

# Is Schema Theory Helpful in Teaching and Learning Based on Visualizing Research?

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## ABSTRACT

Schema theory is one of the critical theories in cognitive linguistics. It has been applied to teaching and learning in recent years. With the question of how schema theory can be used and a benefit for practical application in education, this paper visualizes studies of the use of schema theory in education through the VOSviewer. Co-occurrence and bibliographic analysis provide the directions for the results of the research which will improve teaching and learning. With a close look at the research, we can see that the application of schema theory both in and after class can facilitate teaching and can also strengthen memory, reducing the degree of knowledge forgetting at the same time. This study of schema theory in education can give some suggestions for teachers and students.

## KEYWORDS

Bibliographic Analysis, Education, Knowledge Acquisition, Knowledge Forgetting, Memory, Suggestion, Technique, Video

## INTRODUCTION

With the development of technology, many online platforms and intelligent devices can help teachers and students in class. Especially during the period of dealing with Covid-19, many classes have transformed from traditional classes into online classes. Rapid advances in information technology, such as MOOC, Small Private Online Course (SPOC), Tencent class, and flipped classroom have also contributed to the shift (Qi et al., 2018). Furthermore, electronic products can also be used in learning, such as iPad, computers, and smartphones. Online classes have some advantages: they do not have space limitations, which mean people can have classes everywhere. However, disadvantages also existed in online classes. Lacking face-to-face supervision from teachers, the classroom participation and enthusiasm of students will not be high, and the knowledge students acquired from class is easy to forget. Therefore, certain methods need to be taken in teaching to improve the learning effect. From this visualizing research, it is found that some research has been done on schema theory used in teaching and learning. How does this theory benefit teaching and learning? This is the primary motivation of this study.

Schema theory is a fundamental theory in cognitive linguistics. It represents a dynamic construction in the brain that can connect new information with the old information. When people

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learn new knowledge, they link it with their old information because new knowledge can store in the brain with the interaction with previous knowledge. It is a set of logical and normal ideas which forms a network of relationships that constitute people's knowledge and understanding structure (Ephraim & Theodore, 2017). If their previous knowledge is activated before classes, they will more easily gain new knowledge than people who do not have previous knowledge that is activated (Yu, 2019). In this way, teachers consider schema theory in their educational methods, then the input of new knowledge would become easy and cozy, and the consolidation of knowledge would improve.

Some researchers have proposed some ideas to consider schema theory in their courses in different fields of education. It is essential to recognize the significance of schema in education (Kluen et al., 2017). However, the existing areas in education about schema theory are so heterogeneous and scattered. Moreover, knowledge forgetting is also a difficult problem to be solved in current teaching. Although some researchers have studied knowledge forgetting (Zhao et al., 2019; Lv & Shen, 2021; Meng & Tang, 2021), few scholars associate the cognitive model of schema theory with knowledge forgetting to explore the effect of schema theory in avoiding knowledge forgetting. Therefore, this paper summarizes some feasible suggestions to reduce knowledge forgetting through schema theory, but first of all, this paper makes a visual analysis of the research theme of the application of schema theory in education, combs the research keywords, countries, leading authors, and organizations in this field, and then tries to explore the two problems of "how to use schema theory to improve teaching effects" and "how to utilize schema theory to reduce knowledge forgetting" through the analysis of key literature. Finally, ideas for follow-up research and suggestions for practical educational work are provided.

## **Background**

Some researchers have discussed and adopted schema theory in their educational fields. This section will discuss this theory in classroom teaching and online teaching.

## **Classroom Teaching**

### **Use of Schema Theory in Maths**

The application of schema theory in maths benefits teachers and students. Hejny et al. (2012) found that pupils have difficulty learning concepts and processes in elementary mathematics, and they successfully used schema theory to write a mathematics textbook series and improved students' grades. Some researchers have applied the Action-Process-Object-Schema (APOS) theory in mathematical concepts varying from functions, infinity, limits, mean, standard deviation, and the Central Limit Theorem (Hatfield, 2013). Ubah and Bansilal (2018) proposed a study to apply the APOS theory to test primary teachers' understanding of the addition and subtraction of fractions, and the result showed that teachers tend to ignore the action level of fractions, causing many incorrect procedures, which give rise to misconceptions among students.

### **Use of Schema Theory in Art Education**

Some researchers find that schema theory could improve the ability to draw in art education. Because of schemata, painters could quickly draw the schema of a tree, a mountain, or an animal on paper. In this way, they can retrieve the schemata stored in their mind and utilize them quickly when they want to express their ideas (Liu, 2015).

### **Use of Schema Theory in Medical Science**

The use of schema theory in patient education can explore an appropriate way to interact with patients for nurses. Ji et al. (2018) wanted to study the satisfaction and awareness of competency towards smartphone use and learning using schema theory in dental education. He suggested that

smartphones with schema theory could become a method in dental radiology practice, and that it may be helpful in education.

### **Use of Schema Theory in English Education**

In the English cultural class, Liu et al (2017) suggested presenting a teaching model based on social-communication schema theory, which could help increase students' cultural capabilities and help them learn English well.

In the English listening class, English listening teaching with the guidance of the schema theory is more effective than that of the traditional class. Listening is a complex process because students should recognize words through sounds, and they should immediately get the grammatical structures and understand sentences and get the whole meaning, which is partly based on the context of the utterance (Vandergrift, 1999). The pre-listening process is the critical part of using schema theory. This process should include new and previous background knowledge (Carrel, 1983). It can activate students' schemata and help them guess the content (Du, 2010).

The development of education curriculum standards requires a higher demand in English reading (Luo, 2018). It is a destined requirement for developing the current education to make full use of schema theory in English reading (Zheng et al., 2017). The key to understanding the reading texts is the activation of schemata, so teachers should be the guides who can help students activate their schemata (Luo, 2018). Enriching students' cultural background information is essential in increasing schema content. Teachers should use proper strategies to activate schema existing in students' minds during reading.

### **Online Pedagogical Teaching**

It is concluded that teaching with techniques is beneficial for teachers and students. However, seldom do researchers use schema theory in their teaching processes. Small private online courses and flipped classrooms can show the achievements of students.

Small private online courses in English learning have applied image schema theory in their teaching methods when information technology is developing rapidly. The cognitive theory and educational theory are connected to use in teaching. Many teachers like small private online courses that have become famous globally. Four processes have been proposed: pre-class teaching design, deep cognition in learning, theoretical reflection after study, and knowledge optimization in evaluation. These processes can fully use image schema theory and prevent language fossilization (Qi et al., 2018). Flipped classrooms have also considered schema theory in their teaching methods. The flipped classrooms with techniques could assimilate and adapt learners' schemata before class, which could help students build a foundation for learning in class. After class, students can modify and reconstruct through individual thinking and peer discussion (Yu, 2019).

Some researchers have proposed methods to use schema theory in education. Both Traditional classes such as maths, art, medical science, and English education, and online classes like small private online courses have shown that the use of schema theory can improve the quality of education in their fields. However, the application of schema theory in classroom teaching and online teaching is scattered and varied. They just proposed some methods of using schema theory in their own fields. There is no common method to apply schema theory in all subjects. Although some researchers have proposed suggestions and given methods to improve the quality of classes, they could not eliminate shortcomings in classes (Yu, 2019). They may consider the schema theory in their classes.

### **Main FOCUS OF the ARTICLE**

Some papers study the use of schema theory in traditional classes without techniques, and rare researchers use schema theory and techniques to help students in education. Few mapping systematic literature reviews have represented the use of schema theory in education. In order to intensify

this part, this study will provide solid ground and convincing references for future studies through scientific clusters.

Based on the problems, there are three research questions:

1. Through VOSviewer, what research related to schema theory in education can be found?
2. How can schema theory be used to improve teaching effects?
3. How can schema theory be utilized to reduce knowledge forgetting?

The top ten keywords, countries, authors, and organizations can guide research in the Web of Science, and then this paper summarizes suggestions of using the schema theory in education and mediating knowledge forgetting.

## **Research methods**

### **A Visualizing Study with Bibliometric Evaluation**

Studying co-occurrence and bibliographic coupling analyses can help form a scientific and rigorous study about the immense literature (Boyack & Klavans, 2010; Gmür, 2003). Ding and Yang (2020) analyzed co-occurrence through VOSviewer to review research on management, business, and economics platforms. Co-occurrence and bibliographic coupling are measurements to find the relationships of different documents. Many studies have testified their credibility (e.g., McCain, 1990; Nerur et al., 2008; Yu et al., 2020).

### **Source of Data**

The data used for the study were selected from the Web of Science Core Collection. It is one of the vital statistic platforms for searching academic documents. It includes more than 12,400 international academic journals covering natural sciences, engineering and technology, social sciences, arts and humanities, and many other subject areas. Web of Science has a strict selection mechanism based on Bradford's Law of bibliometrics and only includes critical academic journals in each subject area. The index includes Science Citation Index Expanded (SCE), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index-Science (CPCI-S), and Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH). Because of the large amount of data in the Web of Science, it was selected as a data source used in this study.

### **Steps of Data Processing**

The documents were collected using co-occurrence and citation analysis. The specific steps were as follows.

### **Data Collection**

The data were from the database Web of Science Core Collection (including databases of SCE, SSCI, A&HCI, CPCI-S, CPCI-SSH) using the terms (schema theory) AND (educat\*) OR (schema) AND (educat\*) OR (schema theory) AND (learn\*) OR (schema) AND (learn\*) OR (schemata) AND (educat\*) OR (schemata) AND (learn\*) in titles. 2,990 peer-reviewed articles were identified. Two authors cross-examined the results regarding the quality and relatedness and finally yielded 1,963 articles.

### **Data Quality Cross-Check**

The data from the Web of Science Core Collection were included in other online databases such as Elsevier (329 results), Springer Nature (274 results), Taylor & Francis (238 results), Wiley (134 results), and Sage (112 results).

## Results

### Previous Research about Schema Theory in Education

This study used bibliometric analysis of the literature about cluster mapping in terms of keywords, countries, authors, and organizations.

### Cluster Mapping Based on Keywords

According to VOSviewer, bibliometric analysis' results are shown in Figure 1 in a map including six research clusters. We created a map based on bibliographic data from the Web of Science Core Collection. The type of analysis is co-occurrence, and the unit of analysis is all keywords. The counting method is full counting. The minimum number of occurrences of a keyword is 17, and of the 9,323 keywords, 111 meet the threshold. Finally, 111 keywords are selected.

Cluster 1 includes 35 items, i.e., schema, activation, attention, body schema, brain, cognition, connectivity, consolidation, cortex, decision-making, episodic memory, fMRI, hippocampal, hippocampus, individual-differences, information, integration, language, learning, mechanisms, memory, memory consolidation, models, organization, perception, prefrontal cortex, prior knowledge, recognition, representations, retrieval, schemas, sleep, systems, time.

Cluster 2 includes 35 items, i.e., schemata, achievement, adolescents, anxiety, attitudes, behavior, care, cognitive load, cognitive load theory, communication, construction, context, depression, design, education, English, experience, framework, gender, health, identity, impact, knowledge, management, motivation, perceptions, perspective, quality, reliability, science, self, skills, strategies, students, teachers.

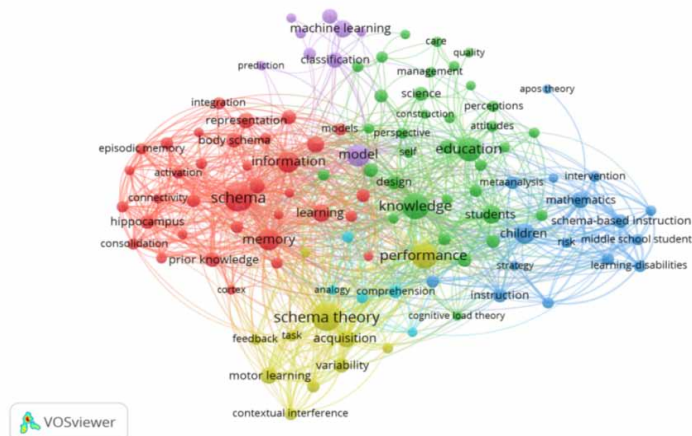
Cluster 3 includes 16 items, i.e., 3<sup>rd</sup>-grade students, APOS theory, children, instruction, intervention, learning-disabilities, mathematics, meta-analysis, middle school students, problem-solving, risk, schema-based instruction, strategy, strategy instruction, thinking, working memory.

Cluster 4 includes 11 items, i.e., acquisition, adaptation, contextual interference, feedback, motor learning, performance, retention, schema theory, skill, task, variability.

Cluster 5 includes 9 items, i.e., classification, deep learning, identification, machine learning, model, ontology, prediction, semantic web, system.

Cluster 6 includes 5 items, i.e., analogy, categorization, comprehension, schema induction, similarity.

Figure 1. Cluster mapping based on keywords



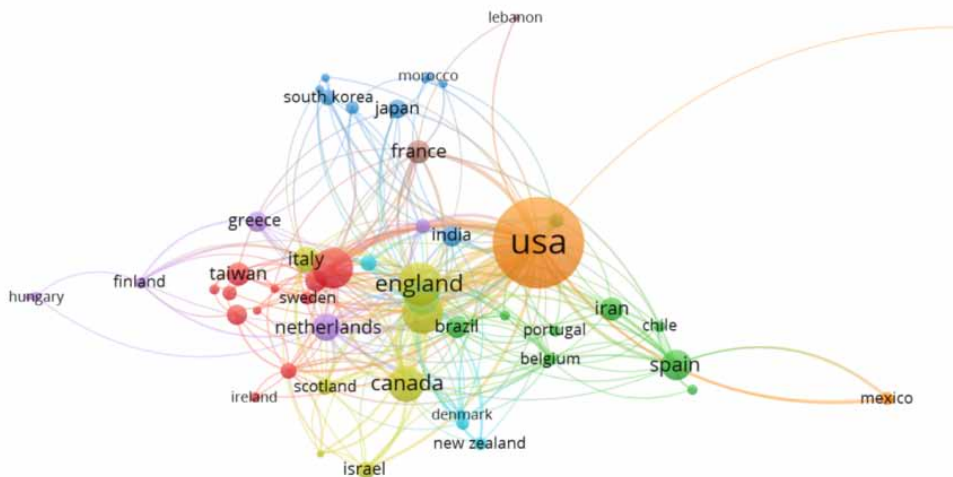
The VOSviewer mainly focuses on the whole level of data (Eck & Waltman, 2017). By visualizing the literature keywords, six clusters talk about schema theory in education. The ten most frequent words are schema theory, knowledge, performance, education, model, memory, information, children, acquisition, and students.

### Bibliographic Analysis of the Citations

According to VOSviewer, the bibliographic analysis of countries, authors, and organizations of publications of schema theory in education are listed below.

The map is created through VOSviewer based on bibliographic data from the Web of Science Core Collection. The type of analysis is the citation, and the unit of analysis is countries. The counting method is full counting. The maximum number of countries per document was set at 25. The minimum number of citations of a country was set at 2, and the minimum number of documents of a country was set at 5. Of the 90 countries, 54 meet the thresholds. The platform showed the most significant total link strengths of countries (Figure 2).

Figure 2. Bibliographic Coupling of Countries

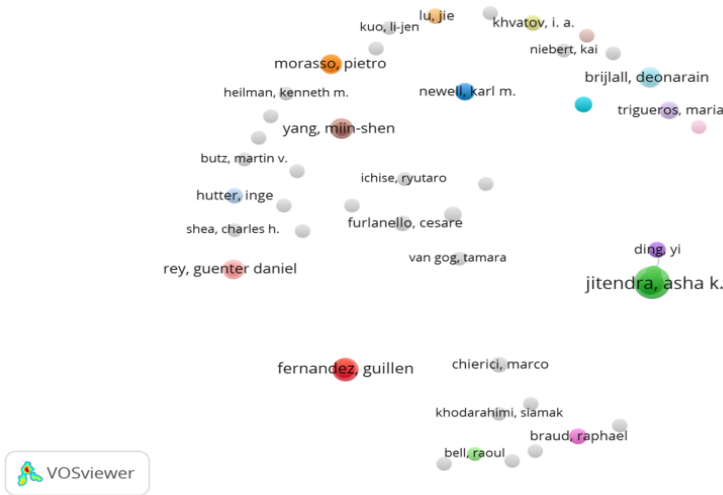


Through visualizing countries of literature, the USA has published the most documents. It has published 706 documents and has been cited by 11,192 times. The significance of studying the countries is to help readers find out which countries focus on schema theory in education. People should pay more attention to countries with high citations because they have previously studied schema theory in education, and they have proposed some related thoughts about it.

There is a bibliographic analysis of authors of schema theory in education. The maximum number of authors per document was set at 25. The minimum number of citations of an author was set at 1, and the minimum number of documents of an author was set at 3. Of the 5,879 authors, 106 meet

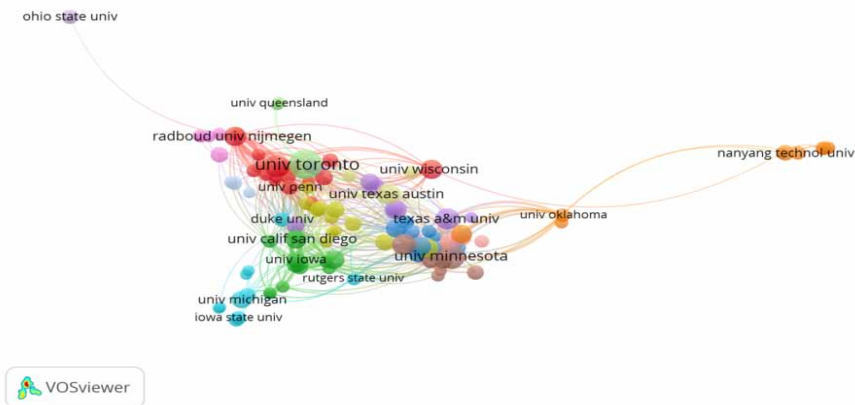
the thresholds. 17 documents written by Jitendra, Asha K., have been cited 448 times (Figure 3). His papers mainly focus on schema-based instruction on proportional thinking (Jitendra et al., 2011).

Figure 3. Bibliographic analysis of authors



There is a bibliographic analysis of organizations of schema theory in education. The maximum number of organizations per document was set at 25. The minimum citations of an organization were set at 2, and the minimum number of documents of an organization was set at 5. Of the 2,045 organizations, 160 meet the thresholds. University of Toronto has published 35 documents, the highest number of documents for any organization. This organization has been cited 1,173 times (Figure 4).

Figure 4. Bibliographic analysis of organizations



The cluster mapping of keywords and bibliographic analyses of countries, authors, and organizations can allow researchers to easily find the hot topics in the mapping. It can provide an outline for them to consider the development of education. The limitation is that the Web of Science Core Collection database cannot cover all the publications since the data are primarily in English. Publications in other languages are not covered (Yu, 2020).

## Schema Theory Strengthening Teaching Effect

Through visualizing the cluster mapping of keywords and bibliographic analysis of countries, authors, and organizations, this paper focuses on some keywords to explore the use of schema theory in education: schema theory, memory, and knowledge acquisition. There are three processes of teaching modes with schema theory, which is a suggestion for teachers and students. Teachers can use the schema theory in traditional and online classes with technology.

### Pre-Class

Making full use of techniques in class is one of the most critical factors to improve the quality of classes. With the development of information technologies, traditional and online classes can use techniques to help enhance teaching. For example, The USA is the first place to use Micro-Course Online. However, only using techniques is not sufficient, because a lot of homework cause students would not spare their time preparing for their class (Yu, 2019). Although they prepare their knowledge about their next class, they read the textbook carelessly, which does not activate their schemata. Furthermore, different students have different schemata in their minds because they have experienced diverse lives. Under this circumstance, teachers should prepare well-organized methods to use techniques and the schema theory.

The development of technologies contributes to the new mixed educational platforms which provide video lessons (Vlad, 2019). Before class, teachers should provide correlated teaching content, which is critical to stimulate students' schemata (Qi et al., 2018). The most common technique is preparing a video correlated with teaching materials. Designing these videos is a challenging task because the videos should not be too brutal or straightforward. The videos are not the textbook's presentation but satisfy the teaching objectives (Yu, 2019). The videos should not be too long. A survey on the frequency and length of short video APP users found that the most popular choice was "5 to 15 minutes," with a proportion of 26.2% (Ni, 2020). Therefore, it can be concluded that most people can accept the length of 5 to 15 minutes. Videos are used to activate schemata that exist in students' minds. The content of videos should be diverse and related to students' majors. It cannot be selected randomly but increases students' interests and stimulates content schemata.

Providing videos is an essential implement to help students learn, but it is not universal for all courses. Videos are suitable for procedural knowledge like maths and sciences (Yu, 2019), and video education has been used for patients (Toraya, 2014) and improving health literacy (Ferguson, 2012). Teachers design a learning environment and create a context through providing video, which supports learners to access course resources quickly, learn the required content independently, and ultimately construct meaningful knowledge. Besides videos, teachers can provide other learning materials for students. For example, before the English listening class, teachers can provide a topic related to the listening materials and ask students to brainstorm (Du, 2010); before politics, teachers can provide related social articles for students to think about. Articles should not be too long or complex. Teachers can also ask students to use some high-quality educational apps (Kolak et al., 2020).

Students experience two processes during their comprehension process: assimilation and adaptation (Brown, 1979). Firstly, in terms of students, because different students have different schemata in their minds, students who do not have enough schemata can use the video or other learning materials many times to digest knowledge, which could facilitate the assimilation of the class. Many students struggle to understand new knowledge because they don't assimilate enough background information (David & Jean, 2005), so preparation before class is necessary. Secondly, if



students find the video or learning materials presented differ from their existing schemata, they can modify their prior schemata. Even if students cannot modify their prior schemata, they can make marks, listen to teachers in class, and reconstruct their schemata in class with the help of teachers. Students should improve their analytical thinking and make assumptions about the next class while using the video or other learning materials. Because of schema theory, the utilization of schema can reduce students' cognitive loads about working memory and improve students' processes of acquiring new knowledge (Yu, 2019).

The preparation of class is essential for teachers and students, which can decrease the burden of class. Students would not learn the knowledge effectively if teachers did not activate their schemata before, although they have schemata in their minds. Teachers can use more time in class to deal with difficulties and hard points while students can prepare the knowledge before class so that they can have more desire to participate in in-class activities, and students could reduce knowledge forgetting because they remember the key points one time before class.

## **In Class**

The in-class process is an essential part of classes. Teachers can help students form their cognition step by step. It is the only process that includes the interaction between teachers and students face to face.

In the modern classroom model, the transfer of knowledge is done before class, and teachers have more time in the classroom to give students individual help to complete the internalization and absorption of knowledge, which is different from the traditional classroom, where the input of knowledge takes place in the classroom. The internalization of knowledge is done after class. Understanding new knowledge is based on the prior knowledge already digested (Anderson, 1977). In traditional classes, teachers just teach new information without considering schema activation. If teachers consider schema theory, the teaching processes will benefit students. Teachers' information should also correlate with videos and other learning materials presented before class (Yu, 2019). In this way, students can effectively understand the new knowledge. It is because the comprehension of new knowledge depends on its consistency with the activated schemata (Yu, 2019). If the new knowledge is consistent with the activated schema, students can learn quickly and easily in class.

At the beginning of the class, teachers ask students to do the pre-class test, which can help teachers know about students' independent learning situations. According to the scores, teachers can know students' complicated problems and existing issues. Tests, especially pre-class tests, can enhance and retrieve memory (Huffmyer & Nemergut, 2015). And then, teachers can present media resources (PPT, video, pictures) according to the pre-class test (Qi et al., 2018).

Teachers can divide students into groups to ask them to collaborate after teaching complex knowledge to students. Students can assimilate their cognitive schemata and fill the gap from others' share (Yu, 2019). Small group discussion is beneficial to students due to its broad impact on the students' learning, such as communication skills and leadership qualities (Sarfrac et al., 2021). After discussing, teachers can ask students questions which are reconsidered through peer discussion and pre-class thinking, making them highly qualified and significant. During this process, teachers can help students adapt their cognitive schemata. The last step in class is to ask students to have a test to consolidate what they have learned. The test can be compared with the pre-class test to find whether the class plays a role in constructing students' schemata and whether the assimilation of new knowledge is complete.

Students should improve their critical thinking during pre-class tests (Qi et al., 2018). During group discussions, students can interact with peers to understand what they cannot deal with by themselves, improving students' creative thinking and communicative skills. If students cannot figure them out through group discussion, teachers should give directions. After discussing, students should ask teachers for help in difficult points. The next part of the process of the class is doing the test. Students should do it independently without asking other students. They can review the knowledge of the whole class while doing the test.

People tend to remember knowledge that are different from their schemata, and they tend to ignore the knowledge consistent with their existing schemata (Lampinen et al., 2001). That is to say, students unconsciously ignore the information of class that is consistent with their existed schema, but they tend to pay more attention to the problematic points of knowledge that do not align with their pre-existing schemata. Therefore, in the class, students can adapt and modify the information which is not consistent with their existed schema through cooperative discussion. Then the inconsistent schema information can be transformed into schema-consistent information. Students can learn the new knowledge effectively.

### **After Class**

After class, teachers can get feedback from students, which could help teachers redesign their teaching contents to accord with students' situations. In turn, students can reconstruct and supplement their schemata through theoretical reflection (Yu, 2019).

This process can make full use of techniques. Teachers should not take it for granted that the end of the class is the end of teaching the content. After class, teachers should collect problems and difficulties that appeared in class and modify the class model according to the conditions of students (Yu, 2019). Teachers can put the outline of the class on the platform such as Ding Talk, Rain Classroom and, Super Star learning APP, of which the information should be brief and transparent. They can also put extra knowledge in platforms for students who have energy and interests to extend their knowledge. Teachers can collect feedback from students to know about their learning requirements. They can accurately identify the key and difficult points in the teaching content through students' feedback. In this way, teachers can prepare more suitable materials and videos to activate students' schemata to improve learning new knowledge.

Students should reflect on what they have learned, moving on to a new learning task. The reflection includes process reflection and result reflection (Qi et al., 2018). Students can draw a mind mapping once they learn a chapter, which is the way to connect new knowledge with prior knowledge. In this way, scientific outlines of understanding can be built. Students struggling to digest new knowledge can repeatedly watch videos or read materials to activate and construct their schemata. They can also ask for help on the platform: teachers and students who learn well can give a hand to them. Students who are good at knowledge can consolidate what they have learned in this interaction, and students who have questions can get knowledge.

Before class, students watch the video provided by teachers, activate their existing schemata, find some information different from their existing schemata, and get some new knowledge. The different points have given them an impression, and then they can learn those different points through individual thinking and peer discussion to reconstruct and modify their schemata in class. After class, students can use online platforms to review what they have learned, and this process can consolidate their schemata. This type of teaching and learning can activate students' schemata three times, providing significant support for the development of students' assimilation and adaptation.

### **Schema Theory Reducing Knowledge Forgetting**

Educators have rarely proposed methods for students to get long-term knowledge retention (Douglas, 2018). Surprisingly, the application of schema theory can reduce knowledge forgetting.

People tend to forget what they have just learned. The degree of forgetting the knowledge is different from one student to another. However, in traditional classes, most teachers give the same method to all students without considering the different degrees of forgetting the students' knowledge. The knowledge forgetting cannot be solved in traditional classes because teachers do not have enough time to review all their knowledge. It also cannot be solved in online classes because most students lack self-control without teachers' regulation. Knowledge forgetting is a formidable obstacle to deal with (Gatt & O'Toole, 2017). Lv & Shen (2020) believed that teachers should consider the knowledge forgetting curve. Furthermore, schema theory could reduce knowledge forgetting.

Knowledge is stored in the schema as an abstract concept in people's minds. The schema is pre-existing knowledge in the brain, which facilitates the encoding, consolidation, and retrieval of schema-relevant information. Such schema-based memory is the key to every form of education and provides attractive insights into connecting new information and prior knowledge. Building a new teaching mode with techniques and schema theory is essential for teaching and learning.

The ultimate goal of taking a class is to get the knowledge. Acquiring knowledge is based on schema theory, and, in classes, teachers can use it as a reference to design their teaching methods because schema theory is the cognitive guidance. It can reduce knowledge forgetting, which would have profound importance in education.

Before classes, students' study of videos and learning materials provided by teachers can impact the following knowledge. In class, the tests at the beginning of the class can consolidate what they have prepared before class. Many researchers testified that the retrieval of information (commonly tests) improves knowledge retention (Roediger & Karpicke, 2010; Iii & Butler, 2011). In this way, the tests before class are beneficial for students to remember what they have digested. After group discussions, students would form an unforgettable memory because of deep thinking. The tests at the end of the class can prevent knowledge forgetting because they can help students summarize the whole class. After class, teachers should give feedback on tests, which could facilitate the retrieval of information (Douglas, 2018). Teachers can ask students to review before going to bed, which is an excellent way to remember knowledge and avoid forgetting. According to The Ebbinghaus Forgetting Curve, teachers can set a notice to tell students to review on time. Because of schema theory, students study the new knowledge three times, and knowledge forgetting can be relieved.

## Conclusion

In recent years, the schema theory has attracted cognitive scholars to come into educational fields such as maths, art education, dental radiology, and English education. This study used bibliometric analysis of the literature about cluster mapping in terms of keywords, countries, authors, and organizations which could provide references for educators. Educators can easily find the hot topics in the mapping, which can provide an outline for them to consider education development.

With the development of information technology, the educational model of teachers teaching and students passively learning cannot meet the emerging online classes model. This traditional educational way may not only reduce the rate of knowledge acquisition but is also not conducive to knowledge retaining. The fundamental logic of schema theory is the key to solving this problem.

According to schema theory, students' understanding ability and effectiveness are related to the schema knowledge in their brains (Qi et al., 2018). Therefore, teachers should try to repeatedly activate students' background knowledge and learning interests to improve their learning efficiency. Moreover, the teaching method based on schema theory has the possibility to promote introverted students. Introverted students are unwilling to ask questions in class and to discuss with their peers. Watching videos before class may inspire their communication desires and add their communication times.

In addition, the application of schema theory in teaching can also improve the quality of teaching. Pre-class preparation pays attention to learners and teaching content, and stimulates interest in learning new knowledge by providing videos or learning materials to students; then students will connect videos or learning materials with previous knowledge schemata and construct new schemata. After class, assessment can enable teachers to obtain teaching feedback from students, and then change teachers' educational methods to effectively help students.

Through visual analysis, this paper summarizes and combs the application of schema theory in education, and finds that schema theory can effectively improve the level of education and reduce knowledge forgetting, providing a reference for further research. Although schema theory conduces to constructing knowledge maps and solving problems (Neumann & kopcha, 2018), there are still some limitations in the application of schema theory in education. For example, in order to better apply the theory to assist teaching, teachers need to spend more time preparing lessons and pay more

attention to strengthening the interaction and communication with students. Moreover, due to the heavy schoolwork tasks of students, it is arduous for them to complete each learning task designed based on schema theory with high quality, so the practical application effect may be greatly reduced. Therefore, the follow-up study should specifically explore the feasibility and effect of schema theory in different application scenarios so that the education quality will be better promoted.

### **Conflict of Interest**

The authors of this publication declare there is no conflict of interest.

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## REFERENCES

- Anderson, R. C. (1977). The notion of schemata and the educational enterprise. General discussion of the conference. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), *Schooling and the Acquisition of Knowledge*. Lawrence Erlbaum Associates.
- Boyack, K. W., & Klavans, R. (2010). Co-citation analysis, bibliographic coupling, and direct citation: Which citation approach represents the research front most accurately? *Journal of the American Society for Information Science and Technology*, *61*(12), 2389–2404. doi:10.1002/asi.21419
- Brown, G. (1979). *Piaget's theory: A psychological critique*. Routledge & K Paul.
- Carrell, P. L., & Eisterhold, J. C. (1983). Schema theory and ESL reading pedagogy. *TESOL Quarterly*, *17*(4), 553–573. doi:10.2307/3586613
- David, C., & Jean, A. B. (2005). The use of a specific schema theory strategy-semantic mapping-to facilitate vocabulary development and comprehension for at-risk readers. *Reading Improvement*, *48*(1), 24–31.
- Ding, X., & Yang, Z. (2020). Knowledge mapping of platform research: A visual analysis using vosviewer and citespace. *Electronic Commerce Research*, *4*. Advance online publication. doi:10.1007/s10660-020-09410-7
- Douglas, L. (2018). Planning education for long-term retention: The cognitive science and implementation of retrieval practice. *Seminars in Neurology*, *38*(4), 449–456. doi:10.1055/s-0038-1666983 PMID:30125899
- Du, J. (2010). Application of schema theory in college English listening teaching. *Journal of Jiamusi Education Institute*, *19*(336), 729–733. doi:10.2991/icsshe-19.2019.179
- Eck, N. V., & Waltman, L. (2017). Citation-based clustering of publications using citnetexplorer and VOS viewer. *Scientometrics*, *111*(2), 1053–1070. doi:10.1007/s11192-017-2300-7 PMID:28490825
- Ephraim, Z., & Theodore, H. (2017). An analysis of connectionism and schema construction in construction studies undergraduate students. *2017 7th World Engineering Education Forum*, *23*(3), 355-360.
- Ferguson, L. A. (2012). Implementing a video education program to improve health literacy. *The Journal for Nurse Practitioners*, *8*(8), 17–22. doi:10.1016/j.nurpra.2012.07.025
- Gatt, D., & O'Toole, C. (2017). Risk and protective environmental factors for early bilingual language acquisition. *International Journal of Bilingual Education and Bilingualism*, *20*(2), 117–123. doi:10.1080/13670050.2016.1179926
- Gmür, M. (2003). Co-citation analysis and the search for invisible colleges: A methodological evaluation. *Scientometrics*, *57*(1), 27–57. doi:10.1023/A:1023619503005
- Hatfield, N. J. (2013). The action, process, object, and schema theory for sampling. *16th Annual Conference on Research in Undergraduate Mathematics Education*.
- Hejny, M., Slezáková, J., & Jirotková, D. (2013). Understanding equations in schema-oriented education. *Social and Behavioral Sciences*, *93*(7), 995–999. doi:10.1016/j.sbspro.2013.09.317
- Huffmyer, J. L., & Nemergut, E. C. (2015). Test-enhanced learning in flipped classroom. *Anesthesia and Analgesia*, *121*(3), 589–590. doi:10.1213/ANE.0000000000000662 PMID:26287290
- Iii, H., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, *15*(1), 20–27. doi:10.1016/j.tics.2010.09.003 PMID:20951630
- Ji, Y. A., Lee, Y. M., Lim, H., Park, W. J., Jung, J. H., Lee, J. W., & Lee, B. D. (2018). Smartphone use and schema-based learning in dentomaxillofacial radiology practice: A case report from one college of dentistry. *Dento Maxillo Facial Radiology*, *47*(6), 1–8. doi:10.1259/dmfr.20170463 PMID:29658785
- Jitendra, A. K., Star, J. R., Rodriguez, M., Lindell, M., & Someki, F. (2011). Improving students' proportional thinking using schema-based instruction. *Learning and Instruction*, *21*(6), 731–745. doi:10.1016/j.learninstruc.2011.04.002
- Klueen, L. M., Nixon, P., Agorastos, A., Wiedemann, K., & Schwabe, L. (2017). Impact of stress and glucocorticoids on schema-based learning. *Neuropsychopharmacology*, *8*(3), 1–19. doi:10.1038/npp.2016.256 PMID:27841278

- Kolak, J., Norgate, S. H., Monaghan, P., & Taylor, G. (2020). Developing evaluation tools for assessing the educational potential of apps for preschool children in the uk. *Journal of Children and Media*, 15(3), 1–21. doi:10.1080/17482798.2020.1844776
- Lampinen, J., Copeland, S., & Neuschatz, J. (2001). Recollections of things schematic: Room schemas revisited. *Cognition*, 27, 1211–1222. PMID:11550749
- Liu, B. (2015). Application of schema theory in painting modeling. *2nd International Conference on Education, Language, Art and Intercultural Communication*, 37(2), 661-664.
- Liu, Z., Ma, Q., & Dong, X. H. (2017). Using schema teaching mode for students' cultural capability through learning culture-type English courses in class. *3rd Annual International Conference on Social Science and Contemporary Humanity Development*, 90(5), 363-368. doi:10.2991/sschd-17.2017.71
- Luo, Y. (2018). The application strategy of schema theory in college English reading teaching. *Atlantis Press*, 179(3), 297–301. doi:10.2991/ieesasm-17.2018.62
- Lv, Z. Y., & Shen, H. (2020). Artificial intelligence with fuzzy logic system for learning management evaluation in higher educational systems. *Journal of Intelligent & Fuzzy Systems*, 40(8), 1–11. doi:10.3233/JIFS-189387
- McCain, K. W. (1990). Mapping authors in intellectual space: A technical overview. *Journal of the American Society for Information Science*, 41(6), 433–443. doi:10.1002/(SICI)1097-4571(199009)41:6<433::AID-ASII1>3.0.CO;2-Q
- Meng, Q., & Tang, L. (2020). An artificial intelligence based construction and application of English multimodal online reading mode. *Journal of Intelligent & Fuzzy Systems*, 40(1), 1–10. doi:10.3233/JIFS-189406
- Nerur, S. P., Rasheed, A. A., & Natarajan, V. (2008). The intellectual structure of the strategic management field: An author co-citation analysis. *Strategic Management Journal*, 29(3), 329–336. doi:10.1002/smj.659
- Neumann, K. L., & Kopcha, T. J. (2018). The use of schema theory in learning, design, and technology. *TechTrends*, 62(5), 429–431. doi:10.1007/s11528-018-0319-0
- Ni, Y. (2020). Insights of short video APP on micro lesson design. *China Education Technology Equipment*, 24(2), 60-63.
- Qi, Y., Zhang, T., & Huang, J. (2018). Small private online course English teaching mode based on image schema theory of cognitive linguistics. *NeuroQuantology: An Interdisciplinary Journal of Neuroscience and Quantum Physics*, 16(5), 626–632. doi:10.14704/nq.2018.16.5.1407
- Roediger, H. L., & Karpicke, J. D. (2010). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science. A Journal of the Association for Psychological Science*, 1(3), 181-210. 10.1111/j.1745-6916.2006.00012.x
- Sarfraz, F., Razaq, N., Sarfraz, F., Ullah, M. S., Jawad, I., & Saeed, R. (2021). Small group discussion, an effective tool for learning. *Pakistan Journal of Medical & Health Sciences*, 15(10), 3281–3283. doi:10.53350/pjmhs2115103281
- Toraya, C. (2014). Evaluation of advanced directives video education for patients. *Journal of Palliative Medicine*, 17(8), 942–947. doi:10.1089/jpm.2013.0585 PMID:24773190
- Ubah, I. J. A., & Bansilal, S. (2018). Pre-service primary mathematics teachers' understanding of fractions: An action-process-object-schema perspective. *South African Journal of Childhood Education*, 8(2), 1–12. doi:10.4102/sajce.v8i2.539
- Vandergrift, L. (1999). Facilitating second language listening comprehension: Acquiring successful strategies. *ELT Journal*, 53(3), 32–34. doi:10.1093/elt/53.3.168
- Vlad, A. (2019). Video education made through content-sharing platforms. *Information and Communication Technology in Musical Field*, 10(1), 24–29.
- Yu, Y., Li, Y., Zhang, Z., Gu, Z., & Chen, E. (2020). A bibliometric analysis using vosviewer of publications on covid-19. *Annals of Translational Medicine*, 8(13), 816–816. doi:10.21037/atm-20-4235 PMID:32793661

Yu, Z. (2020). Visualizing artificial intelligence used in education over two decades. *Journal of Information Technology Research*, 13(4), 32–46. doi:10.4018/JITR.2020100103

Yu, Z., & Zhu, Q. (2019). Schema theory-based flipped classroom model assisted with technologies. *International Journal of Information and Communication Technology Education*, 15(2), 31–48. doi:10.4018/IJICTE.2019040103

Zhao, L., Chen, L., Liu, Q., Zhang, M., & Copland, H. (2019). Artificial intelligence-based platform for online teaching management systems. *Journal of Intelligent & Fuzzy Systems*, 37(1), 1–7. doi:10.3233/JIFS-179062

Zheng, C., Peng, F., & Xu, P. (2017). A study of college English reading teaching based on the perspective of schema theory. *Agro Food Industry Hi-Tech*, 28(3), 714–717.

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