

VOLUME 05

FEBRUARY, 2020

NUMBER 01



SCIENCE INSIGHTS Education Frontiers

PUBLISHED BIMONTHLY BY
INSIGHTS PUBLISHER

COPYRIGHT, 2020, BY INSIGHTS PUBLISHER

Made in the United States of America





EDITORS

Editor-in-Chief

Roger Shouse (*Pennsylvania, USA*)
Email Address: rcs8@psu.edu

Executive Editor-in-Chief

Longjun Zhou (*North Carolina, USA*)
Email Address: sief@scineer.bonoi.org

Editorial Board Members

Se Hye Choi (*Seoul, South Korea*)
Hanlin Deng (*Guangzhou, China*)
Bruce R. English (*Manchester, UK*)
Julian H. Lipsitch (*Pheonix, USA*)
Maria Miller (*Washington, DC, USA*)
Sandro N.F. de Serpa (*Ponta Delgada, Portugal*)
Jane H. Smithson (*Chapel Hill, USA*)

Linguistic Editors

Sarah K. Newton (*Chapel Hill, USA*)
Stephen J. Stenger (*Gainesville, USA*)

Statistical Editors

Dennis S. Lee (*Los Angeles, USA*)

Editorial Office

Paul Barlow (*Production Editor*): paul.barlow@basehq.org
Amie S. Cahill (*Technician*): amie.cahill@bonoi.org
Staphenia D. Park (*Publishing Administrative Coordinator*):
staphenia.park@basehq.org
Monica R. Silber (*Editor Assistant*): monica.silber@bonoi.org

Susan J. Song (*Secretary*): susan.song@bonoi.org
Jean L. Worder (*Editor Assistant*): jean.worder@basehq.org
Editorial Office: editorial-office@bonoi.org

Executive Publisher
Insights Publisher

Table of Contents

Newsletter

Do Private Schools Give Students an Educational advantage? A Study from England (By Henderson, M., Anders, J., Green, F., & Henseke, G.)	445
The Impact of Peer Assessment on Academic Achievement (By Double, K. S., McGrane, J. A., & Hopfenbeck, T. N.)	446
How do Teachers Choose to Give Feedback? (By Skipper, Y., & Douglas, K. M.)	447
Can School Readiness Tests Predict Future Success in School? (By Stormont, M., Cohen, D. R., Herman, K. C., & Reinke, W. M.)	448
Computer Games to Improve Children's Math and Science Achievement (By Roy, P., Rutt, S., Easton, C., Sims, D., Bradshaw, S., & McNamara, S.)	449

Original Article

Teaching for Student Learning: Exploration of Teaching Strategies Based on Protocol-Guided Learning (By Xia, J.) (Zhenjiang, China)	451
Can Student Self-Directed Learning Improve Their Academic Performance? Experimental Evidence from the Instruction of Protocol-Guided Learning in China's Elementary and Middle Schools (By Zhou L., & Li, C.) (Nanjing & Zhenjiang, China)	468
Eating Breakfast or Attending Extracurricular Tutoring, Which One is More Effective in Improving Student's Performance? An Empirical Study Based on the Data from A Large-Scale Provincial Survey (By Liu, Y., Yao, J., Li, W., Cai, R., & Zhou, S.) (Nanjing, China)	481



Science Insights Education Frontiers

pISSN 2644-058X

eISSN 2578-9813

<http://www.scineer.bonoi.org/>

Is Indexed by



Do Private Schools Give Students an Educational Advantage? A Study from England

By Henderson, M., Anders, J., Green, F., & Henseke, G.

RESearchers at the Institute of Education at University College London have conducted a study that looks at whether there are any educational advantages to attending private schools in the upper secondary years (Grades 11 and 12).

Published in the *Oxford Review of Education*, the study used data from the Centre for Longitudinal Studies' Next Steps cohort study and linked this to national student achievement information between 2005 and 2009. The researchers followed a sample of 5,852 students who attended a private or state school while doing their A levels (high-stakes exams taken at the end of Grade 12 and important for university admission). The findings were:

- The profiles of the two groups of students were very different – students arrived in private school sixth forms with significantly higher prior attainment in GCSEs (exams taken at the end of 10th grade), and from households that had twice the income of families whose children attended state school sixth form.
- However, the researchers used the data available from Next Steps to allow for socio-demographic characteristics and prior achievement. Allowing for these characteristics, students at private schools outperformed those at state schools in their total A level score by eight percentile points.
- Private school students also performed better on those subjects deemed to be more important to elite universities.

The researchers suggest that the reason for the difference may lie in the vastly superior resources per pupil in private schools (three times the state school average), including smaller pupil-teacher ratios (roughly half the state school average). However, they caution that their results are not truly causal.

Source: Oxford Review of Education, 2019; Doi: 10.1080/03054985.2019.1669551.

The Impact of Peer Assessment on Academic Achievement

By Double, K. S., McGrane, J. A., & Hopfenbeck, T. N.

RESERCHERS from the University of Oxford's Department of Education conducted a meta-analysis to examine what effect peer assessment interventions have on academic performance.

Published in *Educational Psychology Review*, the meta-analysis evaluated the effect of peer assessment on academic performance when compared to no assessment and teacher assessment. Fifty-four studies were included in the meta-analysis, of which 45% were with school-age students. Studies had to examine the effect of peer assessment on non-self-reported measures of academic achievement and have a control or comparison group, using no assessment, teacher assessment, or self-assessment.

The findings from the analysis indicated that:

- Overall there was a significant positive effect of peer assessment on academic performance compared with no assessment (ES= +0.31) and teacher assessment (ES = +0.28).
- The effect size was similar when peer assessment compared with self-assessment (ES = +0.23) though this result was not significant.
- The effect sizes were slightly larger for school-age children than undergraduates.

The analysis concludes that peer assessment can be effective across a wide range of subject areas, education levels, and assessment types.

Source: Educational Psychology Review, 2019; Doi: 10.1007/s10648-019-09510-3.

How Do Teachers Choose to Give Feedback?

By Skipper, Y., & Douglas, K. M.

WHILE the impacts of feedback on students' learning are well-known, it is less clear what factors influenced the ways teachers providing feedback. To help rectify this, an article published in the *British Journal of Educational Psychology* has examined how teachers' perceptions of task difficulty and views of intelligence influence whether and how they give feedback.

This study was conducted among 169 English teachers from Chinese primary schools attending an English Summer school for enhancing teacher skills. Teachers were given six scenarios to read, each of which described a lesson where the teacher asked a designated student to complete a task. In three of the scenarios, the student succeeded, while in the other three scenarios, the student failed. After reading each scenario, teachers were asked to rate their perception of task difficulty, the likelihood of giving feedback, and the likelihood of giving person and process forms of feedback. Moreover, teachers completed a measure assessing their views on whether intelligence is malleable. The results showed that:

- Teachers were more likely to provide feedback following success than failure
- Following students' failure, teachers were more likely to provide process feedback rather than person feedback.
- When the tasks were perceived to be challenging, teachers were more likely to provide feedback.
- Teachers who believed more in the view that intelligence was fixed reported that they would give more person and process praise.

The authors recommended that future research could explore in detail what feedback teachers in other cultures provide and the underlying reasons so as to enrich our understanding of the entire feedback mechanism in order to benefit students.

Source: British Journal of Educational Psychology, 2019; 89 (4): 804-817.

Can School Readiness Tests Predict Future Success in School?

By Stormont, M., Cohen, D. R., Herman, K. C., & Reinke, W. M.

A STUDY published in *School Psychology* investigates the importance of screening children for their readiness for kindergarten, and how effective this is at predicting outcomes in first grade.

Nineteen kindergarten teachers and 350 children from six schools in Missouri took part in the study. Teachers completed a kindergarten academic and behavior readiness screener at the beginning of the academic year. Melissa Stormont and colleagues then compared student scores from the screening tool to their performance on a math and reading achievement test, and to teacher ratings of their social and emotional skills 18 months later. The results showed that:

- Children with poor academic readiness were more than 9 to 10 times more likely to have low reading scores at the end of their first grade year.
- Similarly, children who rated poor in behavior readiness were six times more likely to be rated as having displayed disruptive behavior and poor social skills by their first grade teachers.

The authors suggest that the screening tool could be used to screen for children low in readiness in order to provide supports and monitoring for early intervention.

Source: School Psychology, 2019; 34(6): 612–621.

Computer Games to Improve Children’s Math and Science Achievement

By Roy, P., Rutt, S., Easton, C., Sims, D., Bradshaw, S., & McNamara, S.

AN independent evaluation in the UK of Stop and Think: Learning Counterintuitive Concepts has found evidence of a positive impact in math and science outcomes for students in Key Stage 2.

The Learning Counterintuitive Concepts project, funded by the Education Endowment Foundation and Wellcome, aimed to improve science and math achievement for Year 3 (7-8 year olds) and Year 5 (9-10 year olds) using an intervention called Stop and Think. When learning new concepts in science and math, students must be able to inhibit prior contradictory knowledge and misconceptions to acquire new knowledge successfully. *Stop and Think* is a computer-assisted learning activity that aims to improve a learner’s ability to adapt to counterintuitive concepts by training them to inhibit their initial response, and instead, give a slower and more reflective answer.

The randomized controlled trial involved 6,672 children from 89 schools across England. The intervention was delivered to the whole class and consisted of 30 sessions delivered for a maximum of 15 minutes, three times a week, for 10 weeks at the start of math or science lessons.

The results suggest that:

- Students who participated in Stop and Think made more progress in science and math on average, compared to children in the business-as-usual control group.
- The combined effect size across the two year groups for math was +0.09 and +0.12 for science.

To check whether this impact was due to the Stop and Think game specifically, or was a result of the extra students’ engagement and motivation arising from having a fun computer-based activity at the start of lessons more generally, schools were offered an alternative computer-based program that did not include any content from Stop and Think. Intervention-group students also made more progress than students in this “active” control group. The combined effect sizes for math and science were +0.13 and +0.15 respectively.

Source: The Education Endowment Foundation, 2019.

Teaching for Student Learning: Exploration of Teaching Strategies Based on Protocol-Guided Learning

Jianping Xia

Zhenjiang Experimental School, Zhenjiang 212000, Jiangsu, China

Abstract: *The teaching strategy based on the case study guide is based on the case study guided, with teachers as the mainstay, students as the main body, and teacher-student working together to complete the teaching tasks, which is in line with Chinese education characteristics of localized teaching strategies. This teaching strategy advocates coordinating the relationship between various elements of teaching, so that teachers, students, and teaching materials maintain a coordinated state. We herein prospect through a case of a middle school in Jiangsu, China to explain the basic content of the teaching strategy, and analyze the practical exploration of the teaching strategy based on the protocol-guided study.*

Sci Insigt Edu Front 2020; 5(1):451-467.

Doi: 10.15354/sief.20.ar011

Keywords: *Teaching Strategy; Protocol-Guided Learning; Protocol-guided Teaching Strategy; Teaching Practice; Zhenjiang Experimental School*

About the Author: *Jianping Xia, Principal, Advanced Teacher, Principal, Zhenjiang Experimental School, Zhenjiang 212000, Jiangsu, China. Email: xwph123@163.com.*

Conflict of Interests: *None.*

Question

TEACHING strategies can also be referred to as generalized teaching methods (Pi, 2000), which are “teaching program plans and teaching implementation measures adopted to complete teaching goals and adapt to students’ cognitive needs in specific teaching situations” (Zhang & Yu, 1996).

In 1964, Taba and other scholars proposed that teaching strategies should be used in the teaching process to motivate students to produce creative thinking (Taba et al., 1964). Since then, studies on teaching strategies had begun to attract attention and developed rapidly with emergence of different teaching strategies such as demonstrations, imitation teaching methods, five-segment teaching methods, mastery learning teaching strategies, and situation-ceramic teaching strategies, nine-segment teaching strategies, scaffolding teaching strategies, random entry strategies, and collaborative teaching strategy, etc. (Wei & Wo, 2006). These strategies have guided and helped students’ learning to a certain extent, and have exerted a positive impact on school teaching activities.

Teachers, students, and teaching content are the main constituent elements of teaching. There is a fierce discussion on which element should be centered in the formulation of teaching strategies, and corresponding different teaching strategies are proposed.

Teacher-Centered Teaching Strategies

The teacher-centered teaching strategy emphasizes the central position of teachers, the transfer of systematic knowledge, the role of classroom teaching, and the importance of teaching materials. As a result, the traditional education centers on teachers, classrooms and teaching materials (Zhang, 2007). This type of teaching strategy attaches importance to knowledge transfer, teaching methods and teaching results, and provides a solid path for students’ basic knowledge learning. It is advocated that students acquire knowledge through teaching materials presented by teachers.

In the 1630s, Czech educator Comenius pioneered the teacher-centered teaching structure in *The Great Pedagogy*, supplemented by generations of educators and educational psychologists throughout the ages to make continuous exploration in this field. In-depth, the research results of teaching theory are also endless. The most representative is the “five-segment teaching method” proposed by the traditional school of education represented by Herbart. After the transformation of the former Soviet educator Kairov in the 20th century, a new five-segment teaching method was proposed, that is: motivating learning, reviewing old lessons, teaching new lessons, using consolidation, and checking results (Lu, 1985).

This type of teaching strategy has dominated classroom teaching methods for a long time, especially Herbart’s five-stage teaching method, which has had a profound influence in China (Hong, 1997). The five-segment approach almost became synonymous with Herbartian pedagogy in China at that time (Li, 2012). However, because of

the five-segment teaching method of “emergency first,” the learning attitude is often “learning from one person to another”, and there is no time to introduce it at the academic level. As a result, the five-segment teaching method finally turned to the old model, which caused the negative phenomenon that “teachers can enter the classroom without writing lessons” (Dong & Shi, 1991).

Student-Centered Teaching Strategies

Since the beginning of the twentieth century, students-centered teaching strategies have been proposed for scholars, such as Dewey, in traditional teaching strategies. From the “child-centered” and “activity-centered” advocated by Dewey (Ding, 2001), to the 1950s and 1960s Bruner vigorously promoted “discovery learning”. Its core idea is also Encourage students to study and explore independently. In the 1990s, radical constructivism represented by Jonathan and characterized by subjectivism further emphasized the idea of “student-centered” and advocated all should be “student-centered” (Cui, 2003).

This kind of teaching strategy tends to the theoretical point of view of constructivist learning, that students are the subject of cognition and the active builders of the meaning of knowledge. Students should be the center of teaching activities, dominate and play a decisive role in education and teaching. The student-centered teaching strategy is a teaching strategy that advocates based on the laws of children’s physical and mental development, and that students should be the center of teaching activities. It emphasizes student initiative and existing knowledge and experience. However, students have a certain degree of initiative, but they cannot replace their subjectivity with their initiative. Blind respect for students may also lead to classroom teaching not being carried out in an orderly and normal manner (Ren & Xu, 2011).

Student-Oriented and Teacher-Led “Dual-Master” Teaching Strategy

With the change of international educational technology and educational ideas, the student-centered strategy with constructivism as the core idea has been questioned in the Western education world, and it has developed into increasingly fierce criticism and accusation. Some thought that teaching is always a dialectical unity of teacher’s teaching and student’s learning. It is a bilateral activity process, not a combination of two activity processes. However, those who support student-centered teaching said that the teaching process was mechanically divided into teaching activities and student learning activities, which violated the nature of the teaching process (Luo et al., 2012). Therefore, some have proposed the teaching strategy of the “dual-master” model (He, 1998), which is “the product of the compromise between the two”. It is necessary to let the leading role of teachers play a role and fully reflect students’ recognition to understand the role of the subject, and it is necessary to combine the advantages of the two to avoid the negative impact of both (Liu, 2008).

Teaching is a complex process. It is not only constrained by the three basic elements of students, teachers, and teaching materials, but also by various factors such as teaching methods, teaching environment, and teaching organization. To ensure the normal operation of the teaching system, the various elements constituting the teaching system should be coordinated with each other, so that a general balance is maintained between the various elements. All elements of teachers and students, teaching and learning, knowledge and abilities, content and methods, in- and out-of-class learning should be coordinated. It is inappropriate to deliberately emphasize student-oriented or teacher-led, separate student learning and teacher teaching, the coordination of opposing knowledge and abilities, and blocking in-class and out-of-class.

The formulation of teaching strategies should also be based on a balanced perspective and consider the development of multiple factors. How to coordinate the relationship between the various elements of teaching and seek a balance between the elements is a topic of common concern to educators around the world. Chinese basic education practitioners have concluded an effective balanced teaching strategy in the long-term teaching practice—a teaching strategy based on the protocol-guided learning.

The teaching based on the protocol-guided learning plan is based on the case study as the carrier of learning and teaching, and as the method of teacher's guidance. This learning strategy pays attention to the guidance of learning methods, focuses on the formation of students' autonomous learning ability, implements the cultivation of core academic literacy, and focuses on cultivating and developing students' thinking habits and learning ability (Xiong, 2019). On this basis, many schools in China Using this as a template, creatively put forward new teaching modes in practice, such as the "10 + 35" mode of Dulangkou Middle School, the "271" mode of Changle No. 2 Middle School, and the "recycling big classroom" mode of No. 1 Middle School, Xia Zhen No. 1 Middle School's "self-learning, doubt-solving, and reaching the goal" teaching mode (Li, 2011).

Zhenjiang Experimental School began to reform the school's classroom teaching based on the protocol-guided teaching model in 2005. Based on the reality of the school, a school-based guidance plan has been developed, and classroom teaching strategies based on the guidance plan have been implemented through multiple reforms. After many years of implementation and application, the school's high school entrance examination score has ranked first in its municipality for 14 consecutive years, and has twice won the first prize of teaching achievements in Jiangsu Province. The radiation range of its teaching reform results has ranged from the school's Runzhou District, Zhenjiang City, Jiangsu Province and many provinces across the country.

Research Status

The teaching strategy based on the protocol-guided learning plan is the basis, using the study guide as the method, the teacher's guidance as the lead, the students' autonomous learning as the main body, and the teachers and students working together to complete

the teaching task, which is in line with Chinese educational characteristics Localized teaching strategies (Luo, 2016).

As a localized teaching strategy in China, the research on teaching strategies based on protocol-guided learning is mainly located in the mainland of China. At the end of the 1990s, Donglu Middle School in Lishui District, Nanjing, Jiangsu Province pioneered the “lecture draft”, which was also the first time that students’ materials had been written from the perspective of students, and the reform of classroom teaching had been carried out accordingly (Tao, 2013). The birth of the “lecture draft” changed the structure of classroom teaching and provided students with materials for autonomous learning, making it possible for students to learn independently (Yang, 2016). With the start of the new curriculum reform, student-centered thinking has been further established, and the “lecture draft” has evolved into a “lead draft” or “learning plan”. Teaching based on the study guide has gradually become an effective teaching method leading the new curriculum of elementary education in elementary and middle schools (He, 2014).

With the deepening of the research, the research on the teaching strategy based on the protocol-guided learning mainly focuses on two aspects, namely theoretical research and practical research.

Theoretical researchers mainly discuss the teaching model of the protocol-guided learning from the theoretical aspect. For example, Yanan Pei summarized the teaching model of the teaching case from the theoretical basis, teaching objectives, operating procedures, teacher and student roles, etc. “Teaching, tutoring, sublimation” teaching mode in four basic stages (Pei, 2007). Zhang & Zheng used the background of educational informatization to explain the theoretical basis. He believed that on the basis of self-regulated learning theory, personalized teaching concepts, recent development zone theories, and the characteristics of middle school students, the implementation of educational practices must be differentiated and flexible The basic principles of sexuality, participation, and stratification of goals (Zhang & Zheng, 2016). In addition, many similar teaching methods derived from the case study teaching have also attracted the attention of researchers, such as the “2223 efficient classroom” teaching method, “1215” interactive teaching method, “271” efficient classroom method, etc., scholars It is believed that these teaching methods are designed to use student-led teaching to cultivate students’ autonomous learning, cooperative communication, experimental operation ability, guide students to explore problems, and handle the relationship between “teaching” and “learning” (Jia, 2017).

The front-line teachers have explored the specific operation of protocol-guided teaching from the perspective of their own disciplines. For example, Haowen Ma takes the physics discipline in middle school as an example, and discusses the practical significance and methods of implementing protocol-guided teaching strategies in physics discipline. It is believed that the protocol-guided method of the case can enable students to complete self-study before class, cultivate students’ self-study ability, promote students to enter the learning state quickly, and improve teaching efficiency (Ma, 2019). Focusing on the design and implementation of protocol-guided learning in high school

English, Mao expounded the content of using middle school English in case study teaching, raised common questions, and specifically described the English teaching in six aspects Strategy implementation measures. Thus, it is concluded that “using protocol-guided learning for English teaching can improve the teaching effect of English classrooms and improve students’ autonomous learning ability, attitude, and methods” (Mao, 2019).

Although there is no clear definition of teaching strategies based on protocol-guided learning in foreign countries, the mainstream educational strategies advocated by foreign researchers are consistent with the teaching strategies mentioned in this research in terms of guiding ideology and educational significance. Rugen Genschein’s “Practice Teaching Method” emphasizes the study of special examples to infer the general characteristics of the development of the same kind of things, so as to grasp the development law of this kind of things and improve students’ objective understanding of things (Jia, 2017). The scaffolding teaching strategy advocates that children with the help of teachers eliminate the gap between the actual level of development (the first level of development) and the potential level of development (the second level of development) when solving problems independently (Helen Askill-Williams et al., 2012). Anchor teaching strategies are based on real-life examples or problems, and encourage learners to enter the real environment to feel and experience (that is, learn by acquiring direct experience), rather than just listening to others (such as teachers) about this experience and explain. The random entry teaching strategy advocates that learners can freely enter the learning of the same teaching content in different ways, so as to obtain multiple aspects of the same thing or the same problem. These teaching strategies emphasize “student-centered”, establish students’ subjective status, and focus on developing students’ initiative and enthusiasm (Mehdi et al., 2016). This coincides with the core idea of teaching strategy based on protocol-guided learning.

The Basic Meaning of Teaching Strategy of Protocol-Guided Learning

The teaching strategy based on protocol-guided learning is to consider teaching as a complete system, to coordinate the relationship between various elements of teaching, and to maintain a relative balance between teachers and students, teaching and learning, and intra- and extra-curricular elements. Teachers compile texts of student’s learning and teacher’s teaching (collectively referred to as protocol-guided learning in this article) based on curriculum standards, textbook content, and students’ cognitive status. Teaching students how to learn by protocol is the major activity of this protocol-guided learning.

This teaching strategy emphasizes the perfect combination of student-oriented and teacher-led activities. On the one hand, it emphasizes that student-centered learning is the center of the teaching process, and that learning is a matter for the students themselves. This advocates that all learning should take place on students and give full play to their main role. On the other hand, in the teaching process, the role of teachers in

students' learning process is emphasized. Students must be guided, guided and counseled by teachers in order to carry out their studies better. Teachers guide students to preview before class, guide (induct) students to study during the class, and to consolidate students after class to give full play to teachers' leading role.

Learning is fundamentally a matter for students. Teaching activities should stimulate students' internal driving force so that learning really takes place on the students themselves. The student's learning path designed under this guidance should be goal-oriented, problem-centered, and premised on self-preparation. Combining self-inquiry and intensive lectures should be supported by on-site training to promote generation in class (Li, 2019).

- Learning goal-oriented: change the teaching goal to the learning goal of the students, and let the students identify the learning tasks that need to be completed in each lesson.
- Problems as the core: The knowledge of middle school students in textbooks is transformed into problems that students need to solve, and students are led to learn through problems. This is the core of protocol-guided learning teaching.
- Self-study is the premise: Students self-study part of the protocol-guided learning pre-class, and complete related supporting test exercises.
- The combination of self-inquiry and intensive instruction is the key: the simpler teaching content guides students to learn independently or cooperate in group learning; for the more complicated teaching content, the teacher will give accurate lectures and make the students understand What you have learned.
- Generation in class and on-the-spot training as a guarantee: the teacher guides the students to raise the problem-solving ideas and methods of this lesson to the principle of knowledge; the teacher guides the students to do the exercises in the classroom, and strengthens the knowledge learned through the in-class training.

The basic starting point of teaching based on protocol-guided learning is to coordinate the relationship between the elements of the teaching, and strive to maintain a good balanced relationship between the elements.

At the teacher level, the basic thinking of this strategy is problem protocol-guided, teaching by learning, combining learning with thinking, and teaching and learning mutually reinforcing.

- Problem protocol-guided: Guide students to think and learn with specific problem presets, so that students have greater initiative and autonomy. High-quality question presets are essential to the formation of an efficient classroom. The so-called "problem" is not only the basic knowledge, but also the method and method, or the strategy of implementation and presentation from different perspectives (Jiang, 2019).
- Teaching based on learning: Teachers should be good at guiding, inspiring, associative, and inquiring questions from students, and students should think, act, try, experience, explore, and predict Then, according to the learning needs of

students at different levels, determine the content of intensive talks, summarize and propose precautions, and guide students in a targeted manner (Zhao, 2017).

- Combination of learning and thinking: Let students think deeply and communicate about relevant issues in the classroom, promote students' further understanding and mastery of learning content, internalize into their own experience and knowledge structure, train students to ask questions, analyze questions, Problem-solving skills to enhance students' initiative and autonomy in learning (Liu, 2013).
- Teaching and learning are mutually reinforcing: protocol-guided learning includes not only student thinking and learning, but also teacher reflection and learning. While teachers are constantly improving the way knowledge is presented, teachers must also continue to think and improve. In the process of teaching and learning, teachers and students continue to grow and progress (Zheng, 2015).

The Basic Content of Protocol-Guided Learning Teaching Strategy

The basic steps of protocol-guided learning in different schools are different. The following describes the basic steps of the protocol-guided learning in Zhenjiang Experimental School as an example. The steps of protocol-guided learning are also different in different types of classroom teaching. For new courses, the teaching steps include nine basic steps: set up study goal, protocol-guided preview, autonomous cooperation, intensive analysis and lecturing, on-site practice, expansion and extension, induction and summarization, homework assignments, and questioning reflection (Xia, 2017).

Set Up Study Goal

According to the new curriculum standards and the students' cognitive level, the common goals of teachers and students in this lesson are determined, so that teachers and students form a strong sense of goals in the teaching and learning process.

Protocol-Guided Preview

Create situations or steps based on learning goals, and guide students to read, study, think, and explore independently, so that students can have a preliminary understanding of teaching materials through self-study before class, discover problems, and complete the first teaching.

Autonomous Cooperation

According to the learning objectives, with the help of textbooks and media, students autonomously or in groups to complete the learning of the basic concepts, basic graphics, and basic methods in the teaching content of this section, focusing on double-

based learning and consolidating the foundation. At the end of the self-study, the students exchanged and discussed with the group of students, cooperated and explored, and complemented each other. On the basis of sharing the collective results, a comprehensive and correct understanding of the current knowledge is achieved, that is, the meaning construction of the learned knowledge is finally completed.

Intensive Analysis and Lecturing

The teacher selects typical examples, analyzes and lectures in class, inducts regular methods, and cultivates students' thinking ability. A basic exercise is configured after each example problem. After the analysis of the example problem, training is conducted in the classroom to achieve the effect of timely feedback and timely reinforcement, and complete the second teaching.

On-Site Practice

In order to understand the effect of classroom teaching, teachers choose appropriate amount and certain "texture" topics as feedback exercises for classroom teaching, so that teachers can "know what", the topic design should be closely related to production and life issues, and there should be some variant exercises. It should not be too difficult. Deal with the student's achievement rate accordingly and prepare a lesson for the next lesson. At the same time, the problems exposed in the test should be evaluated and solved in the classroom without leaving "post-morbidities", so as to complete the third teaching.

Expansion and Extension

Requires extended relocation training, expands thinking, and enhances ability to use. Teachers mobilize their minds, morph their training, solve problems, and develop wisdom. Students concentrate their energy, think positively, discuss solutions, and share results to achieve a leap in teaching.

Induction and Summarization

According to the actual teaching situation, the teacher or student can summarize the classroom teaching, which can be a knowledge review or a talk about the harvest. Teachers should reveal the "mystery" to the students based on the discussions of the students and the content of the teaching materials, so as to form a correct knowledge theory.

Homework Assignments

Teachers arrange students' after-class learning tasks based on the characteristics of the subject and the tasks to be completed in the next lesson: (1) after-class consolidation:

mainly comprehensive, open, and research-type questions to leave room for students to innovate. (2) The preview protocol-guided part of the next class teaching protocol.

Questioning Reflection

We require teachers and students to re-understand the teaching and learning experience in the classroom, which includes reflection on “the lost” and induction of “the gain” in order to implement secondary or multiple lesson preparation.

Take the teaching of the Seventh Edition of the People’s Education Version of the book *Multiplication of Powers of the Same Base* as an example:

Teachers determine the students’ learning goals before class, that is, correctly understand and apply the multiplicative rule of the power of the same base, and then establish the teaching goal of the teacher, even if the student understands the multiplicative rule of the power of the same base, and derive from the “multiplicative rule of the power of the same base” and application, preliminary understanding of special to general, general to special cognitive laws.

Students preview and complete the pre-reading assignments. Students can use the assignments to achieve the effect of the pre-reading texts. Teachers can also determine the key points of teaching based on the completion of the students’ pre-reading assignments.

In the classroom teaching, the teacher creates a situation and derives the question “Let the students get the characteristics of the formula through observation: “ $10^5 \times 10^7 =$ ”, to guide students to study independently and group cooperation to explore the problem. In this process, teachers ask students to explain the reasons for each step according to their understanding of the meaning of power. According to the learning situation of the students, the teacher explains the selected examples and guides the students to summarize the calculation methods of the powers of the same number in the explanation, so as to cultivate the students’ thinking of summing up the laws.

Teachers arrange students for on-the-spot training so as to consolidate in time. In the extended training, the teacher raised the difficulty and asked the students to observe and calculate the left and right sides of the formula and think about the relationship between the base and the index. Then encourage students to summarize the found laws in a relatively concise form, and ask students to explain, explain, and verify its correctness from the perspective of the meaning of power.

$$10^3 \times 10^2 = 10^{(?)}, 2^3 \times 2^2 = 2^{(?)}, a^3 \times a^2 = a^{(?)}$$

The teacher leads the students to summarize and summarize the multiplication rule of the power of the same base, and arrange homework, which is mainly for the consolidation of the lesson content and the preliminary work for the subsequent content. After the class, teachers and students are required to reflect after class. The teacher reflects on the specific situation of this class. Students should self-reflection according to the learning situation, and achieve self-summary and self-remedy. Further, the extended

homework assignments can be arranged in layers according to the student's academic situation to ensure that students with different academic situations can develop.

Implementation of the Teaching Strategies in Protocol-Guided Learning

Planning Teaching Arrangements and Restructuring the Teaching Process

Teaching is a bilateral activity between teacher teaching and student learning. The development of teaching cannot be separated from teacher teaching. Emphasizing the main role of students in the teaching process does not exclude the leading role of teachers in the teaching process. The combination of student's subject and teacher's dominance is a rational state (Hu, 2011).

In the teaching process, the teacher's leadership is reflected in the guidance of the students' learning before the lesson, the guidance (induction) of the students' learning during the lesson, and the tutoring of the students' learning after the lesson. In the teaching process, teachers guide, guide, and guide students to learn. Without teacher guidance and guidance, students' learning is difficult to complete. Therefore, the successful implementation of teaching based on protocol-guided learning must reconstruct the teaching process.

Prepare Lessons Carefully and Compile Excellent Protocol-guided Learning

The teaching foundation based on protocol-guided learning is protocol-guided learning. To implement protocol-guided learning teaching, we must first prepare appropriate protocol-guided learning.

With reference to the meaning of protocol-guided learning in many literatures, we define protocol-guided learning as: primary and secondary school teachers based on curriculum standards and teaching materials, combined with students' academic situation and cognitive status, are guided by learning goals, and focus on problems learning materials as protocol to guide students before, during and after class (Xia, 2017).

Based on its meaning, we can determine the following writing principles:

First, adhere to the principle of student subjectivity or transposition. That is, the users of protocol-guided learning are mainly students, and should not be written from the perspective of teacher teaching but from the perspective of guided students' learning (Yi, 2003). Second, the appropriate principle, that is, the capacity and difficulty of protocol-guided learning should be appropriate. For example, the number of learning goals in a class must not be too much, the learning activities must not be too much, and the difficulty of the problem cannot exceed the students' cognitive level (Li & Teng, 2011). Third, the problematic principle is to stimulate students to think in the form of problems (Li, 2011). Fourth, the principle of order or system, that is, the design of the entire protocol-guided learning content, especially the learning content and teaching process,

must be logical, so that students can form a certain knowledge system after learning instead of only obtaining some fragmented knowledge (Li & Teng, 2011).

The teaching strategy based on protocol-guided learning is a Chinese localized teaching strategy that embodies the collective wisdom of education researchers and front-line education practitioners. For example, the compilation of protocol-guided learning is the product of collective wisdom under China's collective lesson preparation system. Taking the protocol-guided learning writing process of Zhenjiang Experimental School as an example, the school first prepares the subject activity plan and classroom teaching research plan by the class preparation team leader, and compiles the team members' reasonable division of labor. Then the members of the subject administration and subject teaching research and guidance team are responsible for reviewing the master and backup drafts according to the division of labor. Finally, the teachers of each class flexibly modify the protocol-guided learning according to the class teaching progress and academic situation. In addition, the subject administration and preparation team leader will listen to the lessons in the classroom, focusing on listening to some teachers' lessons and key lessons, strengthening classroom teaching monitoring through listening, and implementing personal specialization of school classroom teaching through in-depth exchanges with teachers after the lecture.

Revitalize the Classroom and Teach Well

The core of the teaching strategy based on protocol-guided learning is to organize teaching with questions. In the teaching process, teachers use the problems in protocol-guided learning as clues to teach, and the knowledge in textbooks is transformed into students' learning problems.

In the face of these problems, on the one hand, students can learn to solve them by themselves. Any problems that students can understand or students already understand will not be explained by teachers. Such problems will be left to students to learn independently or cooperatively. On the other hand, the teaching content of many disciplines, especially in the field of science, cannot be explored by the students themselves. Teachers need to explain them carefully. Some very important laws, such as the Law of Conservation of Mass in physics teaching, must be understood by the teacher's explanation of students (Liang, 2018).

The teacher's explanation must be based on the problem of protocol-guided learning, and through the teacher's explanation, the thinking process of solving the problem and the thinking of solving the problem are fully displayed to the students. The explanation is not a long story from the beginning to the end of the teacher. The focus of the explanation is on the dial. Teachers make appropriate assignments to the key points, difficult points, and error-prone points in the students' learning process. Do it in teaching: the teachers that the students have already met will no longer explain; the teachers who can learn by themselves will not explain; the teachers will not explain the "partial, difficult, strange" questions raised by individual students; the teachers will not repeat after the students answer the questions Speak; the teacher can explain clearly the

student does not explain. As thus avoid turning your teacher's lecture into a simple exercise calculus.

Combining “Reading, Thinking, Speaking, and Practicing”, Multiple Teaching Methods Work Together

The teaching based on protocol-guided learning focuses on the collaborative use of multiple teaching methods. In the teaching process, try to reflect the combination of “reading, thinking, speaking, practicing”, a variety of teaching methods work together. Zhenjiang Experimental School insists on “reading, thinking, speaking, and practicing” as its core, combining learning with teaching, and teaching by learning.

“Reading” refers to the reading of students, which highlights the students' overall perception and autonomy through reading. Reading is an important means for students to acquire knowledge, develop intelligence, and develop abilities. It is one of the main ways for students to acquire knowledge, and it is also one of the important methods for cultivating students' self-learning ability. Teachers should guide students to read, organize and deal with the teaching content, clearly ask questions that should be considered when reading, and let students read with questions. Grasp the key points to read, think while reading, and think while you read (Zhang, 2019).

“Thinking” refers to students' thinking. Through thinking, students' inquiry ability can be cultivated to form the habit of cooperation and communication. Thinking allows students to constantly transform old appearances and create new ones based on the knowledge content and self-study effect of a class. “Thinking” is to think and discuss problems that you do not understand or do not understand during the process of “reading.” “Thinking” includes both the students' individual thinking and the collective thinking of several students or a group of students. In the teaching process, students under the guidance of teachers, students, groups, teachers and students to think about and discuss the understanding of protocol-guided learning (Liang, 2016).

“Speaking” refers to the narration, explanation, and analysis of teaching content, so that students can further understand the content of teaching materials through narration and explanation. There are two parts to telling, explaining and analyzing. The first is student's speaking, where the students tell or analyze the ideas and results of solving problems raised by individual thinking or group discussion. The second is teacher's lectures. Teachers provide targeted explanations and analyses to enable students to achieve a high level of awareness of the ideas, concepts, and theories to be expressed in the problems of protocol-guided learning (Wu, 2013).

This step is very important. The quality of the teacher's lectures directly affects the students' knowledge and skills. In the lecture, the teacher strives for the teacher to be familiar with the teaching materials and elaborate design. The structure is required to be systematic, organized, clear-cut, and the key points are difficult to highlight. Language needs to be clear, vivid, accurate, concise and vivid. At the same time, we must also pay attention to the level of emotional realization in classroom teaching, try our best to stimulate students' interest in learning, desire for knowledge, and motivate students' thinking enthusiasm.

“Practicing” refers to students’ homework training before, during, and after class. Through training, students can better master and apply what they have learned. The practice runs through the teaching process. Before the lesson, you can learn about the students’ learning status through the practice of the test questions during the pre-view. In-class training is used to strengthen and consolidate the required knowledge in time. After class, the knowledge will be further strengthened through exercises. Here, special emphasis is placed on classroom training in classroom teaching. The exercises in the above stages achieve the “four completions” of teaching tasks, that is, “every lesson completion”, “daily completion”, “weekly completion”, and “monthly completion” (Liu, 2009). The exercises should be centered on the focus of the textbook, systematic knowledge, and knowledge that is easy to make mistakes, easy to forget, and easy to confuse (Xia, 2017).

Discussion

The teaching strategy based on protocol-guided learning is based on protocol-guided learning, with teachers as the mainstay, students as the main body, and teachers and students working together to complete teaching tasks.

The teaching strategy based on protocol-guided learning advocates that teachers use protocol-guided learning, which is a student learning and teacher teaching material written from the standpoint of student learning to flexibly design and arrange teaching activities. The teaching process should be regarded as a whole, i.e., before, during and after class. Taking students’ learning activities as the mainline and evaluation as the means, based on the students’ pre-class preview, teaching activities are carried out around the main line of students asking and solving problems, displaying learning results, summing up learning experiences, strengthening learning results, and expanding and extending learning content. Pay attention to the development of students, cultivate students’ awareness and ability to discover problems independently, cooperate autonomously and explore problems in class, and allow students to give full play to their autonomy under the guidance of teachers.

The teaching strategy based on protocol-guided learning is an effective attempt to reform the classroom teaching of basic education in China. After being used by thousands of schools across the country for more than two decades, teaching strategies based on protocol-guided learning have been widely recognized (Hu, 2015). Studies have shown that this teaching strategy can help students improve their academic performance and improve their learning ability. At the same time, it can also improve teachers’ teaching ability and teaching level, and teachers’ professional growth. Many studies have proven that the implementation of protocol-guided learning in classroom teaching has improved classroom teaching efficiency and transformed classroom teaching methods (Teng, 2015). To a certain extent, protocol-guided learning teaching can be considered to represent the staged results of the implementation of quality education in China and a major event that marks the new curriculum reform of basic education (Yu & Shi, 2014).

The teaching strategy based on protocol-guided learning also exposes some problems in practice. For example, in the training of top students, many schools report that this strategy is conducive to improving students' academic performance on a large scale, but not conducive to the growth of top students. There are critics who point out that this strategy limits the autonomy of teachers 'teaching and restricts teachers' autonomous teaching behaviors too (Qiu, 2017). In this regard, some researchers have proposed that Internet technology can be used to break the shortcomings of protocol-guided learning in the cultivation of top students. Integrating modern technologies such as the Internet and big data analysis with the classroom to make up for the shortcomings of protocol-guided learning in improving excellence and better teaching and learning in a personalized way (He, 2019).

References

- Cui, J.G. (2003) Review of Constructivist Education View. *Contempo Edu Sci*, (1): 9-11.
- Ding, B.P. (2001) Constructivism and Science Education Reform Facing the 21st Century. *Comp Edu Res*, (8): 6-10.
- Dong, Y.Z., Shi, Y.Y. (1991) *Selected Works of Yu Ziyi's Education*. Beijing: People's Education Press, 479
- Gui, G.J. (2003) Application of the "protocol protocol-guided" model in middle school mathematics teaching. Shandong: Shandong Nor Univ.
- He, K.K. (1998) Review on the Research of Instructional Design Theory and Method (Middle). *Edu Theo Edu Manag*, (03) 19-26
- He, K.K. (2019) *Theory of Deep Integration of Information Technology and Curriculum: Effectively Realizing the Deep Integration of Information Technology and Subject Teaching (2nd Edition)* Beijing: Beijing Nor Univ Press
- He, L.L. (2014) Application of protocol-guided in biology teaching in high school. Jinan: Shandong Nor Univ.
- Helen, A.W., Michael, J., Lawson, G.S. (2012) Scaffolding cognitive and metacognitive strategy instruction in regular class lessons. *Instru Sci*, 413-443
- Hong, C. (1997) Herbart's five-step teaching method in China. *Curr, Teach Mater Teach Meth*, (05): 60-62
- Hu, X.R. (2011) Reflection on the "protocol-guided learning" teaching model. *Xue Zhou Xue*, (03): 13
- Hu, X.T. (2015) The compilation strategy of protocol-guided learning based on classroom teaching. *Middle School Physics*, (08): 30-31
- Jia, L.M. (2017) "One Two Five" autonomous classroom protocol-guided learning teaching mode in middle school biology teaching. Inner Mongolia: Inner Mongolia Nor Univ.
- Jiang, X. (2019) Problem protocol-guided: Quiet Thinking Revolution. *Inner Mongolia Edu*, (35): 51-52
- Li, B.T. (2011) *Nine teaching paradigms of efficient classrooms (Department of Education Discovery)*. Jinan: Shandong Literature and Art Publishing House
- Li, G.Y. (2019) A brief introduction to the middle school mathematics protocol protocol-guided teaching model of auto-

- mous learning protocol. *Curr Edu Res*, (31): 152
- Li, K., Teng, J.P. (2011) Talking about the establishment of “learning protocol” and “learning protocol”. *Chin Teach*, (23): 43-45
- Li, L.F. (2012) Herbart’s five-step teaching method in China: introduction, dissemination and inspiration. *J Shandong Yingcai Univ*, (01): 34-37
- Li, T.F. (2011) How to write practical and effective protocol-guided learning. *Qinghai Edu*. (11): 43-44
- Liang, C.J. (2016) Guided learning to practice and promote thinking-the practice and thinking of protocol-guided learning. *Middle school mathematics (high school version) the first half of the month*, (07): 25-27
- Liang, H. (2018) Reflection and Analysis on the “protocol-guided learning” Teaching Mode. *Math Learn Res*, (02): 73
- Liu, J.Y. (2009) “Learning first, then teaching, training in the classroom”: Solving five major problems — — Analysis of Jiangsu Yangsi middle school classroom teaching strategy. *Prim Mid School Manag*, (05): 16-19
- Liu, S.H. (2013) Using protocol-guided learning to construct a teaching mode of “thinking by learning, combining evaluation with practice”. *Liter (Edu Teach Res)*, (26): 51
- Liu, X.L. (2008) The enlightenment of the “dominant-subject” teaching mode to the teaching of “University Chinese”. *China Sci Educ Innova Guide*, (01): 121.
- Lu, J. (author) (1985) Department of Education, Nanjing Normal University (ed.) Education. Beijing: People’s Education Press
- Luo, S.Y., Wang, S.N., Shao, M.Z. (2012) On the unity of opposites between traditional and constructivist views of learning. *J Dongguan Univ Tech*, 19 (2): 22-25
- Luo, W. (2016) Probe into the protocol-to-guided classroom teaching mode. *Gansu Edu*, (20): 77
- Ma, H.W. (2019) Application of protocol-to-guided method in middle school physics teaching. *Curr Edu Res*, (41): 161-162
- Mao, F.F. (2019) Study on the value of the protocol-guided method in middle school English teaching. *Eng. Wide Angle*, (05): 157-158
- Mehdi, E., Francesco, R., Neil, R. (2016) A survey of active learning in collaborative filtering recommender systems. *Comp Sci Rev*, 29-50.
- Pei, Y.N. (2007) Summary of the protocol-to-guided teaching model. *J Inner Mong Nor Univ (Edu Sci Edition)*, 20 (04): 66-69.
- Pi, L.S. (2000) *Psychology of Intellectual Education [M]*. Beijing: People’s Education Press.
- Qiu, T.Z. (2017) “Pros and Cons of Mathematical Protocol-guided Learning”. *Liberal Arts Navigation*, (3) 62-63
- Ren, D.D., Xu, Y.Y. (2011) The rationality and limitations of the teacher-centered and student-centered theory and their integrated development trends. *J Xingtai Univ*, (1): 45-47
- Taba, H.E., Freeman, F. (1964) Teaching strategies and thought processes. *Teach College Rec*, 65 (6): 524-534.
- Tao, J. (2013) Research on the application of the “lecture draft” mode in the middle school moral and moral lesson. *Jiangsu: Suzhou Univ*.
- Teng, F. (2015) Application of the protocol-to-guided teaching model in biology teaching in high school. Harbin: Harbin Nor Univ.
- Wei, Y.P., Wo, J.Z. (2006) Trends in Teaching Strategy Research: Development of Subject Teaching Strategies. *J Guangxi Nor Univ: Philo Soc Sci Edition*, (42): 105-110
- Wu, J.H. (2013) Height • Gradient • Validity: A Preliminary Study of the “Protocol-guided, Intensive Lecture, and Diligent Practice” Teaching Mode. *Middle School Polit Teach Refer*, (10): 50-51
- Xia, J.P. (2017) School-based Action Research on Student Self-development in the Perspective of Whole Person Education. *Zhenjiang: Jiangsu Univ Press*, 13-15、123-145.
- Xiong, H.X. (2019) Compilation and Application of Protocol-guided Learning for High

- School Biology Review Courses in the “3 + 3” New College Entrance Examination. Shanghai: Shanghai Nor Univ.
- Yang, X.M. (2016) Make good use of the teaching method of lecture draft to create an efficient mathematics classroom: an example of the effectiveness of middle school mathematics classroom teaching. *Mingshi Online*, (09): 33-34.
- Yu, H.L., Shi, Y.H. (2014) On the essence of protocol-guided learning and its enlightenment to teacher education. *Curr Teach Method Teach Mater*,34 (8): 110-115.
- Zhang, B.M., Zheng, H.F. (2016) Protocol-protocol-guided Teaching Mode: Theory, Practice and Prospect. *J Jilin Pro Insti Edu*, (07): 117-120
- Zhang, D.J., Yu, L. (1996) On the basic meaning of teaching strategies and the basis for their formulation. *Curr,Teach Mater Teach Methods*, (9): 6-8
- Zhang, Q.H. (2019) A Brief Discussion on the Protocol-guided, Guided Practice and Guided Reading in the Teaching of Mathematical Analysis.
- Zhang, Y. (2007) Research on the “non-indicative” reading teaching model of high school under the new curriculum background. Jilin: Northeast Nor Univ.
- Zhao, Q. (2017) Protocol-protocol-guided highlights teaching and learning. *Edu (Weekly)*, (21): 53
- Zheng, Y.Y. (2015) Learning-oriented and Teaching Demonstration——The Application and Thinking of Middle School History Protocol-guided Learning. *Polit History Geogra Teach Res*, (43): 133-134.

Received: 29 January 2020

Revised: 05 February 2020

Accepted: 18 February 2020

Can Student Self-Directed Learning Improve Their Academic Performance? Experimental Evidence from the Instruction of Protocol-Guided Learning in China's Elementary and Middle Schools

Longjun Zhou,¹ Chungang Li²

1. Jiangsu Second Normal University, Nanjing 210013, Jiangsu, China
2. Zhenjiang Experimental School, Zhenjiang 212000, Jiangsu, China

Abstract: *Autonomous learning not only requires students to self-monitor and adjust their cognition, emotions, motivation, behavior, and environment, but also requires the creation of external environments and the provision and support of teaching strategies. Protocol-guided learning is a localized teaching strategy in the mainland of China. This study sampled students from two municipal middle schools in Zhenjiang City, Jiangsu Province as research subjects, and used education experiments to find out the role of students' autonomous learning in improving student performance, and observed how to promote students' autonomous learning through protocol-guided learning as well. A total of 612 students from the first grade of two schools in Zhenjiang City, Jiangsu Province, China were selected as the subjects. After excluding extreme values, a total of 196 experimental samples and 201 control samples were obtained. By analyzing the experimental data of the experimental group and the control group, it is concluded that a well-designed protocol-guided learning teaching can become an effective carrier for students' autonomous learning. By promoting students' autonomous learning, students' performance can be effectively improved. At the same time, we further found that in the three subjects of Chinese, Mathematics, and English, students' autonomous learning has the most obvious effect on Chinese learning.*

Sci Insig Edu Front 2020; 5(1):469-480.

Doi: 10.15354/sief.20.ar016

Keywords: *Autonomous Learning; Protocol-Guided Learning Teaching; Education Experiment; Effectiveness; Strategy*

About the authors: *Chungang Li, Zhenjiang Experimental School, Zhenjiang 212000, Jiangsu, China. Email: 13775537939@126.com;*

Correspondence to: *Longjun Zhou, China Tao Xingzhi Research Association, Jiangsu Second Normal University, Nanjing 210013, Jiangsu, China. Email: 294437034@qq.com.*

Funding: *This study was supported by the project from the China Taoxingzhi Research Association, the project number is: ZTH, 2019JS0037A*

Conflict of Interests: *None.*

AUTONOMOUS learning refers to the ability of learners to set learning goals, determine learning content and progress, choose learning techniques, monitor self-learning processes, and perform self-assessment (Holec, 1981). In the process of China's curriculum reform, advocating students' autonomous learning has always been an important issue. Due to differences in national and educational conditions, the common autonomous learning modes abroad are not entirely suitable for China. Chinese educators have been striving to explore the autonomous learning model of students with Chinese characteristics, and have also formed some effective teaching modes. But so far, the understanding of these teaching modes is mostly based on experience rather than scientific evidence, which makes it difficult for giving solid evidence on whether local students' autonomous learning modes are really effective or not and tell the underlying reason. Therefore, how to improve the scientific value in the process of exploring students' autonomous learning mode is an essential problem to be solved. Zhenjiang Experimental School has been exploring students' autonomous learning mode based on protocol-guided learning since 2005. After years of exploration, a protocol-guided learning teaching mode with its own characteristics has been formed and achieved remarkable findings. In order to further discuss the effectiveness of this indigenous teaching model, we intended to evaluate the teaching mode by obtaining scientific evidence through a carefully designed experimental study.

Cause of the Experiment

Autonomous learning not only requires students to self-monitor their cognition, emotion, motivation, behavior, and environment, it also requires the creation of external environments and the provision and support of learning conditions and strategies (Li & Qiu, 2017).

Most studies outside of China have pointed out that teaching strategies such as problem-based learning models, class discussions, debates, and case studies can be used to promote autonomous learning. There are many similar studies, which can be roughly divided into three categories: (1) Teaching mode oriented to interpersonal interaction. This model emphasizes the social nature of learning, and believes that increasing the interaction between teachers and students, students and students can reflect the subjective status of students. (2) Teaching mode oriented to learning self-regulation. Facilitate learning by helping students master self-regulating strategies. (3) Teaching mode oriented to meaning construction. This includes pedestal teaching, anchor teaching, example teaching, and inquiry-based autonomous learning. Problem-solving autonomous learning teaching mode is one of the basic reform ideas in the current wave of constructivist reforms. It stimulates students' inner curiosity through the discussion of problems and constructs their own knowledge (Johnson, et al., 2002).

China domestic scholars have also proposed a series of teaching strategies to promote autonomous learning. For example, Cheng and others have put forward the teaching strategy of "autonomous learning centered on the premise of teacher guidance, student collaborative learning as a platform", with the ultimate goal of helping graduate

students to develop autonomously (Cheng, et al., 2014). “Autonomous-mutual assistance learning class”, “Graduate self-learning”, “Problem teaching mode”, etc. proposed by Wu and Wang have made profound contributions to autonomous learning teaching mode (Wu & Wang, 2012). In addition, Pang of East China Normal University in his monograph *Autonomous Learning-Principles and Strategies of Learning and Teaching* comprehensively discussed the psychological mechanism of autonomous learning, the strategy of autonomous learning, and the development of autonomous learning capabilities. He put forward the idea that cooperative learning is collective autonomous learning, thinking that research on autonomous learning can be carried out through theoretical, experimental, quiz, observation, and action research methods (Pang, 2003).

In the process of exploring the teaching mode that is more suitable for students' autonomous learning, many Chinese schools and teachers have adopted protocol-guided learning as an important means to achieve curriculum reform. At present, based on different perspectives, the definitions of protocol-guided learning are not completely consistent. But generally speaking, it is believed that protocol-guided learning is a protocol prepared by teachers to guide students to autonomous learning, and protocol-guided learning means that teachers use protocol-guided learning as the basis, and use protocol-guided learning to guide students prior to, during, and after the class, so as to constructing knowledge and skills to complete teaching tasks (Dong & Liu, 2017).

Protocol-guided learning has become the main way to implement autonomous learning reform in schools. However, in the implementation process, although most schools declared that the implementation of protocol-guided learning was “in order to change the way students learn”, so that students “learned to learn” and embarked on the road of autonomous learning. However, due to limitations of inherent teaching ideas, teacher allocation, and resource precautions, many schools often use protocol-guided learning as a student's “task list” and “exercise list.” In the teaching process, although there is a form of “learning”, the entire teaching process is still teacher-led. If the teaching is not really implemented from the student's “learning”, it will not produce a substantial change in “student autonomous learning” (Han, 2012; Wu, 2011).

In response to this problem, in the long-term protocol-guided learning teaching reform process, Zhenjiang Experimental School has always inspired students' autonomy and achieved autonomous learning as the goal of this reform. After many years of exploration, a set of distinctive and effective protocol-guided learning teaching programs has been formed. The outstanding feature of this program is the emphasis on autonomous learning of students. Whether it is the teacher's preparation, teaching or after-school tutoring, it must be based on students, take students as the main body, adopt the teacher-student joint construction knowledge, and carry out teaching in the basic form of student cooperation inquiry and teacher teaching. In the teaching process, teachers are different from the traditional role of “inculcator”. They play the role of “problem motivator” and “exploration helper”. They organize students' autonomous learning and teamwork to complete teaching tasks. Only when students face general problems or problems that their own abilities are difficult to solve, will teachers help students complete knowledge learning tasks as “knowledge givers”. So far, Zhenjiang Experimental

School has also formed a complete set of teaching system of protocol-guided learning and has achieved significant findings (Xia, 2017).

So far, although academic circles have discussed the students' autonomous learning and protocol-guided learning teaching, most of the existing researches are academic studies, and related empirical studies are still lacking. In these few empirical studies, Peng et al. studied the situation of autonomous learning in the context of the new curriculum and concluded that even in high school, the attitude, behavior, and environment of students' autonomous learning are still not satisfactory (Peng & Xiang, 2015). This shows that there is still a lot of room for improvement in students' autonomous learning. In addition, some studies summarize the results and experience of front-line protocol-guided learning teaching experiments (Zhang, 2000; Han, 2000). Although this type of research reports research results in the name of "experiment", the research process does not meet the requirements of rigorous experimental research. Most of them are action research, and the robustness of the results needs to be further improved.

The abovementioned analysis has shown that protocol-guided learning does not necessarily help students' autonomous learning. How to compile and implement protocol-guided learning teaching is the key to whether protocol-guided learning teaching can achieve its goals. Even though some schools currently improve student performance through "protocol-guided learning", on the one hand, such studies often do not strictly control the interference variables, so it is difficult to distinguish what factors have improved student performance. On the other hand, as mentioned earlier, although some studies claim to be "protocol-guided learning", but they actually implement "exercise-list teaching" and "task-list teaching." In this case, the improvement of student performance has nothing to do with students' autonomous learning (Jiang, 2005).

To clarify these issues, stronger evidence is needed to support them. However, existing studies do not provide sufficient evidence to help people understand whether protocol-guided learning can improve student performance and what kind of protocol-guided learning teaching can really promote autonomous learning for students. In view of this, this research Zhenjiang Experimental School's protocol-guided learning teaching reform is used as the main intervention variable, and an experimental study is used to discuss the following questions: First, how should students' autonomous learning be promoted through protocol-guided learning? Second, can students' autonomous learning really promote students' performance improvement?

Research Design

Objective

As mentioned earlier, the current use of protocol-guided learning for teaching is a common phenomenon in Chinese elementary and middle schools and is considered to be an effective means to achieve autonomous learning for students. However, because protocol-guided learning prepared by different schools is different, not all protocol-

guided learning can effectively promote students' autonomous learning. In the process of protocol-guided learning, many schools still adopt teacher-led teaching methods, and study plans have become a carrier and means to achieve teachers' unilateral goals. We believe that to achieve effective learning, we must first start with student autonomy. Teaching students realizing autonomous learning is a more important teaching goal than simply teaching students getting knowledge and test-taking skills. To achieve this goal, in the process of designing and implementing protocol-guided learning, we need to adhere to the student-centered teaching philosophy, and incorporate more students' independent inquiry and cooperative learning links and elements through protocol-guided learning to stimulate students' enthusiasm for learning and then get better outcomes.

Based on this understanding, the objective of our experiment is to verify whether student-centered protocol-guided learning teaching can effectively promote student's autonomous learning and improve student performance. In this process, we explore the realization of an efficient protocol-guided learning teaching mode suitable for China's national conditions.

Participant Selection

We selected 6th graders from two middle schools in Zhenjiang, Jiangsu, China as the test subjects. Among them, Zhenjiang Experimental School was used as the experimental group. Due to the large scale of the Zhenjiang Experimental School, which far exceeds that of the control group, only 271 students from classes 1-6 in the 6th grade were selected to participate in the experiment. In the experimental group, the student-centered protocol-guided learning developed by Zhenjiang Experimental School is used for teaching. The control group is another middle school in Zhenjiang. This middle school has a total of 341 students in 8 classes. Although protocol-guided learning is also implemented, during the implementation process, the teaching requirements of the student center are not particularly emphasized. The characteristics of teacher-led teaching are obvious.

In order to better control the influence of students' pre-assignment conditions and pre-test differences on experimental results, we first exclude extreme values according to the student's family background. After obtaining the pretest results, we matched the data in the experimental group with the data in the control group, and matched the reference samples based on the total scores of the students in Chinese, Mathematics, and English. After deleting the samples that were absent, we finally got 196 samples in the experimental group and 201 samples in the control group.

The two schools participating in the experiment were both public schools with good local school strength and reputation. There are no significant differences between the two schools in terms of teachers, student resources, and school conditions.

Experimental Interventions

Student-centered protocol-guided learning is the main intervention in this study. In the teaching reform process, Zhenjiang Experimental School has consistently held the view

that in order to achieve the improvement of students' academic performance; the "learning behavior" must first take place, Even if students really consider learning to be their own thing and not something they have to do that is based on external pressure. To achieve this, the simple implementation of protocol-guided learning is difficult to achieve, but only by using protocol-guided learning as the carrier of student's autonomous learning can improve the academic performance while teaching students how to learn. Zhenjiang Experimental School adheres to this concept, and in the course of more than two decades of teaching reform, it has continuously explored and formed a protocol-guided learning teaching with its own characteristics. Compared with the protocol-guided learning teaching in the control group school, the experimental group's protocol-guided learning emphasizes student autonomous learning in concept. Teachers switched the emphasis of teaching from knowledge infusion to student-oriented guidance and assist. In terms of content and implementation, more autonomous and cooperative learning links are included to give full play to students' own learning initiative. In the use of school plans, they are generally not used as task lists and worksheets, but rather as a process for teachers and students to jointly build knowledge and balance the interaction between teachers' teaching and students' learning.

Experiment Procedure

This experiment was planned by the end of August 2019, officially started in November 2019, and ended in mid-January 2020. Both schools use school-based protocol-guided learning for teaching. The difference is that Experimental School's protocol-guided learning pays more attention to students' autonomous learning. The 6th-grade Chinese, Mathematics and English subjects of the two schools participated in the experiment, and the students' learning progress and content were the same.

From September 2019 to the end of October 2019, the preparation stage for the experiment. At this stage, the two universities first identified the students and teachers participating in the test, and through matching and comparison, ensured that the conditions of the teachers and students were basically the same, and there was no significant difference. Secondly, coordinated the teaching content and progress, and train the experimental and control group teachers separately to ensure that the protocol-guided learning teaching mode of the two schools meets the experimental requirements. Further, prepared the materials needed for the experiment and determined the specific process for the experiment.

From early November 2019 to mid-January 2020, the experimental implementation phase lasted ten weeks. At this stage, the two schools were teaching according to their own protocol-guided learning. Before and after the experiment, pre-test and post-test were conducted on the students participating in the experiment. The test were a unified standardized questions prepared by the *Teaching and Research Office of Zhenjiang City*. In the experimental group and the control group, student performance was used as an indicator of teaching effectiveness. The experimental group and the control group both used protocol-guided learning for teaching, but the difference was that the experi-

mental group mainly improved students' performance by cultivating autonomous learning skills: that is, students actively discover problems through pre-class previews, so that students could bring problems into the classroom. Let classroom teaching become a learning process of independent inquiry and problem solving; group display and achievement sharing in the classroom allow students to fully demonstrate themselves; self-evaluation and mutual evaluation of students after class allowed students to improve themselves in evaluation. The control group's protocol-guided learning emphasized teacher-centeredness and the protocol-guided learning was the carrier of teachers' teaching plans and student homework training. Through the experiments, we tried to clarify whether the students' autonomy can effectively improve student performance.

Experimental Results and Discussion

Class Observation Results

In the course of the experiment, we observed the class situation of the participating classes in the two schools through listening and inter-school communication, and found that there was a significant difference between the two types of protocol-guided learning teaching.

In the experimental group of Zhenjiang Experimental School, since protocol-guided learning itself is the guidance of students' autonomous learning, there are clear requirements for students' autonomous inquiry activities in the teaching process. Therefore, its teaching process has actually become a process of reconstructing the teacher-student relationship. More often, students complete the learning tasks jointly formulated by teachers and students through active inquiry, active thinking and mutual cooperation. The proportion of students' classroom participation and interactive activities is significantly higher than that of the control group. But we also observe that because such classrooms are often not implemented exactly as planned. Therefore, there are many uncertainties in the teaching implementation process. Compared with the traditional teaching mode, this teaching mode places higher requirements on the ability of teachers to coordinate and organize. In some teaching links, classroom order and teaching logic can be optimized further.

In the control school, we have observed that although protocol-guided learning was also used in teaching, the design and implementation of protocol-guided learning was basically based on the teaching mode of teacher-led and textbook-based learning. In the teaching process, although there was teacher-student interaction, the main way was to achieve the form of question and answer; the intensity of group cooperation activities of students was significantly lower than the experimental group; in many cases, the guided protocol was not the student's "activity list" but rather Students' "task list" and "work list". Compared with the experimental group, the teaching in the control group was more rigorous and orderly, and the teaching plan was more complete.

Experimental Effect Size

Based on the performance data before and after the test, we calculated the effect size of the experiment. The calculation results in **Table 1** show that, overall, the effect size of the student's total score is 0.117. According to the research of Chueng and Slavin (2012), under the same conditions, it is often difficult to obtain a large effect amount in the study of large samples (sample size greater than 250). Considering the large sample size of this study, although such an effect size is not very large, it shows that the experiment has achieved results. In terms of the results of various subjects, the experimental effect of Chinese language is the best, and an effect amount of 0.259 is obtained. After further observation of the pre-test results, we found that the language score of the experimental group was slightly lower than that of the control group at the time of the pre-test, but the average score of the experimental group had exceeded that of the control group at the time of post-test. This is obviously a very satisfactory result. The effect amounts of Mathematics and English are 0.091 and 0.071 respectively. Although not large, it also shows that the students in the experimental group have made greater progress in these two subjects than the students in the control group.

Discussion of Results

So far, few China domestic studies have given strong evidence on whether students' autonomous learning can improve their performance. Domestically, many studies have linked students' autonomous learning with quality education and advocated it as the opposite of "examination-oriented education" (Wu, 2011; Dong & Liu, 2017). But as Zimmerman (1986), the representative of autonomous learning theory, believed that autonomous learning can improve the efficiency of learning by improving students' self-efficacy. This means that there is no contradiction between students' autonomous learning and performance improvement. The conclusion of this study proves that well-designed protocol-guided learning has a positive effect on improving students' academic performance while promoting students' autonomous learning.

In this experiment, the experimental school adopted a more student-centered protocol-guided learning teaching mode, and the final research results show that the former is more conducive to the improvement of student performance than the teacher-centered protocol-guided learning teaching. In terms of various subjects, it seems that this teaching mode has a more significant effect on the language subject. This may be due to the more emphasis on logical thinking and the emphasis on memory compared to mathematics. Good communication and positive perceptions are more conducive to improving Chinese performance. As students have autonomous learning, because there is more communication between teachers and students and between students, it is obviously more conducive to students' understanding and grasp of the content of Chinese learning.

Compared to teacher-centered teaching that places more emphasis on knowledge transfer, students' autonomous learning pays more attention to cultivating students' inquiry abilities and thinking styles. In the experiments, the experimental group's protocol-guided learning teaching has always focused on the students' learning

Table 1. Experimental Effect Size.

Subject	Pre-Test				Post-Test				Effect Size
	Control (N=201)		Experiment (N=196)		Control (N=201)		Experiment (N=196)		
	Mean Score	SEM	Mean Score	SEM	Mean Score	SEM	Mean Score	SEM	
Chinese	89.096	6.386	87.435	6.602	92.715	7.788	92.736	7.993	0.259
Math	94.964	14.701	95.769	13.505	88.296	15.458	90.562	15.161	0.091
English	94.343	13.380	96.644	13.933	93.834	14.636	97.218	13.656	0.071
Total	278.379	29.627	279.828	30.153	273.485	37.924	279.555	35.246	0.117
SEM: Standard Error of Means.									

activities. The teaching activities are centered on the students’ problem-solving problems, displaying learning results, summing up learning experiences, strengthening learning results, and expanding the content of extended learning (Xia, 2017). In this teaching mode, fundamental changes have taken place in classroom teaching, from the original one-way, receptive learning to a two-way active learning that combines student cooperation, inquiry, display training, teacher guidance, and guidance, where students truly become the master of learning, learning really happens to students (Lu, 2016). Therefore, we expect that the longer the training for autonomous learning, the longer the impact on student performance. However, due to the limitations of this experiment, we did not further investigate the long-term effects of autonomous learning, which needs to be further strengthened in future research.

Conclusion and Suggestion

This research proves that well-designed protocol-guided learning teaching can be an effective carrier for students’ autonomous learning. By promoting students’ autonomous learning, students’ performance can be effectively improved. Among the scores of each subject, students’ autonomous learning has the most significant effect on the effect of Chinese learning.

Based on this, we believe that, on the one hand, schools and teachers need to further improve teaching concepts and attach importance to autonomous learning of students. Most Chinese teachers are accustomed to the teaching mode of the teacher center, which has both the influence of teaching habits formed for a long time, and the reasons for fear of changing the teaching mode. This study proves that there is no inevitable contradiction between autonomous learning and improving students’ performance. To achieve the teaching mode change, teachers need to be brave enough to change teaching perspectives and boldly return the learning autonomy to students. On the other hand, careful design of protocol-guided learning is needed to make it truly a carrier of autonomous learning for students. As mentioned earlier, many schools only use study

cases as “task sheets” and “worksheets” when teaching protocol-guided learning. This study proves that if protocol-guided learning is to truly promote students’ autonomous learning, it is necessary to carefully design protocol-guided learning, increase the proportion of teacher-student interaction, student inquiry and cooperative learning in the teaching process, and make protocol-guided learning it has truly become a bridge between teaching and learning, providing effective guidance and assistance for students’ autonomous learning.

References

- Cheng, W., Chen, Y.G., Xiao, H.C., et al. (2014) Teaching reform of traffic control graduate courses under the mode of “teacher-guided + group cooperative learning”. *Chin Off-School Edu (Late Issue)*, (z): 1031- 1032.
- Chuang, A.C.K., Slavin, R.E. (2012) How methodological features affect effect size in education. *Edu Res*, 45 (5): 283-292.
- Dong, X.M., Liu, X.Y. (2017) Features and teaching reflections of the guidance model of learning cases. *Teach Manag*, (12): 8-10.
- Han, L.F. (2012) Pros and cons of learning case teaching and suggestions for improvement. *Teach Manag*, (10): 7-8.
- Han, Q.L. (2000) Some basic problems of experimental teaching reform in education. *Edu Res*, (5): 55-59.
- Holec, H. (1981) *Autonomy and foreign language learning*. Oxford: Pergamon, 3.
- Jiang, J. (2005) *An empirical study of English vocabulary teaching under protocol-guided learning mode*. Dalian: Liaoning Nor Univ.
- Johnson, E., Herd, S., Andrewartha, K., Jones, S., & Malcolm, S. (2002) Introducing problem-based learning into a traditional lecture course. *Biochem Mol Biol Edu*, 30 (2): 121- 124.
- Li, Z.J., Qiu, D.F. (2017) Student autonomous learning: teaching conditions and strategies. *Glob Edu Outlook*, 1 (46): 47-57
- Lu, X.F. (2016) The use of protocol-guided learning to cultivate students’ autonomous learning ability. *Jilin Edu (General)*, 21:64
- Pang, G.W. (2003) *Autonomous learning: principles and strategies of learning and teaching*. Shanghai: East China Norm Univ Press
- Peng, X.L., Xiang, B.L. (2015) Empirical analysis of autonomous learning in the context of the new curriculum. *J Shenyang Univ (Soc Sci Ed)*, (1): 103-105 + 113.
- Wu, C.L., Wang, Y.C. (2012) Exploring the cultivation model of autonomous learning ability for graduate students. *Frontiers*, (16): 187-189.
- Wu, Y.J. (2011) Rational thinking on “protocol-guided learning”. *Edu Dev Res*, (20): 6-10.
- Xia, J.P. (2017) *Research on school-based action of students’ self-development in the perspective of whole person education*. Nanjing: Jiangsu Sci Tech Press.
- Zhang, Y.K. (2000) “Learning to Learn” and Teaching Reform. *Teach Res Prim Mid Sch*,3: 12-14
- Zimmerman, B.J., & Pons, M.M. (1986) Development of a structured interview for assessing student use of self-regulated

Received: 06 January 2020

Revised: 24 January 2020

Accepted: 11 February 2020

Eating Breakfast or Attending Extracurricular Tutoring, Which One is More Effective in Improving Student's Performance? An Empirical Study Based on the Data from A Large-Scale Provincial Survey

Yanli Liu,¹ Jijun Yao,¹ Wenye Li,¹ Ru Cai,¹ Shike Zhou²

1. Nanjing Normal University, Nanjing 210024, China
2. Jiangsu Teaching and Research Office of Primary and Secondary Schools, Nanjing 210024, China

Abstract: To improve children's academic achievements, parents often try to provide them with adequate nutrition or/and send them to attend extracurricular tutoring classes. The effect of extracurricular tutoring on students' performance has been well explored, whereas no rigorous empirical study was conducted to observe the relationship between breakfast and students' academic performance. Besides, little empirical evidence has been presented to compare the effect of breakfast and that of extracurricular tutoring on students' academic achievements. This study fills this gap by adopting the multiple linear regression model and Shapley Value Decomposition to analyze the academic quality monitoring data of 50,516 Year-3 students and 83,505 Year-8 students in Jiangsu, China. The results showed that both breakfast and extracurricular tutoring can improve students' grades, and breakfast was superior to the tutoring in efficacy. This conclusion is of great significance for planning family education strategies scientifically and improving family education efficiently. It is necessarily convincible for parents and educators to rationally understand the role of extracurricular tutoring and pay enough attention to breakfast in improving students' performance.

Sci Insigt Edu Front 2020; 5(1):481-499.

Doi: 10.15354/sief.20.ar029

Keywords: Breakfast; Extracurricular Tutoring; Student Achievements; Family Education; Shapley Value Decomposition

Background

THE scarcity of quality education and the fierce competition for advanced education in China force a large number of Chinese parents to send their children to various extracurricular tutoring classes. However, existing studies have not reached a consensus on whether attending extracurricular classes can improve students' academic performance or not. Instead, three different types of findings have been reported: (1) Extracurricular tutoring is beneficial for students' learning (Fang & Xue, 2014; Peng & Zhou, 2008); (2) Extracurricular tutoring is useless (Li, 2018; Liu & Wang, 2018; Tang & Fu, 2007); (3) The effectiveness of the extracurricular tutoring may vary depending on the length of the tutorial, the group of the student, gender and subject (Hu et al. 2015; Li et al., 2016; Sun & Tang, 2019; Xue et al., 2014; Xue & Ding 2009; Zhang, 2013). Meanwhile, issues caused by extracurricular tutoring have also been explored. Such as extracurricular tutoring increased students' workload, decreased their independence and autonomy, and even caused weariness and antagonistic psychology (Wang, 2005; Yang, 2004). Furthermore, urban students and students with high socio-economic background having more chance to get extracurricular tutoring, this becomes an inter-generational transmission channel of family's social, economic, cultural and political capital (Xue, 2017) and also becomes another kind of social reproduction mechanism in addition to regular school education (Xue, 2016).

Besides good educational resources, providing children with enough nutrition is another important function of family education. In comparison with lunch and dinner, breakfast is more important for teenagers' physical and mental health, in that it serves as a nutritional supplement after a long interval of eating. It has been found that breakfast affected adolescents' psychology (O'Sullivan et al., 2009) and it had positive short-

About the Authors: Yanli Liu, School of Education Science, Nanjing Normal University, Nanjing 210024, China, Email: 1609604712@qq.com;

Wenye Li, School of Education Science, Nanjing Normal University, Nanjing 210024, China, Email: 841659607@qq.com;

Ru Cai, School of Education Science, Nanjing Normal University, Nanjing 210024, China, Email: 924654819@qq.com;

Shike Zhou, School of Education Science, Nanjing Normal University, Nanjing 210024, China, Email: jyszsk@163.com.

Correspondence to: Jijun Yao, School of Education Science, Nanjing Normal University, Nanjing 210024, China, Email: yaojijun_njnu@163.com.

Funding: The study was funded by the Priority Academic Program for Development of Jiangsu Higher Education Institutions (PAPD).

Conflict of Interests: None.

term effect on students' cognitive functions (e.g. attention, vocabulary and spatial memory) and emotional functions like alertness (Widenhorn-Muller et al., 2008). Breakfast can produce higher energy and satiety, lower fatigue and less hunger, and higher blood sugar level (Cooper et al., 2011). On the other hand, failure to eat breakfast regularly may lead to poor nutrition condition, a big possibility of obesity, higher blood pressure, and metabolic syndrome (Ho et al., 2015; Rampersaud et al., 2005) and a higher level of stress including anxiety and depression (Lien, 2007). Some studies investigated the relationship between breakfast and students' academic performance and cognitive development and a positive effect was found of breakfast on students' academic performance (Kang & Park, 2016; Sampasa-Kanyinga & Hamilton, 2017; Sun & Yin, 1994; Xu et al., 2014). Specifically, a systematic review of school feeding programs implemented by the International Initiative for Impact Evaluation (3iE) in East and South Asia found that school feeding programs improved student learning outcomes (Snilstveit, et al., 2015). In addition, American School Breakfast Program (SBP) found that SBP significantly improved students' mathematics scores in large academic tests (Frisvold, 2015). When it was compared with many other factors like socioeconomic background and location, breakfast has a greater positive effect on students' academic achievement (Fang, 2018).

Since both breakfast and extracurricular tutoring are the most commonly used interventional measures for improving students' academic performance in family education, the aforementioned studies are of great significance in guiding parents' choices in family education. However, given the limitations of previous data and research methods, our understanding regarding the precise effect of breakfast and extracurricular tutoring is not sufficient yet. For instance, the published researches on breakfast had mostly been conducted in the field of medicine and public health, of which mainly focused on exploring the breakfast habits and their potential influencing factors. Besides, research on breakfast's role in students' cognitive development is relatively deficient. Although a few studies have compared the effectiveness of breakfast and that of tutoring on children's academic achievements, they did not demonstrate their inter-relationship. For example, Hau (2016) published an article "Have breakfast rather than wasting money on tutorials", in which the benefits of breakfast were analyzed, but it remained unclear whether the effect of breakfast was actually greater than that of the extracurricular tutoring. According to a news report, Jian Liu, chief expert of the China's Education Quality Monitoring Center and director of the China Education Innovation Research Institute at Beijing Normal University, made a comprehensive evaluation of the quality of basic education (Year-1 to Year-9) in Zhejiang Province in 2016 and stated that "Weekend tutorial is not as good as having breakfast every day" (Zhejiang, 2017). However, no strong statistical evidence was presented to support the opinion.

Thus, we firstly used large-scale testing and survey data from the monitoring of the academic quality of students in basic education in Jiangsu Province to study the potential role of breakfast in students' cognitive development. Our finding indicated that regularly eating breakfast significantly promoted students' cognitive development (Yao et al., 2019). Based on this finding, we move on to question between eating breakfast

and attending tutoring, which one is more effective in improving students' performance? In this study, breakfast and extracurricular tutoring were selected as the main independent variables and students' academic performance was selected as the dependent variable. A multiple linear regression model was established to analyze the relationship between breakfast, extracurricular tutoring and academic performance under the control of the confounding factors, such as family background and school type. In order to determine which factors are more effective, Shapely Value Decomposition method was used to calculate the relative contribution rate of each influencing factor to the difference in students' performance. The result not only proves the hypothesis, but also provides solid evidence of how to improve students' academic performance more effectively in family education.

Data

The data of this study derived from the monitoring data of academic quality of basic education (Year-1 to Year-9) students in Jiangsu Province in 2018. Specifically, the data was derived from a two-stage stratified sampling survey conducted to gather information on the academic performance (Chinese Language, Mathematics) of Year-3 and the academic performance (Chinese Language, Mathematics, English Language, Geography, Biology and Physics) of Year-8 students in Jiangsu Province. The test papers are prepared by the experienced Committee of Experts of the Jiangsu Province Basic Education Quality Monitoring Center. One year after Setting Questions, Tests, Interviews, and Adjustments to determine the final official and standby papers. To test the level of the students' basic knowledge, basic skills and the accomplishment in collecting and dealing with information, analyzing and solving problems, and so on. The test has higher reliability and validity. A total of 101,673 Year-3 students and 117,010 Year-8 students were sampled in this survey in 2018. In addition, the monitoring data also include the questionnaire of students, teachers and principals, among which student questionnaires were selected to obtain the data needed in this study. Prior to the analysis, the data were processed to eliminate samples with missing values and incorrectly filled key variables. Finally, 50,516 and 83,505 student samples were included in the analysis at the elementary and middle school stages, respectively. Furthermore, we analyzed the remaining data to confirm that the distribution and characteristics of the remaining samples were not significantly different from the sample, from which we found that processing the data did not cause a systematic difference.

It should be noted acknowledged that part of the data we used in this study partially overlapped with our previously reported data (Yao, et al., 2019) which belongs to different research branches of one big project. Therefore, in the process of data analysis, while respecting the copyright of the previously published data, we hereby make a special statement on the reuse of these data. The partially overlapping data can be found in the journal of *Medical Science Monitor* (Yao, et al., 2019).

However, there are differences in the sample scope between this current study and the previously published study. The main reason is that one of the main variables of

this study, extracurricular tutoring, includes incorrectly filled samples in the questionnaire. So a difference appeared in the sample size when we removed these incorrectly filled samples. Specifically, in the original questionnaire, there are two questions (#18 and #20) that reflect whether or not students participated in extracurricular tutoring at the same time. We, in this study, eliminated the samples in which the questions were incorrectly answered. For example, a student selected the option that showed he or she took part in extracurricular tutoring in question #18 but chose 0 as the length of tutoring in question #20 or chose not participated in extracurricular tutoring in question #18, but neither did choose 0 as the length of tutoring in question #20, so this kind of sample was eliminated.

Variables

The core explanatory variables are breakfast and extracurricular tutoring. Breakfast was measured by two indices. One index was “whether do you eat breakfast or not”, which served to estimate the influence of students’ breakfast habit on their grades. Students who ate breakfast every day for a week was valued by 1 and in the case of irregular breakfast, the value was 0. The other index was breakfast frequency, which shows the number of days a student ate breakfast within a week to estimate the impact of breakfast intake on their grades.

Extracurricular tutoring, also known as extracurricular learning and shadowing education, is also an important explanatory variable in this study. The definition and measurement methods were not completely consistent with the previously reported studies (Mark & Liu, 2015). We here defined extracurricular tutoring as remedial activities that students receive outside formal school education, which mainly includes two forms of tutoring - tutorial class and home tutor. A total of five levels were set to represent different lengths of a weekly tutorial, with 1 indicating that not participating in any extracurricular tutoring; 2 meaning that the duration of the extracurricular tutoring was less than 3 hours; 3 showing that the duration was between 3 to 6 hours; 4 depicting that the duration was between 6 to 8 hours; and 5 meaning that the tutorial lasted for more than 8 hours.

The explained variable is the standardized student scores. The mean scores of students’ participating subjects were substituted into the analytical model. Based on the previous studies (Xue, 2016), the control variables in this study involved three layers, which were individual, family and school layers. Among them, individual variables included students’ genders and whether or not they had any siblings. The family variables include families’ socioeconomic statuses, which were presented as the family socioeconomic status index calculated from family economic status, parents’ education degree and occupation. The family economic status was synthesized by Rasch Model into a numerical calculation with the data of household gathered from the questionnaire. The degree of education of parents was expressed with the total number of years of education. Specifically, middle school or below, high school, college or graduate school were defined as 9, 12, 16 and 19 years, respectively. The professional prestige for parents

mainly refers to the research of Li (2005) and Lu (2002). Meanwhile, the socioeconomic status of the family was calculated in the following way. First, to ensure the comparability, the “relative comparison” method was used (Yao, 2008) to standardize the index data:

$$\text{The Standardized Data of An Index} = \frac{\text{The Original Value} - \text{The Minimum Value}}{\text{The Maximum Value} - \text{The Minimum Value}}$$

Second, we used the Principal Component Analysis (PCA) to calculate the weight of each index. The standardized index was multiplied by corresponding weight. Finally, the socioeconomic status index of the family was obtained. The equation is as follows:

Family's socioeconomic status index=family economic status *0.24+ father's education level *0.155+ mother's education level *0.168+ father's occupation *0.186+ mother's occupation *0.251.

The final result in family socioeconomic status was converted into value between 0 and 100. Variables at the school level include urban and rural categories. Besides, considering the differences of social and economic development in the North, Central and South of Jiangsu Province, we also substituted the region where the schools were located as a control variable.

Results and Discussion

Descriptive Statistics

The statistical description of elementary school variables (**Table 1**) shows that 89.7% of the elementary school students ate breakfast every day and most of them spent about three hours per week on extracurricular tutoring. Besides, 46.1% of the students had no siblings. The proportion of boys in the elementary school sample was larger than that of girls, and the sampling schools were mainly public schools locating in the southern part of Jiangsu Province.

The statistical description of variables in middle school (**Table 2**) depicts that 71.6% of the middle school students ate breakfast every day. The percentage was smaller than that of the elementary school students. However, similar to elementary school students, most of the middle school students spent about three hours on extracurricular tutoring each week. Besides, 51.4% of these students had no siblings. Furthermore, the proportion of male students in the middle school sample was larger than that of female students.

The Analysis of Effects between Breakfast, Extracurricular Tutoring and Students' Academic Performance

Table 1. Sample Characteristics (Elementary School).

	Variables	Mean	SD	Min	Max
Dependent Variable	Students' academic performance	525.513	79.709	193.897	719.251
Independent Variables	Eat breakfast	0.897	0.304	0	1
	Breakfast frequency	6.774	0.800	1	7
	Time of extracurricular tutoring	2.267	1.251	1	5
Control Variables	Family socioeconomic status index	58.579	20.704	0	100
	Only child (Non-only children were the control group)	0.461	0.498	0	1
	Gender (Girls were the control group)	0.538	0.499	0	1
	Urban and rural categories schools belong to (Rural schools were the control group)				
	City	0.729	0.445	0	1
	Country town	0.219	0.414	0	1
	Regions schools belong to (Northern Jiangsu were the control group)				
	Central Jiangsu	0.104	0.305	0	1
	Southern Jiangsu	0.665	0.472	0	1
	The type of school (Private schools were the control group)				
Public school	0.935	0.247	0	1	

Note: Due to this research is a different branch of the same project, there is some data overlap. Most of the data in this table are basically consistent with the data of the project team's previous research paper (Yao, et al., 2019). The slight difference is the difference in sample size.

To figure out the influence of breakfast and extracurricular tutoring on students' academic performance, we established five models to explore the relationship between breakfast, extracurricular tutoring and students' performance.

$$\text{Score}_i = \alpha + \alpha_1 B_i + \alpha_i Z_i + \varepsilon_i \tag{1}$$

$$\text{Score}_i = \beta + \beta_1 \text{BrFrequency}_i + \beta_i Z_i + \varepsilon_i \tag{2}$$

$$\text{Score}_i = \delta + \delta_1 \text{TimeofTutoring}_i + \delta_i Z_i + \varepsilon_i \tag{3}$$

$$\text{Score}_i = \lambda + \lambda_1 B_i + \lambda_2 \text{TimeofTutoring}_i + \lambda_i Z_i + \varepsilon_i \tag{4}$$

$$\text{Score}_i = \omega + \omega_1 \text{BrFrequency}_i + \omega_2 \text{TimeofTutoring}_i + \omega_i Z_i + \varepsilon_i \tag{5}$$

Where, $Score_i$ represents the academic performance of $student_i$ and B_i represents whether $student_i$ eats breakfast regularly. If $student_i$ eats breakfast every day for a week, the value is 1; if $student_i$ eat breakfast irregular for a week, the value is 0. Meanwhile, $BrFrequency_i$ is the frequency of student's weekly breakfast intake, $TimeofTutoring_i$ represents the time spent on extracurricular tutoring each week and Z_i is the control variable, which includes gender, having siblings or not, family background, school area and school type. ε_i represents the random error.

The collinearity of the independent variables in each regression model was tested and the results showed that the variance inflation factor VIF of all the independent variables was less than 10, indicating that there was no severe collinearity between the variables in the regression equation. The results of White test showed that the null hypothesis of model (1)-model (5) was reject at the significance level of 1%, so the regression model had heteroscedasticity (see **Table 3** for the detailed results), leading to the estimated results obtained by the regression model biased. The main methods to deal with heteroscedasticity include regression using Weighted Least Square method (WLS) (Wooldridge, 2009). Therefore, in this study, WLS was adopted to modify the heteroscedasticity. The revised regression results of elementary school sample and middle school sample are shown in **Tables 4** and **5**, respectively.

The analysis results in **Table 4** illustrate that after the individual, family and school characteristics were controlled, breakfast and extracurricular tutoring were significantly positively correlated with the elementary students' academic performance, both of which were at the significance level of 1%. According to the results of models (1) and (4), students who ate breakfast every day scored about 30 points higher than those who ate breakfast irregularly during the week. Besides, models (2) and (5) demonstrated that after the other factors affecting students' academic performance were controlled, performance would be improved by about 14 points for every additional day of breakfast in a week. The results of models (3), (4) and (5) depict that, after the other variables were controlled, extracurricular tutoring had a significant positive impact on the academic performance.

Table 4 also illustrates that the socioeconomic status index of the family has a significant positive influence on elementary students' academic performance, indicating that the students with better family background tended to get higher scores. In terms of individual characteristics of students, the scores of the female students were higher than those of the male peers, and the scores of the students without sibling were higher than those with siblings. As for school characteristics, the scores of the urban students were higher than those from the rural area, whereas the scores of the students from counties or towns were lower than those of the rural students. Furthermore, the scores of the students in the Central and Southern parts of Jiangsu were higher than those in the Northern part of Jiangsu. The students' academic grades from public school were less than those of their peers from private schools by 3-4 points.

The statistics in **Table 5** shows that the results of the middle school sample are basically consistent with those of the elementary school sample. After students' individual characteristics were controlled, family background characteristics, school charac-

Table 2. Sample Characteristics (Middle School).

	Variables	Mean	SD	Min	Max
Dependent Variable	Students' academic performance	508.812	87.661	147.151	783.572
	Independent Variables				
	Eat breakfast	0.716	0.451	0	1
	Breakfast frequency	6.356	1.274	1	7
	Time of extracurricular tutoring	2.112	1.328	1	5
Control Variables	Family socioeconomic status index	48.925	18.684	0	100
	only child (Non-only children were the control group)	0.514	0.5	0	1
	Gender (Girls were the control group)	0.535	0.499	0	1
	Urban and rural categories schools belong to (Rural schools were the control group)				
	City	0.648	0.478	0	1
	Country town	0.296	0.456	0	1
	Regions schools belong to (Northern Jiangsu were the control group)				
	Central Jiangsu	0.159	0.366	0	1
	Southern Jiangsu	0.498	0.5	0	1
	The type of school (Private schools were the control group)				
Public school	0.847	0.36	0	1	

Note: Due to this research is a different branch of the same project, there is some data overlap. Most of the data in this table are basically consistent with the data of the project team's previous research paper (Yao, et al., 2019). The slight difference is the difference in sample size.

Table 3. Regression Test.

	(1)	(2)	(3)	(4)	(5)
White test	1054.49***	1133.30***	1145.49***	1367.38***	1478.46***
Maximum VIF	4.47	4.47	4.51	4.51	4.51

Note: ***, **, and * represent significance levels of 1%, 5% and 10%, respectively.

Table 4. Effect of Breakfast and Extracurricular Tutoring on Elementary Students' Academic Performance.

	(1)	(2)	(3)	(4)	(5)
Eat breakfast	29.693*** (26.156)			30.707*** (27.100)	
Breakfast frequency		13.854*** (31.436)			14.150*** (32.141)
Time of extracurricular tutoring			4.514*** (15.473)	4.924*** (17.003)	4.890*** (16.952)
Socioeconomic status index	0.580*** (33.179)	0.577*** (33.137)	0.553*** (30.526)	0.506*** (28.072)	0.504*** (28.059)
Only child	19.574*** (27.611)	19.357*** (27.405)	18.634*** (25.974)	18.445*** (25.920)	18.227*** (25.706)
Gender	-6.405*** (-9.490)	-6.254*** (-9.301)	-6.901*** (-10.157)	-6.492*** (-9.629)	-6.345*** (-9.446)
City	8.394*** (5.094)	7.949*** (4.837)	6.265*** (3.746)	5.949*** (3.581)	5.517*** (3.335)
Country town	-5.507*** (-3.235)	-5.763*** (-3.395)	-5.881*** (-3.421)	-5.972*** (-3.497)	-6.225*** (-3.661)
Central Jiangsu	24.699*** (18.929)	24.465*** (18.824)	25.168*** (19.139)	24.126*** (18.464)	23.908*** (18.365)
Southern Jiangsu	7.287*** (8.058)	7.051*** (7.820)	7.684*** (8.426)	6.686*** (7.383)	6.450*** (7.147)
Type of school	-4.053*** (-2.944)	-4.123*** (-3.006)	-3.613*** (-2.631)	-3.844*** (-2.799)	-3.894*** (-2.850)
Constant term	450.820*** (189.068)	384.434*** (106.371)	470.511*** (211.027)	445.863*** (185.639)	378.384*** (104.360)
Number of samples	50,516	50,516	50,214	50,214	50,214
Adjusted R ²	0.092	0.098	0.085	0.099	0.104
F	571.845	608.147	522.083	549.814	582.295

Note: The value of *t* in parentheses is SD; ***, **, and * represent significance levels of 1%, 5% and 10%, respectively. Data in columns 1, 2 are basically consistent with the data of the project team's previous research paper (Yao, et al., 2019). The slight difference is the difference in sample size and School types (public school, private school) were added to the control variables in this study.

Table 5. Effect of Breakfast and Extracurricular Tutoring on Middle Students' Academic Performance.

	(1)	(2)	(3)	(4)	(5)
Eat breakfast	30.528*** (48.511)			30.988*** (49.578)	
Breakfast frequency		12.037*** (53.712)			12.169*** (54.797)
Time of extracurricular tutoring			6.082*** (26.964)	6.532*** (29.315)	6.564*** (29.562)
Socioeconomic status index	0.844*** (52.185)	0.850*** (52.787)	0.790*** (47.175)	0.723*** (43.694)	0.730*** (44.256)
Only child	9.222*** (15.230)	9.066*** (15.021)	9.070*** (14.815)	7.759*** (12.845)	7.576*** (12.586)
Gender	-18.589*** (-32.985)	-18.083*** (-32.213)	-16.574*** (-29.146)	-17.614*** (-31.410)	-17.075*** (-30.576)
City	15.923*** (12.298)	15.707*** (12.199)	13.288*** (10.163)	13.768*** (10.663)	13.535*** (10.525)
Country town	9.229*** (6.996)	9.006*** (6.866)	9.414*** (7.081)	9.739*** (7.419)	9.506*** (7.272)
Central Jiangsu	19.145*** (21.706)	19.173*** (21.825)	19.578*** (21.984)	18.302*** (20.861)	18.325*** (20.968)
Southern Jiangsu	15.664*** (23.066)	15.361*** (22.697)	14.094*** (20.511)	14.147*** (20.886)	13.834*** (20.497)
The type of school	-40.549*** (-52.251)	-40.575*** (-52.396)	-42.236*** (-54.092)	-40.687*** (-52.632)	-40.748*** (-52.902)
Constant term	461.302*** (282.142)	406.534*** (193.587)	475.805*** (295.861)	455.616*** (277.823)	400.327*** (190.665)
Number of samples	83,505	83,505	83,170	83,170	83,170
Adjusted R ²	0.143	0.148	0.126	0.151	0.156
F	1,543.740	1,608.537	1,333.657	1,479.943	1,541.276

Note: The value of *t* in parentheses is SD; ***, **, and * represent significance levels of 1%, 5% and 10%, respectively. Data in columns 1, 2 are basically consistent with the data of the project team's previous research paper (Yao, et al., 2019). The slight difference is the difference in sample size and School types (public school, private school) were added to the control variables in this study.

teristics, breakfast and extracurricular tutoring were positively correlated with students' academic performance at a significance level of 1%. Specifically, it can be found from the results of models (1) and (4) that students eating breakfast every day had significantly higher scores about 30 points than those who ate breakfast irregularly. According to the results of models (2) and (5), students' scores would be improved by about 12 points for every extra day of breakfast in a week. Besides, extracurricular tutoring also had a significantly positive influence on student' academic performance according to the results of models (3), (4) and (5).

In addition, in middle schools, the students' family background had a significant positive effect on students' performance (see **Table 5**) suggesting that students with a better family background tended to gain higher scores. From the perspective of individual characteristic, male students scored about 16-18 points lower than female students, having siblings scored about 7-9 points lower than students who were the only child in their families. In terms of school characteristics, the scores of students in urban, counties and towns were higher than the scores of the students from rural areas. The students in the Central and Southern parts of Jiangsu Province had a better academic performance than their peers did in the North. Moreover, the scores of public school students were lower than their private school peers about 40 points.

Which is More Effective: Breakfast or Extracurricular Tutoring - The Analysis Based on Shapley Value

The estimated coefficients of the aforementioned regression equation only showed the influence of breakfast and extracurricular tutoring on student' academic performance, but it was unclear that to what extent the relevant explanatory variables would contribute to academic performance (difference in students' performance), and which of them could have a more significant influence on students' academic performance. To get further observation, Shapley Value Decomposition method was used to analyze the factors that lead to differences in students' academic performance and to compare the relative contribution rate each factor.

The idea of Shapley Value Decomposition comes from Shorrocks, (Shorrocks, 1982) and the basic principle of which was to estimate the relative significance of independent variables through examining the contribution rate of different independent variables to the difference of dependent variables. Taking breakfast frequency as an instance, its influence on students' academic performance mainly stems from two aspects: (1) The correlation coefficient between breakfast frequency and students' academic performance. When the other factors remain unchanged, the larger the coefficient is, the greater the degree of explanation for the difference in students' academic performance will be. (2) The distribution of breakfast frequency. The more uneven the distribution is, the greater its contribution to the difference in students' academic performance will be.

Table 6 shows the results of Shapley Value Decomposition method in elementary schools. The contribution rate of family socioeconomic status to the difference in students' academic performance was 31.96%. According to the decomposition result of

Table 6. The Decomposed Contribution of Variables to Elementary Students' Academic Performance.

	(1)	(2)	(3)	(4)	(5)
Eat breakfast	16.99%			16.37%	
Breakfast frequency		23.11%			22.01%
Tutoring			13.33%	11.96%	11.25%
Family socioeconomic background	31.96%	30.07%	32.16%	26.18%	24.75%
Only child	23.27%	21.76%	23.73%	20.27%	19.04%
Gender	1.99%	1.84%	2.28%	1.86%	1.73%
City	9.24%	8.64%	9.05%	7.69%	7.23%
Country town	6.31%	5.95%	6.31%	5.39%	5.10%
Central Jiangsu	7.12%	6.67%	7.82%	6.53%	6.14%
Southern Jiangsu	3.39%	3.15%	3.49%	2.82%	2.63%
Type of school	0.18%	0.17%	0.16%	0.14%	0.14%

model (1), only-one child and breakfast accounted for 23.27% and 16.99% of the difference in student performance, respectively. Characteristics such as gender, school location and type explained about 28% of the difference in students' academic performance. The decomposition result of model (2) was similar to that of model (1). The contribution rate of family socioeconomic status to the difference in students' academic performance was the largest with 30.07%. The breakfast frequency and the only-one child accounted for 23.11% and 21.76% of the difference in students' academic performance, respectively. In model (3), the top three explanatory contributors for the difference in students' academic performance were family socioeconomic status, only-one child, and tutoring time, accounting for 32.16%, 23.73%, and 13.33%, respectively. On the basis of models (1) and (2), after taking the tutoring time into model, we found that the contribution rate of family socioeconomic status on students' academic performance differences was still the largest (26.18% and 24.75%, respectively), the explanatory rate of eating or not eating breakfast and the breakfast frequency for students' academic performance were higher than the tutoring time. The only-one child variable explained for about 20% degree of students' academic performance difference.

Table 7 is the results of Shapley Value Decomposition method in middle schools. From the decomposition results of model (1), it can be found that the contributory rate of family socioeconomic status to the difference in students' academic performance was 30.31%. The type of school and whether they ate breakfast accounted for 20.82% and 20.06% of the difference in students' academic performance, respectively and student characteristics and school area accounted for about 29% of the interpretable

Table 7. The Decomposed Contribution of Variables to Middle Students' Academic Performance.

	(1)	(2)	(3)	(4)	(5)
Eat breakfast	20.06%			19.28%	
Breakfast frequency		23.27%			22.30%
Tutoring			13.92%	11.98%	11.60%
Family socioeconomic background	30.31%	29.46%	31.82%	24.88%	24.20%
Only child	5.69%	5.47%	6.10%	4.70%	4.52%
Gender	7.39%	6.91%	7.40%	6.59%	6.17%
City	4.80%	4.62%	4.63%	3.87%	3.73%
Country town	2.27%	2.19%	2.23%	1.86%	1.79%
Central Jiangsu	2.32%	2.25%	2.70%	2.05%	1.99%
Southern Jiangsu	4.64%	4.39%	4.49%	3.78%	3.58%
Type of school	20.82%	20.17%	24.69%	19.77%	19.17%

variation. The decomposition result of model (2) shows that the contribution rate of socioeconomic status of family to the difference in students' academic performance was the largest with 29.46%, breakfast frequency to the difference in students' performance was 23.27%, and school type to the difference in students' performance was 20.17%. In model (3), the top three explanatory variables for the difference in students' academic performance were family socioeconomic status, type of school and tutoring time, accounting for 31.82%, 24.69% and 13.92%, respectively. According to models (4) and (5), it was found that the contribution rate of socioeconomic status of family to the difference in student' performance was still the largest (24.88% and 24.20%, respectively). The contribution rate of breakfast and breakfast frequency to the difference in students' academic performance was higher than that of the tutoring. The contribution rates of school type to the difference in students' academic performance was 19.77%.

To conclude, based on the result of Shapely Value Decomposition, we found that to both elementary school and middle school students, family socioeconomic status had the greatest impact on their academic performance, indicating that family background is still one of the most important factors affecting education output. Secondly, elementary school students' breakfast variable accounted for 16%-23% of the difference in scores, while extracurricular tutoring explained 11%-13% of the difference in scores. In middle schools, 19%-23% of the differences in students' academic performance were resulted from breakfast, and 11%-14% were resulted from extracurricular tutoring. Thus, we concluded that breakfast and extracurricular tutoring are important contributors for the differences in students' academic performance. However, the influ-

ence of breakfast on students' academic performance is greater than that of extracurricular tutoring.

In addition, for elementary schools, the contribution rate of only-one child variable to the differences of students' academic performance was relatively large, whereas in middle schools, this effect was not that obvious. Secondly, compared with other variables, the types of the elementary schools had the least influence on the difference in students' academic performance. For middle schools, the contribution rate of school type to the differences in students' academic performance was relatively larger, which reached about 19%. Therefore, there may be differences between elementary and middle schools in the mechanisms that affect students' academic performance.

Discussion: Explore More Effective Ways of Family Education

The purpose of this study was to analyze and compare the impact of breakfast and extracurricular tutoring on students' academic performance, so as to offer suggestions to which kind of family education was more effective in improving the students' academic achievements.

It was found that in the basic education stage (Year-1 to Year-9), when the individual, family and school characteristics were controlled, both breakfast and extracurricular tutoring had a significant positive impact on students' academic performance, which is consistent with the findings from others (Fang, 2014; Fang, 2018; Peng, 2008). Meanwhile, previous studies indicated that the socioeconomic status of families would influence the expenditure of extracurricular tutoring, and high-income families might invest more in extracurricular tutoring (Le & Du, 2018; Qu & Xue, 2015), so for children from low-resource families, the high cost of extracurricular tutoring may put them at a disadvantage. However, our study found that extracurricular tutoring is not the only effective way to improve children's performance. Breakfast is also conducive to the improvement of students' academic performance, and the cost of such an intervention is far lower than that of extracurricular tutoring. For example, through a randomized controlled experiment, Kleiman-Weiner et al. (2013) studied 2,686 fourth-graders in 70 schools in five poverty-stricken counties in Gansu Province for six months, and found that a chewable vitamin tablet costing only 0.4 CNY per day could significantly improve students' math scores, meaning that paying more attention to breakfast and providing students with a balanced and healthy supply of nutrients may result in better academic performance.

Possible explanations for the significant influence of breakfast on students' academic performance may attribute to the following three reasons. First of all, nutrition is guaranteed, breakfast provides the nutrition needed by the body and ensures students' energy and condition in learning activities in the morning. Second, breakfast represents some kind of lifestyle, and students with self-discipline are more likely to be successful. Third, insisting on making breakfast for children also means a positive attitude of parents' educational participation, which will also affect students' academic

performance. Li & Qiu (2016) found that parents' participation in children's education had a positive impact on children's academic performance. Li & He (2019) also found that the time invested during family education had the greatest impact on students' academic performance in comparison with the extracurricular tutoring. Breakfast, as a part of family education in the time investment and parental education participation, it obviously has a positive impact on students' academic performance.

Our results also reveal that to prepare their children for fierce academic competitions, parents may not need to increase the academic burdens of their children. Instead, improving students' nutritional status through breakfast and food, improving parent-child relationship through participating in children's education, and creating a good family environment may serve as better options. Besides, both parents and researchers can look for better strategies or combination of strategies to promote child development through low-input but high-productivity family interventions.

The lack of data on breakfast contents in the questionnaire is a limitation of this study, so we are unable to explore the effect of the breakfast quality or its ingredient types on students' academic performance. Meanwhile, our study did not subdivide the extracurricular tutoring types, so it remains unclear if the tutoring types may impact the students' academic outcomes. Further studies are needed to explore these questions and expanding further understanding on these topics.

Conclusion and Suggestions

Eating breakfast and tutoring are two common ways that family education can use to improve students' academic performance. Although studies have explored the relationship between tutoring and students' academic performance, but the relationship between breakfast and academic outcome is less explored, especially with rigorous empirical research. This study used Chinese evidence to analyze this issue. Specifically, based on the monitoring data of basic education academic quality in Jiangsu Province, our study explored the effect of breakfast and extracurricular tutoring on students' academic performance by using multiple linear regression methods. The Shapley Value Decomposition method was adopted to compare the relatively contributory rate of breakfast and extracurricular tutoring to students' academic performance.

Through the empirical study, we found that first of all, breakfast and extracurricular tutoring have a significant positive impact on elementary and middle school students' academic performance. Besides, students eating breakfast every day had a significantly higher score than those who ate breakfast irregularly. For each additional day of eating breakfast for a week, the student's score would be increased by 12-14 points. Taking part in extracurricular tutoring also helped students to improve their scores, but the explanatory power of the breakfast in students' academic performance was greater than that of extracurricular tutoring.

Based on these findings, we strongly suggest that parents should pay more attention to the role of breakfast and be rational to extracurricular tutoring. As the elementary education stage is a crucial period for students' physical and mental develop-

ment, it is crucial to ensure that children can get sufficient nutrient supply. In addition to providing breakfast for children, parents should also try to make children cultivate their healthy habits of eating breakfast regularly and ensure adequate rest to avoid sleep-deprivation associated missing of breakfast. Meanwhile, our research also shows that extracurricular tutoring is positively related to students' performance, but its impact is not as significant as that of eating breakfast. In combination with some other studies showing that high frequency of tutoring was negatively correlated with the scores (Tang & Fu, 2007) suggest that parents should use tutoring rationally. A more efficient and balanced family education strategy should be adopted accordingly with the actual situation of the family and their children.

On the other hand, the government and schools should allocate more resources to promote students' academic progress and reach fair educational outcomes. The results of this study show that extracurricular tutoring can help students to improve their academic performance. However, the cost of extracurricular tutoring is high. In order to minimize the educational inequality brought about by family's different background, the government may consider to provide appropriate resources of extracurricular tutoring to disadvantaged families in the form of preferential or subsidy to maximize the development of those with less resources. At the same time, given the significant role of breakfast in promoting students' performance, the importance of eating breakfast should be popularized by the governments and schools. For the school, they can strengthen students' healthy lifestyle education, and also preach the importance of breakfast and nutritional balance to parents. For the governments, they can increase the welfare subsidies for disadvantaged families and ensure the quality of breakfast they have to leverage the fairness of educational outcomes with limited funding.

References

- Cooper, S. B., Bandelow, S., & Nevill, M. E. (2011). Breakfast consumption and cognitive function in adolescent schoolchildren. *Physiol Behav*, 103(5):431-439.
- Fang, C. C. (2018). An Empirical Study of the Effects of Breakfast on Students' Achievements. *J Shanghai Edu Res*, 375(08):15-18.
- Fang, C. C., & Xue, H.P. (2014). An empirical study of the influence of tutoring on students' performance in compulsory education. *J Shanghai Edu Res*, (12): 5-9.
- Frisvold, D. E. (2015). Nutrition and cognitive achievement: An evaluation of the school breakfast program. *J Public Econ*, (124): 91-104.
- Hau, K. T. (2016). Have breakfast rather than wasting money on tutorial. *EdData Speaks*, No.2. EdDataX Research Centre.
- Ho, C. Y., Huang, Y. C., Lo, Y. T. C., Wahlqvist, M. L. , & Lee, M. S. (2015). Breakfast is associated with the metabolic syndrome and school performance among

- taiwanese children. *Research in developmental disabilities*, 43-44, 179-188.
- Hu, Y. M., Fan, W. F., & Ding, W. L. (2015). Does shadow education aggravate inequality of educational outcomes? An empirical study on PISA 2012 shanghai data. *Peking Univ Edu Rev*, 13(03):29-46+188.
- Kang, Y. W., & Park, J. H. (2016). Does skipping breakfast and being overweight influence academic achievement among korean adolescents? *Osong Public Health Res Perspect*, 7(4):220-227.
- Kleiman-Weiner, M., Luo, R., Zhang, L., Shi, Y., Medina, A., & Rozelle, S. (2013). Eggs versus chewable vitamins: which intervention can increase nutrition and test scores in rural China? *Chin Econ Rev*, 24:165-176.
- Le, Z. Q., & Du, Y. H. (2018). The influence of family backgrounds on the students' behavior choices of the private tutoring. *Res Edu Dev*, 38(10), 7-14.
- Li, C. L. (2005). Prestige stratification in the contemporary china: Occupational prestige measures and socio-economic index. *Soc Stud*, (02):74-102+244.
- Li, J. L., & He, R. Z. (2019). Family education, time investment, economic investment and youth development: social capital, cultural capital and the interpretation of shadow education. *Chin Youth Res*, (08):97-105.
- Li, J. L. (2018). The effect of private tutoring on the academic achievement of students from western rural area in china? Fixed effect analysis based on panel data. *J Sch Studies*, 15(01): 90-98.
- Li, J. L., Hu, Y. M., & Fan, W. F. (2016). Family background, shadow education and student achievement: Based on empirical research of Wisconsin model. *Chin Econ Edu Rev*, 1(01): 70-89.
- Li, Z. L., & Qiu, Z. Q. (2016). Family background and children's academic performance: Evidence from the compulsory education in China. *Socio Stud*, 31 (04): 121-144.
- Lien, L. (2007). Is breakfast consumption related to mental distress and academic performance in adolescents? *Public Health Nutri*, 10(04):422-428.
- Liu, T. X., & Wang, Q. (2018). Private tutoring and student's educational attainment: Evidence from secondary school in China. *China Edu Econ Rev*, 3(05):70-94.
- Lu, X. Y. (2002). Analysis of the top ten classes in contemporary Chinese society. *Stu Pract*, (3): 55-63.
- Mark, B., & Liu, J. Y. (2015). Conducting Research into Private Supplementary Tutoring: Methods and Approaches. *Peking Univ Edu Rev*, 13(03): 2-16.
- O'Sullivan, T., Robinson, M., Kendall, G., Miller, M., Jacoby, P., Silburn, S., & Oddy, W. (2009). A good-quality breakfast is associated with better mental health in adolescence. *Public Health Nutr*, 12(2):249-258.
- Peng, P., & Zhou, Z. B. (2008). Study on tutoring in urban compulsory education—Based on sample survey of h district, Wuhan city, Hubei Province. *Prim Seco Sch Man* (4), 22-25.
- Qu, Y., & Xue, H. P. (2015). Research on private cost of extracurricular tutoring in compulsory education in China. *J Shanghai Edu Res*, (04):21-26.
- Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metzler, J. D. (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *J Am Diet Association*, 105(5), 743-760.
- Sampasa-Kanyinga, H., & Hamilton, H. A. (2017). Eating breakfast regularly is related to higher school connectedness and academic performance in Canadian middle- and high-school students. *Public Health*, 145: 120-123.
- Shorrocks, A. F. (1982). Inequality decomposition by factor components. *Econometrica*, 50 (1):193-211.
- Sniltstveit, B., Stevenson, J., Phillips, D., Vojtkova, M., Gallagher, E., Schmidt, T., Jobse, H., Geelen, M., Pastorello, M., & Eyers, J. (2015). Interventions for improving learning outcomes and access to education in low- and middle- income countries: a systematic review, *3ie Systematic*

- Review 24. London: International Initiative for Impact Evaluation (3ie).69-97.
- Sun, J.,&Yin, J. S. (1994). The impact of breakfast quality on classroom teaching effectiveness. *Chin J Sch Health*, (06): 447-447.
- Sun, L. X., & Tang, J. J. (2019). The effectiveness of private tutoring: an estimation based on China education panel survey. *Peking Univ Edu Rev*, 17(01): 123-141+191.
- Tang, L. C., & Fu, L. J. (2007). An empirical study on the relationship between academic burden and academic achievement. *J Shanghai Edu Res*, (12): 32-36.
- Wang, J. J. (2005). Family education and school education: a vicious circle that cannot be achieved. *J Sch Stu Res*, (10): 8-9.
- Widenhorn-Müller, K., Hille, K., Klenk, J.,&Weiland, U.(2008).Influence of having breakfast on cognitive performance and mood in 13- to 20-year-old high school students: Results of a crossover trial. *pediatrics*, 122(2): 279-284.
- Wooldridge,J.M. (2009).Introductory econometrics: A modern approach (4th edition). South-Western Cengage Learn.
- Xu, H. Q., Hu, X. Q., Zhang, Q., Li, L., Zhang, F., & Pan, H., Ma, G.S. (2014). Analysis of the correlation between breakfast frequency and students' scores in poor areas. *Chin J Sch Health*, 35(12):1788-1790.
- Xue, H. P. (2016). Extracurricular tutoring, student achievements and social reproduction. *Edu Econ*, (02):32-43.
- Xue, H. P. (2017). Family capital and education acquisition: A Perspective of shadow education. *Edu Sci Res*, (02):31-41+48.
- Xue, H. P., & Ding, X. H. (2009). A study on additional instruction for students in cities and towns in China. *Edu Res*, (01): 41-48.
- Xue, H. P., Wang, D., & Wu, X. W. (2014). The impact of private tutoring on left-behind students' academic achievements in Chinese compulsory education. *Peking Unive Edu Rev*, 12(3):50-62.
- Yang, Q. L. (2004). On the necessity of "tutorship" reform and its selection strategy—re-discussion on the issue of "tutorship" in practice. *Cont Edu Sci*, (21):8-11.
- Yao, J. J. (2008). On the comprehensive measuring of educational balancing development: Principles and methods. *Edu Sci*, 03: 5-8.
- Yao, J. J., Liu, Y. L., & Zhou, S. K. (2019). Effect of eating breakfast on cognitive development of elementary and middle school students: An empirical study using large-scale provincial survey data. *Med Sci Monit*, 25: 8843-8853.
- Zhang, Y. (2013). Does private tutoring improve students' national college entrance exam performance? A case study from Jinnan, China. *Econ Edu Rev*, 32:1-28.
- Zhejiang News. (2017). Students who regularly eat breakfast every day have generally good academic performance [EB/OL].http://zjnews.zjol.com.cn/zjnews/hznews/201705/t20170523_4029557.shtml.

Received: 04 January 2020

Revised: 10 January 2020

Accepted: 03 February 2020

Note to Contributors

Science Insights Education Frontiers (SIEF) is published under the auspices of the Bonoï Academy of Science and Education to provide authoritative, critical surveys on the current status of subjects and problems in the diverse fields of education.

We accept manuscripts on every aspects of education. We only accept four types of manuscript: Editorial, Short Communication, Article, and Review. Editorial is an invited perspective written by our editors. Review is solicited and welcomed from the experts in corresponding research fields. All manuscripts should be submitted [online](http://scineer.bonoi.org/basicpage/submission) (<http://scineer.bonoi.org/basicpage/submission>) or E-mail to executive.editor.scineer@bonoi.org. In addition, the following suggestions may serve as a general guide.

Authors should note that they are writing for an international audience. National colloquialisms and idiomatic use of language should be avoided to the extent possible. Word choices and sentence constructions that might imply bias against persons on the basis of gender, racial or ethnic group membership, disability, sexual orientation, or age should be avoided.

Manuscripts are accepted for publication subject to copyediting. Manuscript submission indicates the author's commitment to publish in *SIEF* and to give *SIEF* first publication rights. No paper known to be under consideration by another journal will be reviewed.

Judicious selection of references is an important function of the authors. Cited references should be listed alphabetically according to author, and the author's last name and publication year should be used in the text. The full title of each paper should be given. Each citation should be checked with the original publication to avoid embarrassing errors. The system used in the Chemical Abstracts for abbreviations of journal names should be followed.

The length of a paper is no measure of its quality, and it is only the latter that determines acceptability for publication. However, practical considerations make it desirable to set a provisional limit of 10,000 words of the main text that does not include tables, figures, and references; and at least 1,000 words for each accepted paper should have for the main text.

The acceptability of a manuscript cannot, of course, be finally decided until the finished product has been examined. The acceptance is contingent upon the advice of the Editor-in-Chief of the *SIEF*.

Correspondence relating to editorial matters should be addressed to the editorial office via online contact form.

(In writing to advertisers, please mention the journal – it helps.)



Science Insights Education Frontiers

pISSN 2644-058X

eISSN 2578-9813

<http://www.scineer.bonoi.org/>

ORDER FORM

Start my 2020 print copy subscription to the journal of
Science Insights Education Frontiers
pISSN 2644-058X, eISSN 2578-9813

_____ \$105.00 Author Individual _____
_____ \$375.00 Non-author Individual _____
_____ \$1480.00 Institution _____

Sales Tax: 5.75% _____

TOTAL AMOUNT DUE: \$ _____

Subscription orders must be prepaid. Subscriptions are on a calendar year basis only. Allow 4-6 weeks for delivery of the first issue. We use the same subscription rate internationally.

SEND THIS ORDER FORM TO (*Hard copy only*)

Science Insights Education Frontiers

Insights Publisher

Subscriptions

7020 Kenbridge Dr.

Clemmons, NC 27012

Call +1 336-528-4762

Email: base.publication@basehq.org (*Send E-copy*)

Website: <http://scineer.bonoi.org/basicpage/subscription>

Check enclosed (Make Payable to BASE)

Charge me: Visa MasterCard
 American Express UnionPay

Cardholder Name _____

Card No. _____

Exp. Date _____

Signature (*Required for Charge*)

Billing Address

Street _____

City _____

State/Province _____

Zip _____ Daytime Phone _____

Email: _____

Mail To

Name _____

Address _____

City _____

State/Province _____

Zip _____

Country _____

SIEF20

(You can make a copy of this form)



Science Insights Education Frontiers

Vol. 5, No. 1, 2020

pISSN: 2644-058X

eISSN: 2578-9813

DOI: 10.15354/sief

Science Insights Education Frontiers

Vol.5, No. 1, 2020

Insights Publisher