Group Cooperative Teaching Design With Knowledge Graphs in Project-Driven Learning

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ABSTRACT

Using the educational knowledge graph to express the logical characteristics of knowledge, this paper takes project-driven learning in the teaching of “Information Technology in Secondary Schools” as an example and studies the group cooperative teaching mode based on the educational knowledge graph. The relationship between knowledge points in subject courses is described in the form of a knowledge graph, and the learning activities of coordinating the cooperation of each group are completed through the integration process of the knowledge graph. The use of a group cooperation teaching mode in the classroom can not only build a collaborative knowledge system between teachers and students but also help to carry out project-driven learning. The application of the knowledge graph of “Information Technology in Middle School” in the classroom can better show the logic between knowledge, and its graphical structure can help students to structure the knowledge they have learned.

KEYWORDS

Group Work, Knowledge Graph, Middle School Information Technology, Project-Driven

INTRODUCTION

The development of information technology has brought great convenience to life. In terms of education, the integration of education and information technology can stimulate student learning motivation and guide students to study independently. There have been many applications based on knowledge graphs in the general domain, but in terms of education, there are fewer applications. The “New Generation Artificial Intelligence Development Plan” clearly states that it is necessary to study knowledge graph construction technology, focus on educational knowledge graphs, and give full play to the advantages of knowledge graphs in teaching (State Council.,2017). The use of knowledge graphs in education can
effectively establish connections between knowledge points, thereby forming structured knowledge and establishing a complete knowledge system (Chen et al., 2018). As an important part of the new generation of intelligent education, knowledge graphs can not only stimulate self-learning motivation but also provide educational services for visualizing the relationship between knowledge concepts (A. Li et al., 2020), which facilitates teachers in carrying out project-driven learning group cooperation modes. At present, most information technology education relies on teachers to conduct classroom lectures. In this case, by using the logical characteristics of the educational knowledge graph, students are further guided to structure the knowledge system, and through the knowledge graph, a group cooperative teaching mode of project-driven learning can be carried out, which can actively guide students to conduct cooperative learning. A graph can improve the dull phenomenon of students in the classroom, create a warm learning atmosphere for students to learn, and improve the scientific and rational aspects of teaching. By investigating the application of knowledge graphs in teaching with information technology in middle school, the application of knowledge graphs can assist teachers in comprehensively understanding the process of students’ cognitive development and tacit knowledge learning through group meaning wisdom. Carrying out group cooperation learning activity classes and guiding students to carry out project-driven learning can stimulate autonomous learning motivation, improve the knowledge acquisition rate, increase communication and interaction, enhance students’ sense of participation in the learning process, and promote the improvement of learning quality.

RELATED WORK

Educational Knowledge Graphs

An educational knowledge graph is a knowledge base composed of nodes and their relationships, in which nodes represent knowledge points or teaching resources related to knowledge points (Li, 2020). Also known as a subject knowledge graph, it can help students and teachers understand subject development and basic knowledge and combine the implicit semantic information in a knowledge graph to promote the efficient use of subject knowledge. At present, some researchers have carried out related research on educational knowledge graphs. Li Zhen et al. (2019) analyzed the connotation of educational knowledge graphs from different perspectives, proposed the classification and construction technology of educational knowledge graphs, and expounded the application prospect of educational knowledge graphs from the aspects of educational big data intelligent processing, educational resource aggregation, and teaching implementation. Hou Xia et al. (2019) proposed an online teaching resource construction model based on the knowledge graph and the collaborative open online course (COOC) as the object. Su Xiang (2019) proposed the knowledge graph construction process and semantic retrieval of the course.

Currently, an increasing number of scholars at home and abroad have begun to focus on the research and construction of high-quality, large-scale knowledge graphs. At present, many large-scale, open, and shared knowledge graphs have been constructed at home and abroad, among which the most representative ones are Word Net (Fellbaum, 1998), Freebase (Bollacker et al., 2008), DBpedia (Auer et al., 2007), Zhishi.me (Niu et al., 2011), and so on. The introduction of knowledge graph technology into the field of education is helpful for the visualization, acquisition, and retrieval of knowledge (Hu et al., 2016), and it can also effectively promote the personalization and precision of teaching work. Therefore, education experts and scholars have begun to pay close attention to the research of knowledge graphs in education.

In foreign countries, Wolfram Research has built Wolfram Alpha, a knowledge base engine for intelligent knowledge retrieval, which supports knowledge query and calculation in multiple fields (Chechelnytskyy, 2012). Hall (1996) introduced a knowledge graph as a teaching aid in teaching and found that a knowledge graph can effectively improve learning efficiency. Domestically, the Knowledge Engineering Research Office of Tsinghua University has built eduKG, a knowledge graph of basic education with wide coverage. The knowledge graph covers the knowledge points of nine courses in the basic education...
stage, and based on the knowledge graph, it provides learners with search queries, intelligent questions, and answers (Xu et al., 2019). Feng Li (2019) constructed a middle school Chinese subject knowledge graph based on the ancient poetry data in the software and visualized the subject content.

In summary, the educational knowledge graph is in a developing stage, and there is still much research space. The construction and retrieval functions of educational knowledge graphs are basically perfected. Through the construction and retrieval of educational knowledge graphs, knowledge graphs can be introduced into teaching work. On the basis of constructing the knowledge graph of information technology in middle school, using the construction process of the knowledge graph, students are guided in carrying out project-driven group cooperation learning activities. Teachers issue tasks, and students are task-driven to build a knowledge graph in an individual – in-group – between-groups manner. In the process of building a knowledge graph, students, as the main body of learning, actively participate in the construction of the knowledge graph.

Project-Driven Teaching

The project-driven teaching method is a teaching method that implements an inquiry-based teaching mode. From the learner’s point of view, project-driven learning is a learning method that can help learners construct knowledge actively with clear learning goals. From the teacher’s point of view, project-driven teaching is a teaching method based on the theory of constructivism, which is suitable for cultivating students’ ability to learn independently, analyze problems and solve problems. As the main body of learning, students no longer regard learning as a task but learn according to project needs and change from passively accepting knowledge to actively seeking knowledge. The process of students completing the project is the process of student learning.

Group Learning Mode

The development and research of cooperative learning have a long history and involve a wide range of areas. Group cooperative learning activity is a creative classroom teaching thought and teaching strategy. To adopt the teaching method of group cooperative learning, it is necessary to combine various factors to design the teaching link. Combined with the specific situation of individuals and the differences of different individuals, students are divided into groups to achieve intragroup heterogeneity and intergroup homogeneity. In group cooperative learning, all members should have clear and common learning goals. Team members have both individual and collaborative tasks. Student groups work together to promote cognitive and emotional learning, and teachers should award classroom rewards based on the group’s overall performance.

Research on cooperative group learning models has also been a topic of great interest in the educational community. In the current study, Lubis (2017) concluded that physics students using a cooperative learning model have better academic performance GI than traditional learning, and there is an interaction between the cooperative learning model GI and AQ in terms of academic performance in physics. Cao Xue (2019) studied the practicality of a cooperative group learning model in the context of “Internet+” and how it can be applied to the teaching practice of English in college. Emilia S. compared the cooperative group learning model with the conventional learning model and concluded that the cooperative group learning model is more beneficial to students’ learning by considering the indicators of logical thinking, learning mode, and performance. Liu Yimin (2020) explored the facilitative effect of the group cooperative learning model on student learning by integrating it into the classroom through several cases.

DESIGN OF A GROUP COOPERATION MODE IN PROJECT-DRIVEN TEACHING

According to the curriculum requirements of information technology in middle school, the application of a knowledge graph in teaching was carried out. The curriculum design adopts a teaching mode based on group cooperation and carries out project-driven learning. Teachers drive student learning by publishing tasks. In the early stage of the course, students draw a personal knowledge graph
through their own recall and review; in the middle of the course, students cooperate in drawing a knowledge graph within the group through group discussions and comparison of the knowledge graphs of classmates in the group. Then, the intragroup knowledge graph of each group is combined to draw the intergroup knowledge graph; in the later stage of the course, the intergroup knowledge graph is compared with the teacher’s knowledge graph, the existing knowledge system is checked and filled, and the teacher-student collaborative knowledge graph is obtained. Through the collaborative knowledge graph between teachers and students, students and teachers reflect on and correct the deficiencies in previous learning and teaching, respectively. In this teaching design, teachers and students, as the main characters of the collaborative system, jointly build a collaborative system. In the whole process, teachers guide students in completing tasks correctly, mastering the students’ learning situation, and reflecting on deficiencies in previous teaching. By completing the tasks issued by the teacher, after recalling the knowledge they have learned, the students actively participate in the cooperative discussion of the group. The specific design is shown in Figure 1.

**Construction of the Knowledge Graph**

The main task of teachers is to carry out project-driven learning and guide the student community to carry out collaborative knowledge construction. In the process of project-driven learning, teachers need to prepare knowledge graphs in advance, and students also refine and form knowledge graphs in the course learning. The construction of the knowledge graph can be regarded as an iterative updating process, and each iteration contains four stages: knowledge storage, information extraction, knowledge
Knowledge storage involves designing the underlying storage method for building the knowledge graph and complete the storage of various types of knowledge. The storage method will directly affect the query efficiency and application effect. Information extraction involves extracting entities, attributes, and interrelationships among entities from various types of data sources and then form ontological knowledge representation. Knowledge fusion involves integrating new knowledge after obtaining it in order to eliminate contradictions and ambiguities, such as multiple expressions of entities, a specific appellation corresponding to several different entities, etc. Knowledge calculation involves adding the qualified parts to the knowledge base after screening and evaluation with human participation to ensure the quality of the knowledge base. The process of constructing the knowledge map under the cooperative group learning model is shown in Figure 2.

In the preparation stage before the course, the teacher enters the knowledge graph visualization software by importing each entity and its relationship, that is, each knowledge point and its relationship, and obtains the teacher’s knowledge graph for use in the course summary. In the early stage of the course, teachers will group students according to their learning situation and ability to ensure that two or more groups are assigned to the same learning tasks, and at the same time, two or more students in the group must be assigned to the same learning tasks. At the same time, we comprehensively control the difficulty of the course and the difficulty of building a knowledge graph in this class to avoid the incomplete knowledge graph constructed due to the one-sided knowledge system of students. Through different student understandings of the relationship between the same knowledge, teachers actively guide students to visualize the acquired knowledge and the relationship between knowledge and create a knowledge graph of students. In addition, guide students to take the initiative to share the acquired knowledge and connections and to discover the knowledge points missed in the process of knowledge acquisition in the process of independent discussion and sharing.

In the middle of the course, after the construction of the individual knowledge graph of students is completed, the teacher will lead the students to merge the knowledge graph within the group to ensure that each entity in the knowledge graph has the same name and correct relationship. After the knowledge graph is merged, an appropriate amount time for students to discuss and share is allowed. Afterward, the individual knowledge graphs of students are merged into a group knowledge graph within the group. The teacher collects the knowledge graphs of each group and compares the knowledge graphs constructed by the groups assigned to the same task with the knowledge graphs constructed by the teacher in the course of lesson preparation. The teacher leads the students to analyze the differences in the knowledge graph constructed under the same task, analyze the weak parts of the students’ knowledge, and improve the knowledge graph within the group again.

In the later stage of the course, the collected knowledge graph of the group will be merged to complete the construction of the class knowledge graph of the class, and the top-to-bottom explanation
will be given according to the entities provided in the class knowledge graph and the relationship between the entities to deepen student understanding of the knowledge and subtly guide students to sort out the knowledge structure. Then, teachers will compare the knowledge graph constructed during lesson preparation with the knowledge graph constructed by students in the classroom, focusing on the differences in the knowledge graph. Students were instructed to supplement, revise and improve the knowledge structure diagram they designed and optimize their understanding of the structure of the current course knowledge points.

**Design of Student Learning Activities**

The main task of students is to build a learning activity of reviewing knowledge points based on the individual – in-group – intergroup knowledge graph according to the tasks issued by the teacher and participate in the process of collaborative knowledge construction together with the teacher. In the early stage of the course, students define the learning objectives of the class according to the tasks of the learning activities arranged by the teacher, recall and review the knowledge points they have learned before, and conduct review discussions with the students who have been assigned the same tasks to build a simple personal knowledge structure diagram. In the middle of the course, under the guidance of teachers, students build and improve the knowledge graph within the group and share their understanding of the learned knowledge points in groups. Then, the knowledge graph is merged between groups to construct the knowledge graph between groups. In a later stage of the course, students will compare the intergroup knowledge graph constructed in class with the knowledge graph constructed by the teacher in the course preparation, supplement and improve the knowledge graph designed by themselves, and reflect on their problems in learning by comparing the different parts.

**Teacher-Student Collaborative Knowledge Graph**

At the end of the course, teachers carry out task summaries and compare the knowledge graphs of teachers with the knowledge graphs of students between groups, focusing on the differences between the graphs. Teachers and students discuss and communicate together, discover their advantages and disadvantages, and finally construct a teacher–student collaborative knowledge graph. Through the process of constructing a knowledge graph in collaboration with teachers and students, students reflect on their shortcomings in their learning, what knowledge points are missing, and carry out targeted supplementary learning. Teachers reflect on their own shortcomings in teaching, analyze the reasons for the problems, and make corrections. As a result, between teachers and students, through the knowledge graph, positive feedback of learning in the learning process is given, and a collaborative knowledge system is constructed.

**SYSTEM VERIFICATION**

**System Presentation**

Through the learning path recommendation system, teachers can find the knowledge graph of each chapter in the system during lesson preparation, obtain the teacher knowledge graph required by the course, and check students’ in-group knowledge graph and intergroup knowledge graph after class. The teacher-side design is shown in Figure 3.

In addition, students can view the intragroup knowledge graph and intergroup knowledge graph of each class through the system. At the same time, the student side has a series of functions, such as feedback, to their own learning situation through the system. The student-side design is shown in Figure 4.

**Effect of Validation**

The teacher evaluates the performance, participation, and classroom performance of each group member. The group displays learning outcomes through knowledge mapping to demonstrate mastery
of learning knowledge. In the process of joint cooperative exploration, the group cooperation model in project-driven teaching not only stimulates student interest and enthusiasm in learning but also further improves their comprehensive application skills. At the same time, this model also cultivates a student spirit of cooperation, innovation and problem solving.

A six-week validation experiment was conducted on approximately 100 students from two classes in the first grade of the middle school affiliated with Henan Normal University. Student acceptance of the new teaching mode is reflected through the change in the number of interactive weeks per
capita. The weekly number of interactions per capita, that is, the weekly average of the total amount of information feedback between teachers and students in the modified class, can reflect the enthusiasm of students for learning in this mode. Judging from this degree indicator, the expected result should be that the number of interactions gradually increases with the experimental time of the system and finally stabilizes at a relatively high value. It can be seen that students are willing to accept the group cooperation mode in project-driven learning based on knowledge graphs, and under this teaching mode, the teamwork spirit is also continuously enhanced. It can be seen that students are willing to accept the group cooperation model in project-driven learning based on knowledge graphs, and in this teaching model, the frequency of student use increases, which shows that student initiative in learning is continuously enhanced, and they are adapting to this new teaching mode. Figure 5 shows the experimental results of evaluating this indicator of the above two classes as follows.

The group project completion score, in which the instructor rates the group students weekly based on their completion and quality of work in project-driven sessions. This indicator reflects how motivated the group members are in terms of progress toward completion. The six-week grading trend shows the growth of student motivation, participation, and collaboration in completing the project-driven lessons. It is evident that project completion ratings in the knowledge mapping-based, project-driven learning increased week by week in the collaborative group model. This phenomenon indicates that student motivation, participation, and collaboration increased significantly in this model compared to the beginning. Figure 6 shows the evaluation results of this indicator for the eight groups of students in the two classes mentioned above.

CONCLUSION

In the whole teaching model design, regardless of the early, middle, or late in a course, the knowledge graph as a tool runs through it all the time. The application of a knowledge graph plays a key role in student cognition and the improvement of the overall structure of knowledge points. For teachers, a knowledge graph is used as a teaching tool to visually organize the knowledge that students have mastered to structure the knowledge system that students have learned. The teaching mode of group cooperation is adopted in the learning activity class to construct the collaborative knowledge system and reflect on the problems existing in teaching. For students, based on the knowledge map of information technology based classroom teaching mode design theme is to let students in knowledge

Figure 5. Experimental results of weekly interaction per capita

<table>
<thead>
<tr>
<th>WEEK</th>
<th>Class A</th>
<th>Class B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>3.573</td>
<td>2.962</td>
</tr>
<tr>
<td>Week 2</td>
<td>4.682</td>
<td>3.957</td>
</tr>
<tr>
<td>Week 3</td>
<td>6.874</td>
<td>6.156</td>
</tr>
<tr>
<td>Week 4</td>
<td>10.548</td>
<td>11.138</td>
</tr>
<tr>
<td>Week 5</td>
<td>11.647</td>
<td>11.831</td>
</tr>
<tr>
<td>Week 6</td>
<td>11.596</td>
<td>11.935</td>
</tr>
</tbody>
</table>
and knowledge as much as possible to establish contact, through the relevance of various knowledge as far as possible divergent students’ scientific thinking, rather than the students’ thinking fixed in a class of fixed knowledge, let students active systematic establish the overall structure of information technology basic subject. Teachers should encourage students to take the initiative to systematize the whole structure of the basic subject of information technology. The purpose of this teaching mode is not only to let students master the teaching tasks stipulated in the textbook but also to cultivate students’ scientific literacy, scientific thinking ability, independent learning, and awareness of scientific inquiry; to improve students’ consciousness regarding cooperation; and to deepen their concept of independent cooperation and unity.

In high school, information technology-based learning activities using this method, students not develop only scientific thinking and unity cooperation but, at the same time, learn knowledge. It helps students form an understanding of the basic knowledge of information technology, construct knowledge structures, and consider relationships, while cultivating scientific thinking, promoting the students’ learning behavior, cultivating a consciousness of independent learning, promoting cooperation and communication skills, building scientific literacy, enriching students’ cognition of scientific knowledge, and exercising students’ abilities in independent inquiry.

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