Original Article

Effectiveness of Students' Self-Regulated Learning during the COVID-19 Pandemic

Ruichang Cai, Quanzhou Wang, Jiangjun Xu, Longjun Zhou

SUMMARY

Self-regulated learning means that learners can set their own learning goals, determine content and progress, choose skills and methods, monitor the entire process, and conduct self-assessment. During the COVID-19 Pandemic, students' self-regulated learning became the main learning method, but whether this learning method is effective remains to be tested. This study used 8th grade students from four middle schools in Changyuan County, Henan Province of China as objects, and explored the effects of self-regulated learning for students in special periods through educational experiments, and on this basis, proposed methods that would be more suitable for students self-regulated learning. A total of 2,536 students in the 8th-grade of the four middle schools, including 1,270 in the experimental group and 1,266 in the control group were selected. Through SPSS20.0, the pre- and post-test results of the two groups are analyzed and found: (i). Under a special period of background, self-regulated learning of some subjects is effective; (ii). Compared with self-regulated watching teachers live on the Internet platform Learning method, using protocol-guided learning for self-regulated learning, students learn better. Therefore, we suggest that: (i). Teachers should guide students to carry out self-regulated learning according to the characteristics of the discipline; (ii). Teachers should choose self-regulated learning materials and methods suitable for students according to their academic conditions.■

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SELF-REGULATED learning refers to actively and flexibly applying metacognitive learning strategies, inspiring learning motivation, and making active self-monitoring, self-feedback, and self-regulation of their learning behavior based on learning goals set in advance and perform self-examination and self-evaluation (1). In China, self-regulated learning advocated by curriculum reform has always been an important issue. Due to different countries and educational conditions, the common self-regulated learning model abroad is not completely suitable for China. Chinese educators have made arduous efforts in exploring the self-regulated learning model of students with Chinese characteristics, and also formed some effective teaching models (2). However, so far, most people recognize and understand these teaching models based on experience rather than empirical evidence. Therefore, it has been difficult to provide robust evidence on whether students' self-regulated learning methods are effective and which self-regulated learning methods are more effective.

During COVID-19 Pandemic, under the call of the Chinese government, schools have launched online teaching activities. During this period, students' self-regulated learning became the mainstream learning method. In the context of breaking away from the school's routine teaching and counseling, can students' self-regulated learning improve students' performance? And which self-regulated learning method is more effective? became problems that need further study.

The first middle school in Changyuan County, Henan Province has begun to explore the use of protocol-guided learning to guide students in self-regulated learning in recent years. After years of practice, it has formed a unique model and achieved remarkable results. During the isolation period of COVID-19, No. 1 Middle School of Changyuan County strictly followed the national requirements and implemented online teaching to ensure the normal progress of the teaching process. To observe the effectiveness of students' self-regulated learning methods using protocol-guided learning in special periods, we intended to obtain scientific evidence through a rigorously designed experimental study to evaluate students' self-regulated learning methods.

THE CAUSE OF THE RESEARCH

In the early 1980s, Holec proposed that self-regulated learning means that learners can set their own learning goals, determine contents and progress, choose skills and methods, monitor the process of self-learning, and conduct self-assessment. For self-regulated learning, there are many successful studies abroad (3).

Van and Schenk once researched self-regulated learning of college students, and found that compare students who used mechanized learning methods with those who could use their existing knowledge to try to understand new knowledge and explain new knowledge, no big difference existed in the knowledge they learned, but in the study of subjects that require understanding, synthesis, and creation, the latter performed significantly better than the former (4). Zimmerman and Martinez found in their follow-up study of the tenth graders that those who had better grades usually use more self-regulated learning strategies, such as goal setting, record-keeping, self-rewards, etc. than average students (5). Pintrich and Groot studied the relationship between the self-efficacy, self-regulation of the learning process and the academic performance of 173 grade 7 students, and the results showed that the higher the self-efficacy of the students, the more they could mobilize their desire for self-regulated learning, thereby enhancing the students' academic achievements (6).

The study of self-regulated learning in China began in the late 1970s, and domestic scholars and education experts have dedicated themselves to teaching experiments aimed at guiding students to self-regulated learning. Typical teaching experiments include Duan Lipei's "Eight-Character (Bazi) Teaching Method" of Shanghai Yucai Middle School; "Self-study, Discussion, Guidance" teaching method of Li Gengnan of Nantong Qixiu Middle School; "Self-study Tutoring Teaching" by Institute of Psychology, Chinese Academy of Sciences; Wei Shusheng's "Six-Step Teaching Method" in Liaoning Province; Qian Menglong's "Guidance Teaching Method" at Shanghai Jiading Middle School, etc.. The above experiments were all based on students' self-regulated learning. In the long-term research, they aimed to find a more scientific and rigorous way to promote self-regulated learning and thereby improving students' academic level (7).

Since 2001, research on self-regulated learning has shifted from theory to practice (7). Yang and Zhang surveyed 152 college students using a questionnaire, studied the correlation between the application of self-

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regulated learning strategies and reading comprehension, and found that self-regulated learning level was significantly positively correlated with students' reading performance (8). Gong and Liu observed middle school students' reading metacognition and suggested that the strength of students' self-regulated learning ability greatly affects their grades (9). Zeng and Wu also used a questionnaire survey to investigate the use of self-regulated learning strategies for the second-year non-English major students in a university in Shanghai and found that reading ability was significantly positively correlated with the use of self-regulated learning strategies (10).

Although many domestic and foreign studies have proved that self-regulated learning could effectively improve students' academic performance. However, it is not difficult to see that the results were based on the guidance of teachers under normal teaching in the school or the guidance of counseling institutions under normal operation. Therefore, both factors of teacher guidance and counseling institution guidance had not been effectively controlled. This makes it difficult to see whether students' self-regulated learning is effective or not without the guidance of teachers or counseling institutions, so the robustness of these studies needs to be further verified.

Affected by COVID-19, the Ministry of Education issued the document "Performing 'School is Out, but Class is On' through Internet Platform" in January 2020. The document stated that the Ministry of Education is coordinating and integrating the relevant teaching resources and relevant schools, providing a variety of high-quality online teaching resources that can be selected that cover all areas, and fully guarantee that teachers teach online and students learn online (11). It can be seen from this that the key to students' "Non-Stop Learning" lies in what and how students learn. Around this problem, many schools have made effective attempts.

The above-mentioned analyses show that students' self-regulated learning contributes to the improvement of their academic level. However, without the guidance of teachers and counseling institutions, is the student's self-regulated learning effective? Do different self-regulated learning methods affect students' academic performance? To clarify these problems, stronger evidence is needed. This study took self-regulated protocol-guided learning as the main intervention variable in Changyuan No. 1 Middle School of Henan Province and

explored the above two issues through an educational experiment.

METHODS

Objective

As mentioned above, self-regulated learning is a hot topic in the field of education at home and abroad, and it is also an effective means to improve students' academic performance. However, in previous studies, the influence of two factors – guidance from teacher and counseling institution, could not be ruled out. Therefore, the robustness of these results needs to be further improved. Based on this understanding, the main purpose of our study was to verify whether it is effective for students to independently conduct self-regulated learning during the COVID-19 pandemic and in this process, explore and propose an effective method that is more suitable for students' self-regulated learning.

Participants

We selected 8th-grade students from four middle schools in Changyuan County, Henan Province, China as subjects. Among them, the No. 1 Middle School in Changyuan County was used as the experimental group. Only 1,270 students from its 8th-grade classes were selected, and in which the students received the teaching mode of protocol-guided self-regulated learning. The control group was three other middle schools in Changyuan County with a total of 1,266 students. These three schools adopted the online live teaching mode, so the characteristics of teacher-led teaching are more obvious.

To better control the influence of the students' intellectual conditions and pretest differences on the results, we first investigate the students' family background and parents' educational level, etc., to exclude the influence of related confounding factors. After getting the pre-test scores, we matched the two sets of data and matched the samples according to the students' total scores of Chinese, Mathematics, and English. Finally, there were 1,270 effective samples in the experimental group and 1,266 effective samples in the control group. The four schools participating in the research are all public schools with good local strength and reputation.

They are comparable in terms of teachers, students, and schooling conditions among the four schools.

Intervention Procedures

Protocol-guided self-regulated learning is the main intervention in this experiment. During the Pandemic period, the No. 1 Middle School in Changyuan County, Henan Province adhered to the teaching concept of taking students as the main body, combined with the school students 'learning situation, and adopted a six-step teaching method to guide students' online learning at home (12). The procedures are as below:

(i) Teachers assign learning tasks. The teacher arranges protocol-guided learning through the platform, and the students receive and complete it.

(ii) Students follow the protocol preview and upload the independently completed preview to the learning group on the platform for discussion and communication between the group members.

(iii) Parental supervision and teacher guidance. Parents urge children to learn. Teachers should check the group's summary report in time to understand the students' self-regulated learning situation, answer questions, and communicate with parents on time.

(iv) Question feedback progresses layer by layer. For the preview tasks assigned by teachers, students gradually digested in groups, and the problems that could not be digested were solved as the major and difficult points of teaching.

(v) Teachers give online lecture guidance, and then feedback on error correction. Teachers give targeted guidance according to the preview situation.

(vi) Consolidate and improve. The teacher once again arranges exercises to students through the online learning platform, the students complete the corresponding exercises independently and review and summarize under the guidance of the teacher.

The control group only used the online live broadcast method provided by the "cloud video" remote conference software to carry out teaching activities.

Test Tools

The test tool was a unified and standardized test paper prepared by the Teaching and Research Section of Changyuan County, Henan Province. The staff who prepared the test papers had rich teaching experience,

and the test papers had shown good reliability and validity. The pre-test results are selected from the 2019 final exam results, and the post-test results are the test results on April 28, 2020.

In both groups, the primary outcome was based on student achievement as an indicator of teaching effectiveness. The experimental group mainly conducts self-regulated learning based on the protocol-guided learning mode. Students actively find and solve problems through pre-class previews, and improve their achievements by training students' self-regulated learning ability. The control group used the mobile company "cloud video" remote conference software for online teaching, teachers' "teaching" was the main body, students "learning" was the subsidiary.

Time Segmentation

This study started planning in late January 2020, officially started in early February 2020, and ended in late April 2020. The three subjects of 8th grade Chinese, mathematics, and English in the four schools are used as a research reference, and the students' learning progress and contents were consistent.

The preparation stage for research planning will be in late January 2020. At this stage, the four schools first determined the participating students and teachers. Through matching and comparison, to ensure that the situation of the participating teachers and students is the same, there is no significant difference. Second, coordinate the teaching content and progress, and train the two groups of teachers separately to ensure that the four schools' autonomous online learning model meets the experimental requirements. Finally, prepare the materials needed for the study and determine the specific process.

The implementation phase was from February to the end of April 2020 that lasted for 13 weeks. At this stage, the four schools taught according to their teaching models. Before and after the study begins, pre-test and post-test were conducted on the participating students. The pre-test scores are selected from the final exams of the four schools, and the post-test scores are the test scores organized in a unified manner after resuming to normal teaching.

RESULTS

Both groups selected the final test scores of 8th-grade students as the pre-test data. The analysis of test scores is shown in **Table 1**.

SPSS 20.0 was used to conduct independent sample t test for the three subjects of Chinese, mathematics, and English. It can be seen from **Table 1** that the two groups have similar averages in the three subjects. Mathematics has the smallest t value of 0.179, English has the largest t value of 0.938, and all three subjects have values greater than 0.05, with no significant difference. According to the data, it can be concluded that before the self-regulated learning of the two groups of participating schools, there is no significant difference in student learning level.

To verify the effectiveness of the use of protocol-guided self-regulated learning, after the students resumed, the participating schools used the unified standardized test papers prepared by the Teaching and Research Section of Changyuan County, Henan Province to post-test the 8th-grade students' Chinese, mathematics, and English. The results are analyzed as follows:

Table 2 shows that the post-test student achievements, whether in the experimental group or the control group, have completed basic learning tasks in the Chinese language discipline. The average value of the Chinese subject in the experimental group was 75.241, and the average value of the Chinese subject in the control group was 63.152. However, the effect of English and mathematics learning is not significant, and the average value has not reached the qualified level, i.e., the average value is greater than or equal to 60% of the total score. Therefore, we conclude that students' self-regulated learning is effective in some disciplines, but the learning effect in some disciplines is not obvious.

The further comparison revealed that the average scores of the two groups in Chinese, mathematics, and English were significantly different from the previous test. Among them, the average score of the two groups of mathematics subjects differed by nearly 10 points, indicating that the use of protocol-guided self-regulated learning improved academic performance ($p < 0.01$). At the same time, the test effect amount is expressed as the standardized mean difference (Cohen's d), and its threshold is 0.2-0.5 small difference, 05-0.8 medium difference, and more than 0.8 difference. When comparing the two front-to-back effects, it was found that all three subjects produced moderate effects. Based on this, we believe that students using protocol-guided self-regulated learning have better learning effects than conventional online learning.

DISCUSSION

Is Student's Self-Regulated Learning Effective in the Context of Special Period?

Based on the data in Table 2, we can see that students' self-regulated learning is effective for some disciplines, and there are certain differences in the effectiveness of different disciplines. For this difference, we analyze from the following points:

(i) The knowledge structure is different.

Different disciplines have different logical structures. Generally, scientific knowledge with stronger scientific discipline is more systematic, and the effect of systematic knowledge analysis on data to improve student performance is often more significant. This is also the main reason for the difference in the effect of using data analysis systems between different disciplines.

The basic structure of the subject refers to the relevant concepts and principles of the modern scientific knowledge system in each subject area (13). The basic structure of different disciplines means that teachers and students need to use different ways of thinking and different learning methods; at the same time, learners need to understand and master the thinking quality of each subject for effective learning in each subject. The development of specific thinking in subject learning is conducive to improving learning efficiency (14).

Therefore, in online teaching activities, teachers should understand the characteristics of the disciplines they teach, and adopt a variety of teaching methods to train students' thinking in subject learning, so that students' academic performance can be improved.

(ii) Teachers have different teaching methods.

Lin pointed out in his research that students in different disciplines have different requirements for classroom teaching methods, and the requirements of such differences are significant (15). The data showed that among the 985 valid student data, 405 students wanted teachers' teaching methods to be more funny and humorous, accounting for 41.1% of all students participating in the

Table 1. The Pre-Test Data of the 8th Graders.

Subject	Group	N	Mean	SD	*t*	*p*	*Cohen's d*
Chinese	Experiment	1,270	84.859	14.890	0.574	0.566	0.023
	Control	1,266	84.528	14.140			
Mathematics	Experiment	1,270	75.606	30.608	0.179	0.858	0.007
	Control	1,266	75.398	27.631			
English	Experiment	1,270	66.865	26.456	0.938	0.348	0.037
	Control	1,266	65.868	27.098			
Total	Experiment	1,270	227.331	63.242	0.716	0.474	0.028
	Control	1,266	225.795	42.786			

Table 2. The Post-Test Data of the 8th Graders.

Subject	Group	N	Mean	SD	*t*	*p*	*Cohen's d*
Chinese	Experiment	1,270	75.241	14.193	17.920	0.000	0.712
	Control	1,266	63.152	19.386			
Mathematics	Experiment	1,270	32.218	18.060	13.846	0.000	0.550
	Control	1,266	22.684	16.581			
English	Experiment	1,270	54.933	24.675	15.472	0.000	0.615
	Control	1,266	40.499	22.236			
Total	Experiment	1,270	162.392	49.943	18.125	0.000	0.720
	Control	1,266	126.336	50.237			

test. Further authors also found that the humanities and social science students who chose this item were 12.7% higher than those of science and engineering. This data showed that the humanities and social sciences students have higher requirements on the teaching methods of teachers. Not only do they hope that teachers have rich professional knowledge, but also require teachers to be funny in teaching and become students' friends.

Based on this, teachers should adopt corresponding online teaching methods according to the learning needs of students in different disciplines to better stimulate students' learning interest and creativity.

(iii) Students have different study habits.

Ma et al. used a questionnaire to conduct a survey of 1,131 college students in three different disciplines: medical, science and engineering, and liberal arts (16). The data shows that in terms of students' good learning habits, the performance of liberal arts students was significantly stronger than that of the other two disciplines (P < 0.01 and P < 0.001, respectively).

Therefore, we believe that students in different disciplines have obvious differences in their learning habits. When conducting online teaching, teachers should cultivate students' good study habits according to the characteristics of the subject, to improve the quality of teaching and students' academic performance.

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Using Protocol-Guided Self-Regulated Learning, Do Students Learn Better?

Protocol-guided learning as a local teaching model in China, its effectiveness has been confirmed by many studies. To verify the effectiveness of the protocol-guided learning-based flipped classroom model, Ma surveyed 144 students in a school through questionnaires and educational experiments (16). 90% of the students believed that the protocol-guided learning-based flipped classroom plays an important role in cultivating and improving cooperative learning ability.

The author also found that the average difference between the two groups was 0.788, the t-value was 3.911, and the significance was 0.000 (P < 0.01). This shows that the flipped classroom teaching based on protocol-guided learning is acceptable and successful.

To verify the effectiveness of protocol-guided learning, Du verified the effectiveness of protocol-guided learning through questionnaire surveys and data analysis by analyzing four dimensions like students' self-regulation, time management, learning strategies, and learning motivation (17). The results showed that compared with the control, the experimental one had a p-value of less than 0.05 in all four dimensions, and the mean value was greater than that of the control. It is concluded that the learning ability of students using the "protocol-guided learning" teaching model is higher than that of students using the traditional teaching model, which may improve the students' learning ability. Zhou et al. also showed through research that compared with the traditional teaching model, the teaching model based on protocol-guided learning is more student-centered because it is more student-centered, which can mobilize student autonomy (2). It plays a significant positive role in students' academic performance, and the effect before and after the research is 0.259.

By comparing the post-test results of the two groups, we found that the post-test results of all three subjects in the experimental group are significantly higher than the control group, which is consistent with the above-mentioned studies. Based on this, we believe that using protocol-guided self-regulated learning, students' learning effect is better.

CONCLUSION AND SUGGESTION

Based on the results of this study, we suggest that:

(i) **Teachers should guide students to carry out self-regulated learning according to the characteristics of the discipline.**

From the results of the pre- and post-test analysis of the experimental group, we can see that even if the students use the same teaching materials and methods for self-regulated learning, there are still significant differences between the achievements of different disciplines. Therefore, we suggest that teachers should fully consider the characteristics of different disciplines when guiding students to conduct self-regulated learning, starting from the knowledge structure of the discipline itself and adopting appropriate methods to guide students to carry out self-regulated learning, to improve students' academic performance effect.

(ii) **According to students' academic conditions, choose appropriate self-regulated learning materials and methods.**

Learning is a student-centered activity. Therefore, regardless of the choice of teaching methods or the choice of learning methods, teachers must fully consider the students' cognitive level.

In the selection of self-regulated learning materials, we should take the standpoint of student learning from the perspective of student development, cultivate students' awareness and ability to discover and solve problems independently, and let students fully exert their autonomy under the guidance of teachers, thereby enhancing students' Academic performance (18).

To guide students in the choice of self-regulated learning methods, teachers should change students' learning methods and guide students to effectively carry out self-regulated learning according to the characteristics of students' home learning and on the premise of respecting learning laws, so as to improve students' self-learning ability and the purpose of learning interest (19).■

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