position in knowledge map network is to analyze the circles with rose color outside the circle rim. According to Figure 5, nodes with high-centrality include “virtual environment”, “design”, “self efficacy”, “social presence”, “social media”, “knowledge sharing” and so on. Three keywords are clear as follow to interpret the contextual research hotspots of virtual learning communities in the view of timezone evolution.

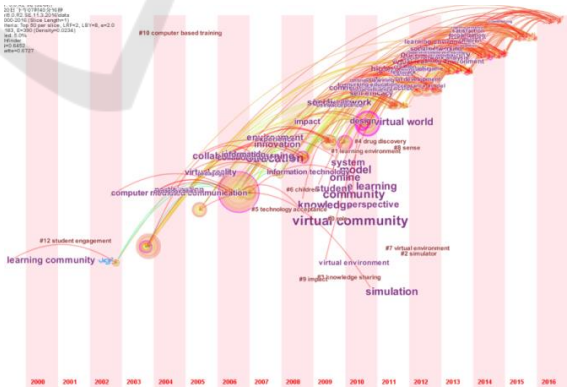

Figure 5: View of timezone evolution.

3.3.1 Knowledge Co-construction Beyond Knowledge Sharing

There’s no doubt that Knowledge sharing is the internal impetus for the development of virtual learning communities where learners of totally

different backgrounds join, gather and communicate for same or similar interests and purposes. It's obvious that knowledge sharing is the important basis for virtual learning communities whether the experience exchange in early time or communication and knowledge co-construction beyond knowledge sharing afterwards, therefore the key to ensure effective participation and shape the communities is to offer what members need indeed in the mechanism of knowledge sharing. To get the goal, on the one hand, internal motivation and external influencing factors are analyzed to create conditions to inspire members especially learners with abundant valuable learning resources to share on their own initiative and improve their willing to share knowledge even co-construct knowledge beyond sharing which means learners need to create new knowledge based on the integration with original experience; on the other hand, the result of knowledge co-construction must be positive and bidirectional. Positive result is to build rules to forbid plagiarize or other intellectual property infringement, and the ideal positive knowledge sharing is to promote meaningful knowledge co-construction beyond knowledge sharing which needs to consolidate existing knowledge and motivate knowledge co-construction on the basis of experience exchange and communication instead of remember or download resources from others. Bidirectional knowledge co-construction is supposed to make knowledge and resources flow adequately to generate dynamic communication network in which learners of virtual learning communities are available for requisite information and the knowledge co-construction expands the knowledge repository for communities to attract more and more learners and strengthen communities in return.

3.3.2 Friendly Social Relationship

Friendly social relationship guarantees good performance of learners and there are some people elder and some new in virtual learning communities. The elder usually hold the post of leaders who shape community culture, guide the new to fit the communities and resolve contradictions and the responsibility drives leaders to make and execute rules, collect and share resources, warm the communication atmosphere, provide members with identity affiliation and so on.

Differ from traditional class, the identity affiliation of members in virtual learning communities reflects from online behaviors such as comments and discussions in forums rather than talk face-to-face in classroom. Generally, the identity affiliation represents members' subjective feelings like self-efficacy and trust. Members with diverse prior experiences grow the sense of belonging through communication with the elder after joining the communities and reduce independent actions gradually. To celebrate the process, the elder introduce rules and members to new member and help he/she feel the collective honor, good leader convinces new members and the warm atmosphere in virtual learning communities prompts members to construct trust in shorter time. Trust among members will intensify all identity affiliation, enhance the willing of participating activities and knowledge co-construction and then push the virtual learning communities to a higher stage.

3.3.3 Technology Optimizes Learning Experience

As an essential element of virtual learning communities, technology provides members with convenient learning platforms and channels to gather and communicate synchronously or asynchronously, and achieve members' participation break the limitation of time and space. In other words, multiform virtual learning communities is based on the technological construction and technology makes the upload, download and sharing of resources as well as evaluation of learning performances measurable, in which process technology deepens the friendship and social collaboration. Frankly speaking, technology restricts the development of virtual learning communities to some extent, for instance, it shuts the door against people who can not afford the network or use technologies, but investment from the government finance has focused on educational equality and closed the gap step by step. Besides, how to optimize learning experience and make communication convenient with the easiest technological operations have become research hotspots of virtual learning communities recently and studies on artificial intelligence applied in education are underway. With the development of technology, deep integration of technology and education will contribute on learner-oriented learning experience and improving learning outcomes, and some new multiform virtual learning communities such as mobile learning communities and 3D virtual learning communities rise to consummate the research framework of virtual learning communities in ubiquitous learning environment.

4 DISCUSSION

The purpose of this paper is to visualize the evolution and development of virtual learning communities by means of Citespace while selected articles are limited in Web of Science ™ Core Collection Database, "Science Citation Index Expanded (SCI-EXPANDED)" and "Social Sciences Citation Index (SSCI) search" specifically and keywords Citespace extracted are from titles, abstracts and keywords of articles instead of the whole papers, which might makes the visual consequence unclear in some degree. Although we have read and checked the typical articles in detail, it's inevitable that some cases are ignored for that 516 related papers in this research can not be read completely in person. In addition, taken account of the limitation, the research analyzes the evolution and development of virtual learning communities on the macro level but not microscopically. Obviously, there are still much work to do with the analysis of the benefits of instructional technology applied for better learning and optimized learning experience in communities.

5 CONCLUSIONS

In conclusion, the paper combines pedagogy theory and technology application to illustrate the evolution and development of virtual learning communities based on visual graphs drawn by Citespace. From the co-citation analysis, technology constructs the online platforms and provide channels like Q&A communities and forums to make learning efficient and convenient in early times. After carrying community entities on the Internet, more and more interactions are requested through technological update and virtual environments are applied in communities to optimize the learning experience as well as learning interests. Quantities of studies focus on learners' subjective feelings and present that it's essential to create internal and external conditions to motivate knowledge sharing and improve learning performances. Afterwards, the view of timezone evolution interprets the contextual research hotspots of virtual learning communities from three angles which are knowledge co-construction beyond knowledge sharing, friendly social relationship and optimized learning experience by technology. However, the visual analysis also finds that cooperation among researchers and institutions is insufficient and the network in Figure 6 shows the independent research with low contact and joint.

Figure 6: Graph of co-operating institutions.

It must be realized that professional research teams are essential and cooperation researches promoting the evolution and development of virtual learning communities are feasible. Therefore, cooperation astride countries and research institutions and sharing the research achievements under the background of technology integrated education will devote to pushing virtual learning communities to develop higher level and make technology serve education authentically in further research.

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