A Scope Review of Computer-supported Collaborative Argumentation in the Past Decade

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In the context of the knowledge economy era, solving complex scientific and social problems usually requires citizens to possess critical, collaborative and logical reasoning skills. The acquisition of argumentation skills helps citizens to critically evaluate information and participate in social activities. The use of collaborative arguments significantly improves conceptual knowledge and provides reliable rebuttals to arguments. The outbreak of the new crown epidemic has challenged traditional learning methods and set off a boom in online education. Guided by advanced digital learning innovations, computer-supported argumentative collaborative learning (CSCL) has come to dominate a variety of instructional settings that support students' participation in authentic argumentative activities. This study is mainly based on the Web of science- SSCI core database, and reviewed the related journal papers on computer-supported argumentative collaborative learning research from 2012 to 2021. Using the Vosviewer data analysis tool, bibliometric and statistical analysis methods were used to screen out the selected The 36 relevant papers were analyzed in nine aspects: publication volume, journals and regions, author partnerships, number of citations, keyword co-occurrence, research methods, participants, subject areas, and technologies or platforms that support argumentative collaborative learning , which aims to expand the international vision of research related to argumentative collaborative learning supported by computers in China, and lay a foundation for future educational practice and theoretical research.

Keywords: Argumentative learning; Collaborative learning; Computer supported collaborative learning (CSCL); Computer supported collaborative argumentation; Scope review

Introduction

The potential benefits of computer-supported argumentative collaborative learning have been recognized early on by researchers, with scholars agreeing that engaging in various forms of argumentative activities helps to gain debate knowledge and domain-specific knowledge that can be applied to complex and poorly defined problem solved. For example, computer-supported argumentative collaborative learning promotes higher-order thinking and problem solving, which can lead to deeper understanding of the topic and improved quality of learning outcomes. Noroozi et al. (2012) published the article"Argument-Based Computer-Supported Collaborative Learning (ABCSCL): A 15-Year Research Review", the main review analyzes the fifteen-year period of argument-based computer-supported collaborative learning in 1995-2011 Influencing factors and constituent factors in the main review and analysis of the influencing factors and constituent factors of argument-based computer-supported collaborative learning in the fifteen years from 1995 to 2011, pointing out that argument-based computer-supported collaborative learning should be carried out in a systematic way. Design, and take into account various specific learning conditions, to pay attention to the nature of the student's learning process. However, the review by Noroozi et al. did not provide a review and analysis of the subject areas, participants, and supporting platforms of computer-supported argumentative collaborative learning research. This paper is mainly based on the review by Noroozi and Weinberger et al. The development of this field is analyzed.

1 Argument

Argument is not only not a new word, but has a long history. Argument can be traced back to three classical disciplines in ancient Greece: logic, argumentation, and rhetoric. Throughout the ages, many scholars have given different definitions to argumentation: Aristotle believed that argumentation is a bridge to reason, and the core issue of argumentation theory research is the goodness of argumentation as an argument evaluation criterion; Advocates of argumentation see argumentation as a way for learners to explore dialogue spaces together, with learning partners coming together to present reasons and evidence from different perspectives, building a shared understanding of the problem, rather than persuading or changing one's own and each other's attitudes (Baker 2009); Argument refers to the process or language form of using a certain reason to support or refute a point of view. An important function is to critically reflect on one's own reasoning (Hoffmann 2016).

Argument was first used at the legal level. Stephen Edston Toulmin is famous for his theory of argumentation logic derived from law, which opened up a new field different from formal logic. It is not only empirical, but also necessarily historical. Logic is only a standard for the approval of theory. A better argumentation method brought about by progress in any field is not only logical, but also a substantive and content progress in that field. Toulmin's model of argumentation (TAP) in his argumentation monograph "The Use of Arguments" includes six factors: (1) Claim, that is, the argument, conclusion, Opinions, etc. (2) Data, the data, facts, and evidence used to support the "claim"; (3) Warrant, which explains how to get the "claim" from the "ground", that is, the "claim" The relationship between the argument and the "base" provides a "guarantee" for the process; (4) Qualifier, which limits the scope and strength of the argument to ensure that the claim/conclusion

is valid; (5) Rebuttal , refute from the basis, justification and support, doubt its correctness and legitimacy, and raise objections, re-verify the correctness of the claim from the reason to the claim; (6) Support (Backing), for the legitimate reason Provide further supporting statements to demonstrate the objectivity of principles, laws. The formulation of this model provides a solid theoretical foundation for subsequent argumentation research and problem solving (Edward et al. 2018). Although TAP is used as argumentation The analytical tool has received various criticisms (Voss and Van Dyke 2001), but it is still an effective method for constructing arguments or designing argument scaffolding. Lin, Chiu, Hsu, and Wang (2015) point out that TAP provides A complete structure for constructing high-quality arguments by linking the various components with complete accuracy to the problem in question is flexible and field-invariant and thus can be applied to different domains (eg. Law, Science, Politics, etc.) (Aleixandre et al. 2000; Lin et al. 2015).

2 Argumentative collaborative learning

Collaborative learning is a learning mode that organizes students to learn in groups or teams, so as to promote students' understanding and mastery of knowledge. In collaborative learning, teachers create situations and ask questions, and members demonstrate the questions through interactive means such as arguing, discussing countermeasures, and information exchange for a common learning goal. Collaborative learning has proven valuable in improving students' domain knowledge and higher-level skills, such as critical thinking and argumentation (Weinberger and Fischer 2006). At the group level, productive debate processes can help learners resolve conflicts effectively (Baker 2003; Andriessen 2006; Belland, Glazewski and Richardson 2008). Research results over the past few decades have shown that collaborative learning with others may greatly benefit the acquisition of emotional, motivational, and social knowledge.

Zheng Xiaoli and Jin Huizhu et al. (2014) considered that deep interaction is an important mediating variable affecting the effect of collaborative learning, and believed that argumentation is one of the effective ways to promote deep communication among learners. Argumentation can not only guide students to deeply understand the topic of inquiry learning And content, but also help to improve students' expression ability. Argumentative learning introduces "argument" as a learning method into the classroom. Under the guidance of teachers, students express their own opinions and clarify their positions according to the learning theme. Teachers divide learners into positive and negative groups according to different viewpoints. When there is a disagreement, both parties (or multiple parties) carry out demonstration activities through dialogues, discussions, debates, etc. to establish the connection between views and evidence, to determine objective answers to questions, and to construct knowledge independently to develop students' thinking. Argumentative collaborative learning belongs to a specific type of collaborative learning mode. The collaborative argumentation process takes the analysis and solution of problems as the core goal. It is of great significance to understand and cultivate students' scientific literacy (Aleixandre and Erduran 2017).

3 Argumentative collaborative learning supported by computer

Early collaborative learning was first regarded as a "black box", and the influence of various factors on the effect of collaborative learning was investigated by designing teaching experiments (Zhang Zhenhong et al.

2010). With the continuous popularization of computers, some scholars have found that the research on the analysis and demonstration process in collaborative learning is the key to opening the "black box" of computer-supported collaborative learning research. Computer-supported collaborative learning refers to a learning model in which multiple learners interact and cooperate with each other on the same learning content by using computer networks and multimedia and other related technologies to achieve a deeper understanding of the learning content and acquire corresponding knowledge. Scholars agree that computer-mediated forms of communication offer several advantages to the collaborative learning process, facilitating productive peer dialogue in educational settings (Kim and Anderson et al. 2007), in computer-supported collaborative learning environments of students are more reflective (Guiller, Durndell, and Ross 2008), interact more equitably and democratically (Asterhan and Eisenmann 2009; Herring 2001), and communicate more clearly (Kim, 2007; Newman et al. 1995). Argumentative learning, as an important teaching technique, is integrated into a collaborative learning environment supported by computers. By constructing debate learning in the learning process, it promotes in-depth discussion, which is beneficial to help learners gain deeper understanding and form fruitful arguments. , making argumentation activities more effective (Andriessen, Baker and Suthers 2013). Computer-supported argumentative collaborative learning allows the construction of critical discourse and argumentative processes through a variety of methods, with advantages and benefits in helping learners to construct knowledge, gain comprehensive understanding, cognitive development, and solve complex problems (Jeong and Lee 2008). A recent meta-analysis showed that collaborative learning has a positive impact on knowledge acquisition, student perception, and skill development in digital learning environments (Chen et al. 2018).

In recent years, researchers' research on collaborative learning has gradually shifted from whether it can promote learning to studying the relevant conditions for promoting learning, and which situational model of collaborative learning is particularly effective. It is advocated to carry out collaborative activities focusing on deep learning based on a variety of learning theories providing a variety of interactive ways to meet the individual needs of different learners. Researchers have developed various platforms to support computer-supported argumentative collaborative learning, for example: Hayama et al. (2013) developed a system for face-to-face collaborative argumentative learning using knowledge to improve the quality of collaborative learning debates ; Paraskeva et al. (2016) discussed argumentative learning in a virtual environment and its process in combination with the Toulmin argumentation model, and created a new type of online argumentative learning with reference to the six parameters in the Toulmin model framework to support the argument. The most commonly used platforms among real teaching researchers are LASAD, online discussion boards, Google platform, Moodle learning management platform and Facebook series of applications, etc. Critical thinking skills and logical reasoning skills.

Guided by advanced digital learning innovations, computer-supported argumentative collaborative learning (CSCL) is gradually gaining prominence in a variety of instructional settings that support student engagement in authentic proof-of-fact activities (Fatimah et al. 2020). The purpose of this review is to systematically review and organize the research literature on computer-supported argumentative collaborative learning from 2012 to

2021 based on the Web of Science-SSCI core database, using literature analysis, qualitative and quantitative hybrid methods to enhance the research. Comprehensiveness and reliability, using the VOSviewer software to draw a knowledge map, the publication volume of 36 articles by year, journals and regions, authors, document citations, keyword co-occurrence, research methods, participants, subject areas, and online support platforms In order to better understand the development and trend of computer-supported argumentative collaborative learning in the past ten years, it will broaden the research horizon and lay a theoretical foundation for follow-up research. Based on the above objectives, this study attempts to investigate the following research questions:

(1) From 2012 to 2021, what is the distribution of the number of papers published on computer-supported argumentative collaborative learning?

(2) From 2012 to 2021, what are the main publications on computer-supported argumentative collaborative learning? Where are most located?

(3) From 2012 to 2021, what is the relationship between authors in computer-supported argumentative collaborative learning research?

(4) From 2012 to 2021, what is the citation number of the literature on computer-supported argumentative collaborative learning studied in this paper?

(5) From 2012 to 2021, what are the key aspects of research on argumentative collaborative learning supported by computers?

(6) From 2012 to 2021, what research methods will be used in research on computer-supported argumentative collaborative learning?

(7) From 2012 to 2021, who will be selected as participants in the computer-supported argumentative collaborative learning study?

(8) From 2012 to 2021, what are the applied subject areas of computer-supported argumentative collaborative learning research?

(9) From 2012 to 2021, what are the online argumentation collaboration platforms in computer-supported argumentative collaborative learning research?

Method

Inclusion criteria

This research uses the Web of Science—SSCI core database as the data retrieval source, which integrates a large-scale citation index database of multidisciplinary professional journals such as natural sciences and social sciences, which can ensure that the documents are highly academic , authoritative, reliable and high-quality. influence . This paper examines and reviews relevant journal papers on computer-supported argumentative collaborative learning from 2012 to 2021, for the four overlapping concepts of computer-supported argumentative collaborative learning, namely argumentative learning, collaborative learning, computer-supported collaborative learning Learning and computer-supported argumentative collaborative learning uses a systematic multi-keyword search strategy. In order to ensure the accuracy and comprehensiveness of the data sources, this study uses the "Advanced Search" function in the "Literature Search". In the first step, synonyms or related terms are identified using an online thesaurus dictionary ; in the second step , the subject-related terms are combined with Boolean operators (and/or) and four overlapping

conceptual areas to " all journals " For the retrieval object, the retrieval time is December 31 , 2021, with "A rgumentation L earning ", " Collaboration L earning ", " Computer Supported Collaborative Learning ", " CSCL ", " Computer Supported Collaborative Arguing " as the search terms to carry out "subject" combination A total of 666 articles were retrieved. In the third step, in order to ensure that the retrieved literature is sufficiently relevant to the research field, the core database of Web of Science was further selected, and irrelevant literatures such as conferences, online publications, and social materials were excluded. The time was intercepted from 2012 to 2021, and a total of 426 articles were obtained. Academic journal papers, some 386 publications that did not address: (1) Computer-supported collaborative learning,such as CSCL not related to teaching, refer to other attribute names other than a learning style, environment, or just personal and computer interaction; (2) an argument, that is, an argument not in a computer-supported collaborative learning environment or an argument not related to education; (3) the research was conducted in a computer-supported collaborative learning environment; and finally, an argument for The remaining literature was read in full, and 36 literatures related to computer-supported argumentative collaborative learning were finally identified for research and analysis. Select "Full Record Cited References" and save as a tab-delimited file. This review does not include previously published literature review literature, and is not limited to empirical research. The search strategy and identification process are not limited to a single field of interest, and the most relevant literature is selected for coding analysis. The specific screening flow chart is shown in Figure 1 :
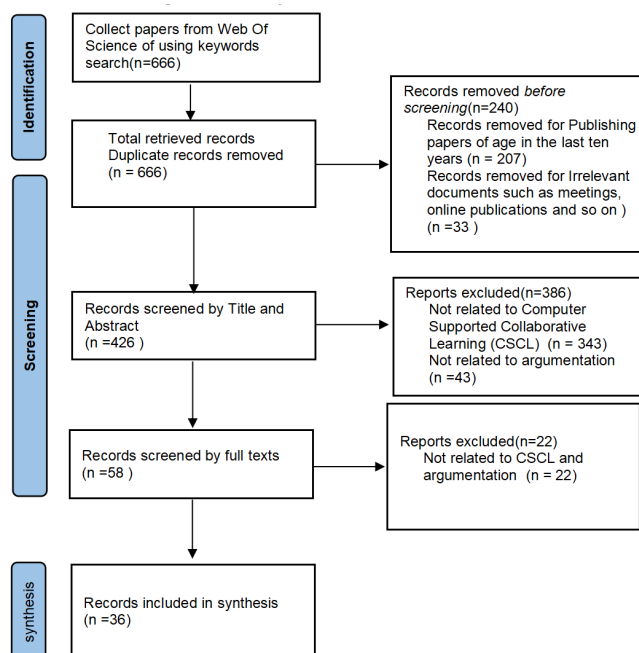

Figure 1 The flow chart of literature screening

Coding Schemes

Subject area of computer-supported argumentative collaboration indicated that there was no specific framework for analyzing and synthesizing this research. Starting from the fields of pedagogy and psychology, this study refers to the technology-based learning model proposed by Hsu et al. (2012) Participants, research

methods, subject areas, and computer-supported argumentative learning platforms are used for literature review coding. The specific coding content is described as follows:

(1) Participants: According to Hsu et al. (2012) , participants were classified as primary, middle, high, tertiary, teachers, working adults, mixed, unspecified, and no participants.

(2) Research methods: This study is based on McMillan and Schumacher 2006 using qualitative research method, quantitative research method and mixed research method as the coding scheme of this dimension.

(3) Subject areas: In this study, according to Lai 2020, the research subject areas in the literature are divided into science (physics, chemistry, biology), mathematics, arts, languages, social studies (including history), engineering (including computer courses), Health, Medicine and Sport, Business or Management, Interdisciplinary (eg. STEM), Unspecified and Mixed. A combination of two or more topics means that the article contains two or more learning topics. No topic of study means that the article only consists of a questionnaire, literature review or trend analysis.

(4) Demonstration collaboration platforms supported by computers: The support platforms in this study can be divided into social platforms (including common Facebook, Google platforms, etc. which provide online discussion platforms to meet user needs and solve social problems), professional platforms (for example: LASAD, LAD, etc. are used to promote students' knowledge construction, problem solving and analysis of students' argumentation behavior), hybrid platforms (Moddle learning management system platform, etc. provide argumentation tools for classroom teaching and improve argumentation skills) and other research based on scholars A self-developed platform is required.

Data Analysis Tools

(1) VOSviewer

A JAVA-based free software developed in 2009 by Eck and Waltman of the Science and Technology Research Center of Leiden University in the Netherlands. Drawing, showing the structure, evolution, cooperation and other relationships of knowledge fields, focusing on the visualization of scientific knowledge. There are three data analysis views, they are:

①Clustering view (Network Visualization) consists of a circle and a label to form an element, and the size of the element depends on the degree of the node, the strength of the connection, the number of citations, etc. The color of an element represents the cluster to which it belongs, with different clusters represented by different colors, and this view allows each individual cluster to be viewed. Such views can discover the structural distribution of research hotspots through topic co-occurrence, discover research groups through author collaboration, and discover similarities and differences between scholars on research topics through author coupling networks.

② The density view (Density Visualization) point on the map is filled with color according to the density of the elements around the point, and the density depends on the number of elements in the surrounding area and the importance of these elements. The Density View can be used to quickly observe important areas and the density of knowledge and research in a field.

③The label view (Overlay Visualization) presents the time map to study the development and evolution

trend. Users can assign different colors to nodes according to their own research needs, so as to better analyze the evolution of research trends in the field.

(2) Excel

Microsoft Excel is one of the components of Microsoft's office software Microsoft Office , and it is a powerful data analysis and visualization tool. Excel is not only a data storage tool, but also a simple data analysis tool. After adding the Excel data analysis plug-in, you can do some simple correlation and regression analysis. In addition, Excel is an excellent software in terms of drawing. Excel does not require users to have certain programming knowledge and matrix knowledge. There are various types of charts set up inside. The graphics are accurate, detailed, beautiful, and the operation is flexible and fast. The immediate effect can be used to draw simple graphics as well as more complex professional graphics. This paper uses Excel to carry out descriptive statistics of literature data, obtain useful information from a large amount of data, use corresponding skills and methods to carry out scientific analysis, and show the required results.

Results

This paper adopts bibliometric methods and visual analysis methods to objectively describe and evaluate the research and development status of computer-supported argumentative collaborative learning from 2012 to 2021. Bibliometrics uses statistics on the number and distribution of documents to discuss the number of publications, journals, regions, and citations. On the basis of bibliometric method, combined with visual analysis method, further qualitative analysis of author and keyword co-occurrence was carried out. The specific research results are analyzed as follows:

1 Annual analysis of the number of publications

The changing trend of published papers reflects the research progress and trend of scholars in this field. Through the statistical analysis of 36 journal papers, the year distribution histogram of the number of published papers is drawn, as shown in Figure 2. In the past ten years, due to the influence of scientific and technological fluctuations, the research and development of argumentative collaborative learning supported by computer Ups and downs. As can be seen from the figure, since 2012, the number of research papers related to argumentative collaborative learning supported by computers has been steadily increasing until it reached its peak in 2015, but since 2016, the number of papers published has decreased significantly, from 2017 to 2019 Few scholars have done research on this in recent years. With the advancement of science and technology and the impact of the new crown epidemic on offline education, the number of published papers has gradually recovered since 2020, and online education has once again received attention in the national education field. attention, showing a gradual upward trend. It can be predicted that argumentative collaborative learning supported by computer will become a hot topic in future research, attracting more and more scholars to study.
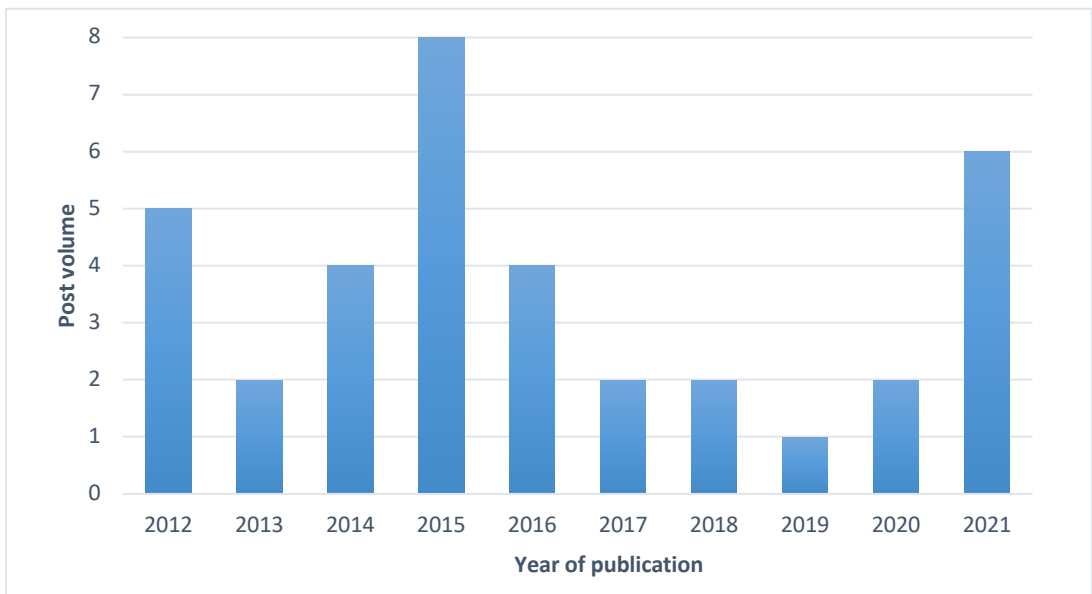
Figure 2 Annual analysis of the number of published papers

2 Publishing journals and regional analysis

Journals are the carriers of academic papers, and the source journals of the literature can locate the hot journals of the discipline and the spatial distribution of literature in a certain field. Through the processing of all publication sources, all relevant journals were identified , as shown in Figure 3 : the most productive journals accounted for 20% of the selected papers, and the top 3 were COMPUTERS EDUCATION (computer education journals), JOURNAL OF COMPUTER ASSISTED LEARNING, COMPUTERS IN HUMAN BEHAVIOR, and INTERNATIONAL JOURNAL OF COMPUTER SUPPORTED COLLABORATIVE LEARNING . As shown in Figure 4, these publications come from 10 countries , from the graph we can see that the United States is the country with the most production, leading almost the entire period, with 27.8% of the total publications, followed by Germany. Compared with the above-mentioned countries, the number of publications by Chinese scholars on computer-supported argumentative collaborative learning research is relatively small, and the research is not paid enough attention . Therefore, our country should strengthen research in this field, conform to the trend of continuous development of information technology, and attach importance to the continuous integration of technology and education.
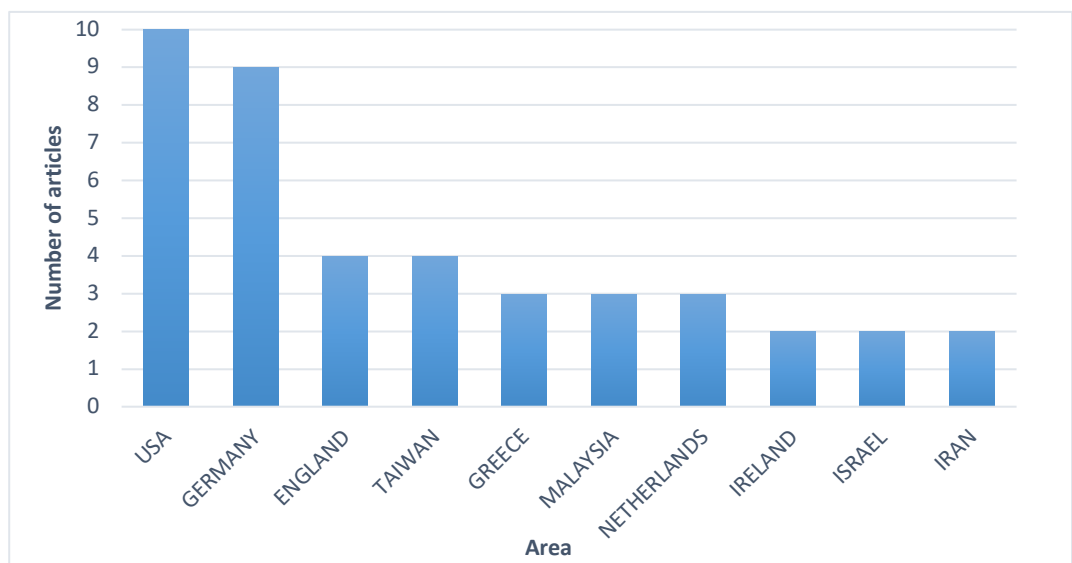
Figure 3 Statistics of published journals

Figure 4 Statistics of Posting Regions

3 Author partnership analysis

Analyzing authors can help us understand the research representatives in a certain field, help follow-up researchers to determine research trends, grasp the research process, and provide references for follow-up research. Import the documents retrieved from WOS into VOSviewer software, and perform cluster analysis on the authors, as shown in Figure 5 , in which authors with the same color belong to the same clustered cooperative network, and the lines represent the cooperative connections between authors . It shows that the stronger the association between two authors and the higher the connection strength, the greater the centrality

of the author , that is, the greater the influence in the co-occurrence cooperation relationship. Through a clear understanding of the author's cooperation network in the research field, it is possible to understand the hotspots in the annual interval. This study found that Weinberger has close cooperation with other scholars. On the whole, the distribution of the author's cooperation network is relatively uniform. Most scholars conduct their own research, and there is a lack of academic exchanges with other scholars in the same research direction. to expand the research field, that is, to involve as many aspects of the development of this field as possible, and to jointly contribute to educational research.
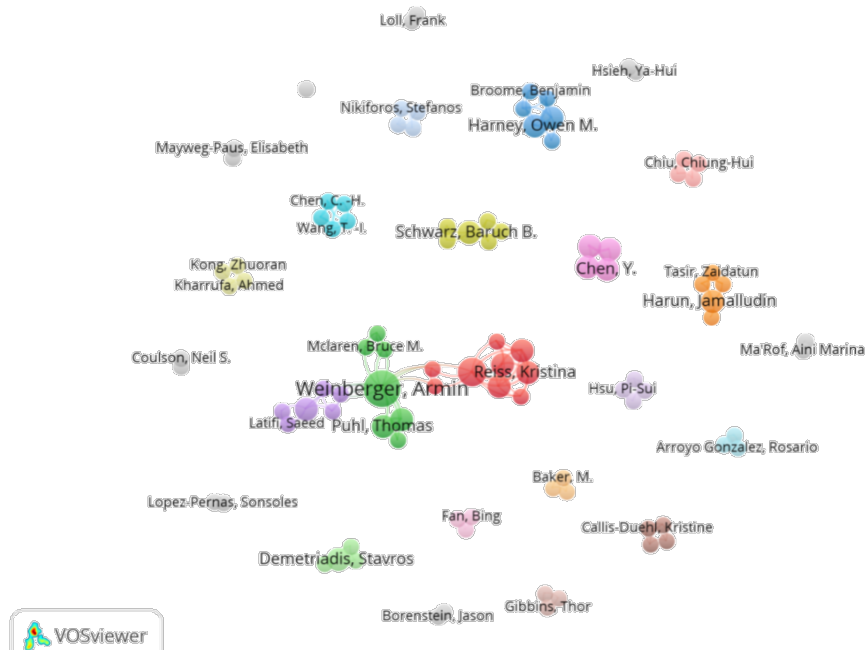

Figure 5 Author co-occurrence analysis cluster diagram

4 Analysis of the number of citations in the literature

The citation frequency of a paper is a reflection of the academic influence of a paper. Generally speaking, the more citations a paper has, the greater its academic value. Export all records from WOS in Excel format, including: author, title, publication year, number of citations, etc. As shown in Table 1 : Through the operation summary analysis of data in Excel , it is found that the paper "Promoting the construction of argumentative knowledge through transactional discussion scripts in CSCL " published in 2012 has been cited 92 times. In the interdisciplinary CSCL group, how to promote the construction of argumentative knowledge through transactional discussion script, pointed out that interactive discussion script is helpful for the construction of argumentative knowledge in discourse. Followed by "Collaborative Argumentation and Cognitive Exposition in Computer-Supported Collaborative Learning Environments", cited 78 times, this empirical study found that computer-supported collaborative scripting can promote the formal quality of arguments and the

corresponding cognitive refinement . The construction of formal arguments is positively related to in-depth cognitive elaboration and personal acquisition of argument knowledge. Through the number of citations, we can also see that these documents have great academic value, and are worthy of in-depth analysis by scholars when doing this kind of research. They are very meaningful for academic reference and lay a solid theoretical foundation for future research.

Table 1 Table of the number of citations cited in the literature

Number	Title	Cited times
1	Facilitating argumentative knowledge construction through a transactive discussion script in CSCL	92
2	Collaborative argumentation and cognitive elaboration in a computer-supported collaborative learning environment	78
3	Re-thinking scientific literacy out-of-school: Arguing science issues in a niche Facebook application	46
4	Small-group, computer-mediated argumentation in middle-school classrooms: The effects of gender and different types of online teacher guidance	37
5	Therapeutic Affordances of Online Support Group Use in Women With Endometriosis	30
6	Promoting critical, elaborative discussions through a collaboration script and argument diagrams	27
7	Exploring Students' Knowledge Construction Strategies in Computer-Supported Collaborative Learning Discussions Using Sequential Analysis	26
8	Developing argumentation skills in mathematics through computer-supported collaborative learning: the role of transactivity	23
9	Scripts, individual preparation and group awareness support in the service of learning in Facebook: How does CSCL compare to social networking sites?	23
10	Promoting academically productive talk with conversational agent interventions in collaborative learning settings	22
11	The effect of a graph-oriented computer-assisted project-based learning environment on argumentation skills	22
12	Making L2 learners' reasoning skills visible: The potential of Computer Supported Collaborative Learning Environments	19
13	The effect of moderator's facilitative strategies on online synchronous discussions	19
14	Enhancing skill in constructing scientific explanations using a structured argumentation scaffold in scientific inquiry	18

15	Understanding Ill-Structured Engineering Ethics Problems Through a Collaborative Learning and Argument Visualization Approach	18
16	LASAD: Flexible representations for computer-based collaborative argumentation	18
17	Peer-monitoring vs. micro-script fading for enhancing knowledge acquisition when learning in computer-supported argumentation environments	18
18	Integrating computer-supported collaborative learning into the classroom: the anatomy of a failure	18
19	Blending Facebook discussions into seminars for practicing argumentation	15
20	Learning to learn together with CSCL tools	11
21	Investigating the effects of peer to peer prompts on collaborative argumentation, consensus and perceived efficacy in collaborative learning	9
22	Investigating the effects of prompts on argumentation style, consensus and perceived efficacy in collaborative learning	9
23	The effects of computerized inquiry-stage-dependent argumentation assistance on elementary students' science process and argument construction skills	7
24	Implementation of Web-based argumentation in facilitating elementary school students to learn environmental issues	7
25	A cross-cultural study of the effect of a graph-oriented computer-assisted project-based learning environment on middle school students' science knowledge and argumentation skills	6
26	Peer feedback or peer feedforward? Enhancing students' argumentative peer learning processes and outcomes	5
27	The role of collaborative argumentation in future teachers' selection of online information	4
28	The influence of a web-based learning environment on low achievers' science argumentation	4
29	Argue like a scientist with technology: the effect of within-gender versus cross-gender team argumentation on science knowledge and argumentation skills among middle-level students	4
30	Virtual Learning Communities (VLCs) rethinking: From negotiation and conflict to prompting and inspiring	3
31	Modelling diffusion in computer-supported collaborative learning: a large scale learning analytics study	2
32	Missed Opportunities for Science Learning: Unacknowledged Unscientific Arguments in Asynchronous Online and Face-to-Face Discussions	2
33	Scaffolding argumentation in mathematics with CSCL scripts: Which is the optimal scripting level for university freshmen?	0

34	Learning Effect in a Multilingual Web-Based Argumentative Writing Instruction Model, Called ECM, on Metacognition, Rhetorical Moves, and Self-Efficacy for Scientific Purposes	0
35	Exploring Pre-University Students' Construction of Reasoned Argumentation during Computer - Supported Collaborative Discussions Using Sequential Analysis	0
36	Argumentative Knowledge Construction Process in Social Collaborative Learning Environment towards Students' Higher Order Thinking Skills	0

5 Analysis of key word co-occurrence frequency

Keywords reflect the research focus of the literature, and are also an important way to understand the research hotspots of argumentative collaborative learning supported by computers. The documents retrieved from the Web of Science were imported into VOSviewer, and after removing the repeated keywords, cluster analysis was performed on the keywords to obtain the keyword views in the relevant literature in this study, including cluster diagrams and density diagrams. The nodes in the clustering diagram represent keywords, the size of the nodes represents the frequency of keyword occurrence, the lines represent the frequency of co-occurrence of keywords, and different colors represent different clusters. The larger the font size of the keyword, the higher the frequency of occurrence. As shown in Figure 6 , the keywords with high frequency in the related literature of computer-supported argumentative collaborative learning research are mainly collaborative learning, collaborative argumentation, critical This shows that in recent years, scholars have been committed to using computer-supported argumentative collaborative learning methods to promote students' independent knowledge construction, and improve their argumentation and critical thinking skills .
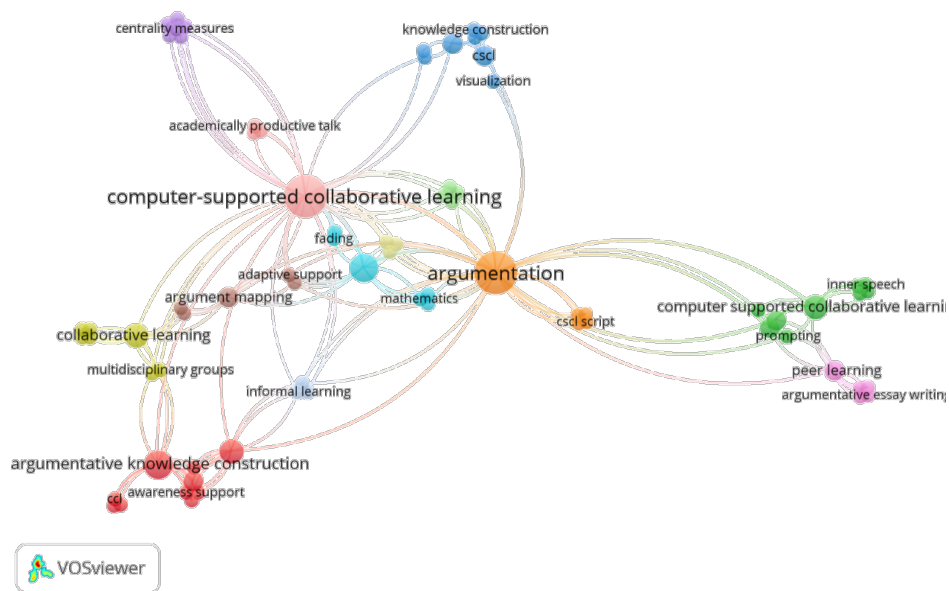

Figure 6 Keyword co-occurrence cluster analysis

6 Analysis of research methods

Generally speaking , research methods can be divided into three categories: qualitative research methods, quantitative research methods and mixed research methods. Qualitative research method is to mine the specific nature and characteristics of things or participants through literature research, data research, character interviews, etc. The final result needs to go through a series of understanding and analysis, and explain and summarize the conclusions in the form of words. A research method of testimonial research; quantitative research method is a research method in which the results are represented in the form of numbers or charts. By establishing various data models or data comparison forms, the research theory is proved from the data level; Hybrid research method, as the "third methodological movement", is an independent methodology that combines qualitative research with quantitative research. As shown in Figure 7 , the research methods employed by the computer-supported argumentative collaborative learning study between 2012 and 2021 are presented. Among them, the most commonly used research method is mixed research method (publication = 16), followed by mixed quantitative research method (publication = 11). From 2012 to 2016, the most used research method was quantitative research method (publication = 10), followed by qualitative research method (publication = 7). However, from 2017 to 2021, the mixed research method (publication = 10) was more favored by research scholars, and few researchers used quantitative research methods and qualitative research methods separately in the past five years.
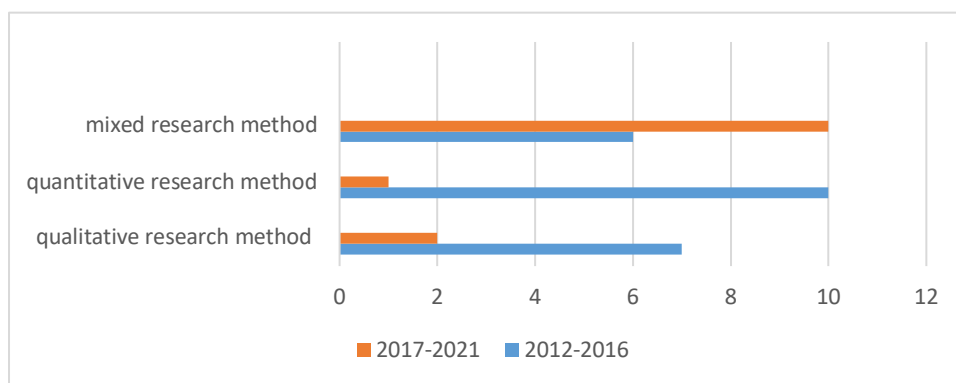

Figure 7 Analysis of research methods

7 Participant Analysis

After studying the literature related to argumentative collaborative learning with computer support (2012-2021), many scholars applied this learning method to teaching to support students' personalized learning, as shown in Figure 8, in the past ten years. During the year, study participants were primarily focused on students in higher education (Publications = 20), followed by elementary and mixed participants (Publications = 8). Few studies were conducted on middle and high school students, as well as teachers. There is little research on working
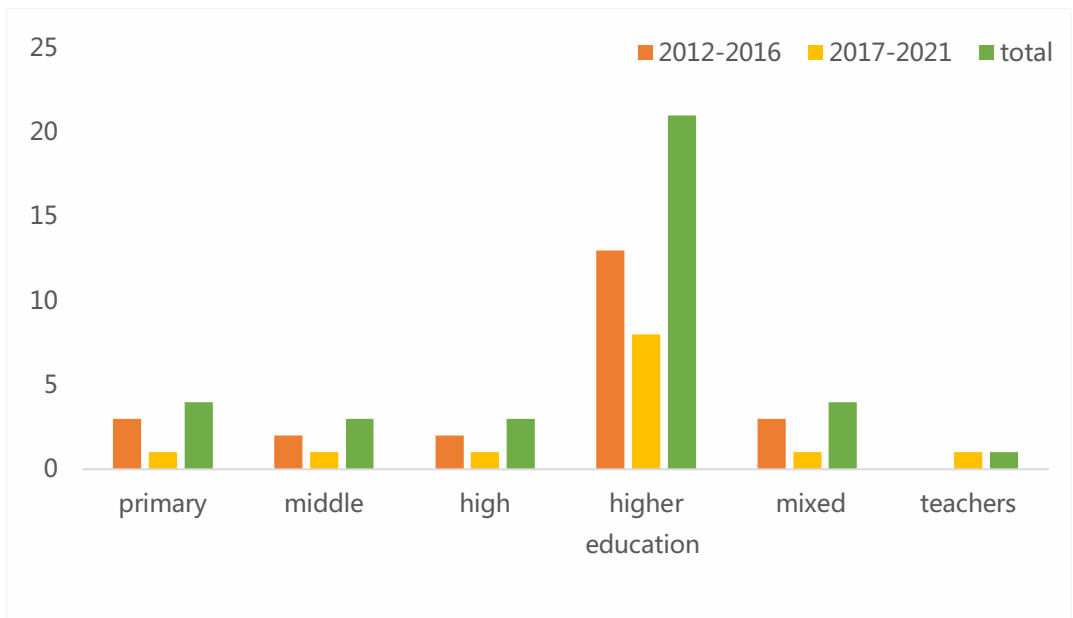
adults.

Figure 8 Statistical analysis of participants

8 Subject Area Analysis

From 2012 to 2021, the research on argumentative collaborative learning supported by computers shows that the institute applies a wide range of disciplines. As shown in Figure 9 , we found that the subjects most studied by scholars were first in the field of science (publications = 11) , followed by engineering subjects including computer courses (publications = 6), followed by psychology (publications = 5) Field. In addition, mathematics, English, and geography are also covered, but few scholars have studied basic and secondary education.
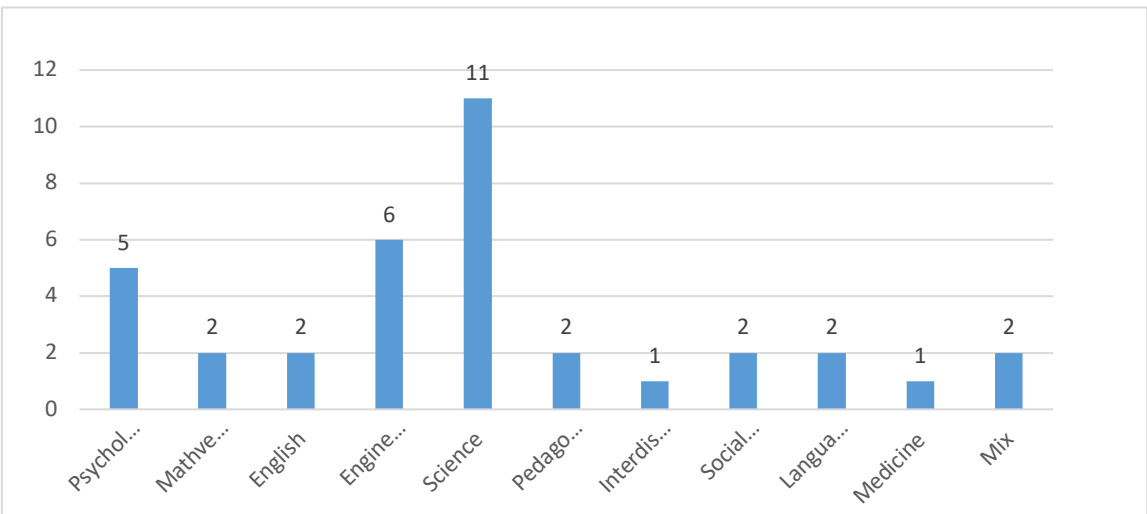

Figure 9 Distribution map of subject areas

9 Computer Supported Argumentation Learning Platform

With the advent of the era of intelligence and the rapid development of information technology, a large number of practical teaching collaboration platforms have emerged. Many online platforms use graphics as a representation tool and are embedded in the online environment in the form of schemes, tables or visualizations to support the process of dialogue and argumentation and argumentation learning. , or in the form of textual prompts or scripts to coordinate the procedural construction of specific interaction modes by various roles and activities learners (Kirschner et al. 2003; Scheuer et al. 2010; Noroozi et al. 2012). The online demonstration and collaboration platform is an extremely important part of the collaborative learning environment. It is a hotspot in the field of educational technology research to build a good learning environment for learners through the network and help them acquire more knowledge . In this study, as shown in Table 2 , each researcher chose different collaborative learning platforms to support students' demonstration activities. Facebook series applications and social platforms such as Google platforms are the most used demonstration platforms. The second is the hybrid Moodle learning management system platform and the professional LASAD platform. In addition, there are discussion boards, blackboards, Webspiration and many other platforms to support students' demonstration and collaborative learning, and even many researchers have independently developed a series of teaching methods. platform to assist your research.

Table 2 Argumentation collaborative learning platform supported by computer

serial number	title	platform
1	Developing argumentation skills in mathematics through computer-supported collaborative learning: the role of transactivity	Self-developed CSCL environment
2	Scaffolding argumentation in mathematics with CSCL scripts: Which is the optimal scripting level for university freshmen?	Self-developed CSCL environment
3	Implementation of Web-based argumentation in facilitating elementary school students to learn environmental issues	Web Interactive Argumentation System (WIAS)
4	The effect of a graph-oriented computer-assisted project-based learning environment on argumentation skills	Webspiration
5	The influence of a web-based learning environment on low achievers' science argumentation	WAP
6	Facilitating argumentative knowledge construction through a transactive discussion script in CSCL	SharePoint Text asynchronous discussion board

7	Argumentative Knowledge Construction Process in Social Collaborative Learning Environment towards Students' Higher Order Thinking Skills	SCLE
8	Modelling diffusion in computer-supported collaborative learning: a large scale learning analytics study	Moodle Learning management system
9	The effect of moderator's facilitative strategies on online synchronous discussions	Moodle Learning management system
10	Learning Effect in a Multilingual Web-Based Argumentative Writing Instruction Model, Called ECM, on Metacognition, Rhetorical Moves, and Self-Efficacy for Scientific Purposes	Moodle Learning management system
11	Learning to learn together with CSCL tools	Metafora、 LASAD
12	Promoting academically productive talk with conversational agent interventions in collaborative learning settings	MentorChat
13	Argue like a scientist with technology: the effect of within-gender versus cross-gender team argumentation on science knowledge and argumentation skills among middle-level students	Lucidchart
14	Scripts, individual preparation and group awareness support in the service of learning in Facebook: How does CSCL compare to social networking sites?	LASAD 、Facebook
15	LASAD: Flexible representations for computer-based collaborative argumentation	LASAD、Belvedere、 Digalo、 Athena
16	Investigating the effects of prompts on argumentation style, consensus and perceived efficacy in collaborative learning	IM meeting
17	Investigating the effects of peer to peer prompts on collaborative argumentation, consensus and perceived efficacy in collaborative learning	IM meeting
18	Peer-monitoring vs. micro-script fading for enhancing knowledge acquisition when learning in computer-supported argumentation environments	i Argue
19	Exploring Pre-University Students' Construction of Reasoned Argumentation during Computer - Supported Collaborative Discussions Using Sequential Analysis	Google Meet
20	Virtual Learning Communities (VLCs) rethinking: From negotiation and conflict to prompting and inspiring	Google Docs
21	A cross-cultural study of the effect of a graph-oriented computer-assisted project-based learning environment on middle school students' science knowledge and argumentation skills	GOCAA，Webspiration
22	Blending Facebook discussions into seminars for practicing argumentation	Facebook(SNS 、 GAT、AKC)
23	Re-thinking scientific literacy out-of-school: Arguing science issues in a niche Facebook application	Facebook (Hot Dish)

24	Therapeutic Affordances of Online Support Group Use in Women With Endometriosis	Facebook
25	Peer feedback or peer feedforward? Enhancing students' argumentative peer learning processes and outcomes	EduTech
26	Integrating computer-supported collaborative learning into the classroom: the anatomy of a failure	Drew
27	Collaborative argumentation and cognitive elaboration in a computer-supported collaborative learning environment	Discussion board
28	The role of collaborative argumentation in future teachers' selection of online information	Discord
29	Making L2 learners' reasoning skills visible: The potential of Computer Supported Collaborative Learning Environments	Digital Mysteries (DM)
30	Small-group, computer-mediated argumentation in middle-school classrooms: The effects of gender and different types of online teacher guidance	Digalo
31	Promoting critical, elaborative discussions through a collaboration script and argument diagrams	CSILE、FACT scripts、LASAD
32	Exploring Students' Knowledge Construction Strategies in Computer-Supported Collaborative Learning Discussions Using Sequential Analysis	Course discussion board
33	The effects of computerized inquiry-stage-dependent argumentation assistance on elementary students' science process and argument construction skills	ASIS
34	Missed Opportunities for Science Learning: Unacknowledged Unscientific Arguments in Asynchronous Online and Face-to-Face Discussions	Blackboard
35	Enhancing skill in constructing scientific explanations using a structured argumentation scaffold in scientific inquiry	ASIS
36	Understanding Ill-Structured Engineering Ethics Problems Through a Collaborative Learning and Argument Visualization Approach	AGORA -Net

Conclusion

In recent years, we have witnessed the continuous development and unstoppable progress of computer-supported argumentative collaborative learning research , and more and more researchers are devoted to this research. The platform of argumentative collaborative learning realizes the separation of time and space in teaching during the epidemic. It does not delay teaching, but also allows students to learn and communicate online, which is of great significance for cultivating their collaborative learning ability, critical thinking ability, and argumentation ability. This study reviewed research on computer-supported argumentative collaborative learning published in academic journals in the Web of Science database from 2012 to 2022 . Based on the

results of the data analysis, this study makes several findings for the research question:

(1) Research is gradually heating up. From 2012 to 2015 , the number of publications generally showed an upward trend, and reached its peak in 2015. The number of publications has declined since 2016. Due to the sudden attack of the new crown epidemic, offline education has been hit hard, setting off a wave of online education. , the collaborative learning environment based on computer support breaks through the constraints of time and space, provides learners with a real-time interactive platform environment to support learning, and ensures the normal progress of education. This study found that the number of published papers was affected by the new crown pneumonia epidemic. Since 2020,scholars' research in this area has begun to show a clear upward trend. In view of the current situation of the epidemic, this study predicts that research in this area will become more and more popular, and its theoretical research and practical exploration have made significant progress, and it will gradually expand in the entire education community, which will attract more and more scholars to participate in the research.

(2) The more times the literature is cited, the more closely related it is to the most active research topics in this field, the more academic value it is, and the more worthy of further study and analysis. " Promoting the Construction of Argumentative Paper Knowledge through Transactional Discussion Scripts in CSCL " is a very classic document in this research field, which has been cited by many scholars and has a very high reference value. Knowledge learning and improvement of argumentation ability. Followed by "Collaborative Argumentation and Cognitive Exposition in Computer-Supported Collaborative Learning Environments", these classic literatures widely recognized and cited by scholars provide the knowledge and methodological basis for follow-up research.

(3) Cluster analysis of authors found that the distribution of authors was evenly distributed, and most researchers generally did not study the field for a long time and duration. Between teachers, students or colleagues within the same institution, and the number of times is relatively small, there is a lack of cohesion and consistency of research pace among researchers in different regions and disciplines, and a centralized and large-scale researcher group has not been formed.

(4) The regional distribution is uneven. The study found that most of the research on demonstration and computer-supported collaborative learning was initiated by American scholars, with more foreign publications, and continued in-depth research. Next is Germany . my country's current pursuit of quality education requires focusing on cultivating students' thinking ability. Demonstration-based teaching has been widely used in today's teaching, focusing on how to promote students' demonstration ability in collaborative learning under face-to-face teaching. However, collaborative demonstration based on computer support It has not received enough attention, and only some Taiwanese scholars have carried out research. In the context of the knowledge economy era, our country should also keep up with the world trend and promote students' argumentation

learning in combination with the current intelligent environment.

(5) The higher the co-occurrence frequency of keywords, the more people pay attention to this research field, and it is also a hot topic and trending topic in this field. Pay attention to the role of knowledge construction and collaborative scripting in computer-supported collaborative argumentation learning, which is also the hotspot and trend of future research. Encourage learners to acquire knowledge and skills and learn to argue in a computer -supported argumentative collaborative learning environment. Efforts are made to improve students' knowledge construction ability and collaboration skills , and through the adjustment of internal and external script brackets, to promote students' collaborative argumentation ability, and to cultivate students' critical thinking and logical thinking .

(6) The study found that the research method of argumentative collaborative learning supported by computer from 2012 to 2016 was quantitative research method, followed by qualitative research method. With the continuous development of science and technology and the deepening of research, in recent years, scholars mostly use the mixed research method of quantitative research and qualitative research to conduct research.

（7）The study found that regardless of the year interval, the main players for computer-supported argumentative collaborative learning are concentrated in higher education, with the largest proportion, however, the application of basic education, secondary education and teachers is less, There is little research on working adults.

(8) An analysis of the literature on computer-supported argumentative collaborative learning from 2012 to 2021 found that in the past ten years, this learning method has been applied in many disciplines in teaching, and it is most commonly used in science classrooms , followed by the fields of Engineering and Psychology. There are few studies in interdisciplinary, medical and other disciplines.

(9) By analyzing the online argumentation support platforms in the literature, it is found that many different argument visualization platforms are used in the research to support student learning. Among them, the Facebook series of applications, the Google platform and the Moodle learning management system are most used, and some scholars need to use the LASAD platform, ASIS platform or self-developed demonstration learning platform due to their professional research.

Based on the above research findings, some suggestions are put forward for the related research of argumentative collaborative learning supported by computer:

(1) The continuous development of Internet technology and its widespread application in education provide students with an environment where they can learn anytime, anywhere, and dynamic personalized services. In a computer-supported argumentative collaborative learning environment, students can freely express their opinions, discuss and communicate with others, and use arguments to prove their arguments, acquire knowledge and skills in the process of discussion, solve problems , think critically, Collaboration skills

and argumentation skills also improved accordingly. In the context of the era of big data, we must be good at grasping the use of advanced technology to assist teaching.

（2）In future research, the research object of argumentative collaborative learning supported by computer should be extended to secondary education and basic education, and the scope of participants should be expanded so that more learners can benefit in the learning process. Encourage learners to develop critical thinking and argumentative thinking from an early age, learn to reason correctly, and lay the foundation for achieving educational goals.

（3）The use of qualitative research or quantitative research alone is not necessarily the best research method, and the specific use needs to be consistent with the research objectives. In future research, it is recommended to choose the appropriate research method according to the needs of this study. Relatively speaking, the mixed research method can conduct a comprehensive and in-depth study of the research problem.

（4）This study suggests that computer-supported argumentative collaborative learning can be applied across disciplines and encourages interdisciplinary integration. Grouping learners with different disciplinary backgrounds can analyze and discuss problems from different disciplinary perspectives, help them acquire knowledge related to the content, seek common ground while reserving differences in the team, give full play to the initiative of each group member, and let all members participate in it.

（5）Cooperation between authors in common research fields is conducive to further research. It is hoped that authors can strengthen cooperation, conduct more academic exchanges, broaden research fields and directions, and strengthen cohesion and research pace among researchers in different regions and disciplines. to form a centralized and large-scale researcher group and exert the group effect .

（6）Future research can conduct an in-depth analysis of this topic, explore the impact of argumentative collaborative learning on the academic performance of various types of students: problem solving, knowledge building, interdisciplinary learning, etc. discussing the process of argumentative collaborative learning supported by computers. Increasing those educational interventions can promote student learning and overall development.

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